LEARNING STYLES, SUBJECT MATTER, AND EFFECTIVENESS IN UNDERGRADUATE DISTANCE EDUCATION

by

Darren C. Wu

Liberty University

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

Doctor of Education

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ABSTRACT

Are potential relationships among students' learning styles and effectiveness in online education moderated by subject matter for undergraduate students at a private higher education institution? This causal relationship correlational study evaluated the effects of subject matter as a moderating variable between students learning styles and effectiveness of distance education (DE). Students in online English courses and online math courses at a private university located in the southeastern United States completed the Index of Learning Styles (ILS) instrument and an end of course satisfaction survey. Tests for homogeneity determined that the two comparison groups (English and math) were comparable since only one out of 11 variables analyzed had a statistically significant difference. Eight null hypotheses were evaluated for each of the four dimensions of the ILS and achievement or satisfaction. The null hypotheses were retained for seven of the eight null hypotheses. Subject matter did not appear to be a moderating variable for these seven relationships. However, the eighth null hypothesis was rejected. The correlation between the ILS measure of sequential/global learning style and student satisfaction for students completing an English course differed significantly from that of students completing a math course. There was a high correlation in the English group between the sequential/global dimension of the ILS and course satisfaction. DE course designers of English courses should take extra precautions to present material in logical or sequential steps.

Keywords: distance education, learning styles, subject matter, achievement, satisfaction, Index of Learning Styles

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List of Abbreviations

Abstract Conceptualization Abilities (AC)

Active Experimentation (AE)

Analysis of Variance (ANOVA)

Approaches and Study Skills Inventory for Students (ASSIST)

Canfield Learning Styles Inventory (CLSI)

Christian University (CU)

Cognitive or Learning Styles (CLS)

Cognitive Style Index (CSI)

Concrete Experience Abilities (CE)

Distance Education (DE)

Grade Point Average (GPA)

Group Embedded Figures Test (GEFT)

Higher Education Institution (HEI)

Index of Learning Styles (ILS)

Individual Development & Educational Assessment (IDEA)

Information Technology (IT)

Institutional Review Board (IRB)

Learning Style Inventory (LSI)

Learning Styles Question (LSQ)

Master of Business Administration (MBA)

Myers-Brigg Type Indicator (MBTI)

New International Version (NIV)

Partial Least Squares (PLS)

Reflective Observation Abilities (RO)

Scholastic Aptitude Test (SAT)

Statistical Package for the Social Sciences (SPSS)

Visual, Auditory, Read/write, and Kinesthetic (VARK)

CHAPTER ONE: INTRODUCTION

Over the last few decades, there has been an "intense interest" (Pashler, McDaniel, Rohrer, & Bjork, 2008, p. 106) in learning styles in education. This construct has been tremendously popular both academically and commercially, which has resulted in controversy and contradictory results. With the simultaneous explosive growth of distance education (DE), the body of literature pertaining to learning styles and DE has also continued to grow. Similar to the general learning styles literature, this has resulted in controversy and contradiction. Additionally, most of the literature and current paradigm explored the "meshing hypothesis" (Pashler et al., 2008, p. 108) theory of learning styles, which neglected the effects of subject matter (Coffield, Moseley, Hall, & Ecclestone, 2004). More research is needed to resolve these contradictions and controversies and to address the existing gap concerning the subject matter. Consequently, the purpose of this current study was to provide empirical evidence concerning the effects of subject matter as a moderating variable between students' learning styles and effectiveness of DE. Instruction should be matched to subject matter rather than individual student learning styles, as advocated by the meshing hypothesis and the reoccurring themes and strategies of existing studies. These problems and the purpose of this study resulted in the research question, hypotheses, and variables subsequently discussed in detail in this chapter. Additionally, this chapter will provide definitions pertinent in framing all discussions of this current study.

Background

The following background presents an overview concerning learning styles and distance education. This background includes details concerning the popularity of learning styles in

research and commercial arenas. The explosive growth of distance education will be introduced. These movements inevitably resulted in the convergence of learning styles and distance education. However, the existing research has gaps that have warranted further exploration.

Popularity of Learning Styles

The popularity of learning styles as an area of research has been tremendous in the last few decades (Pashler et al., 2008). This interest has resulted in a large body of literature on learning styles. However, the literature is fraught with controversy. There are many aspects of the controversial nature of learning styles research. Philosophically, the controversy involves whether learning styles should be viewed as fixed or flexible. Coffield et al. (2004) wrote a literature review that identified 71 existing models of learning styles, evaluated in detail 13 of those models, and provided a theoretical framework to classify learning style models. Coffield et al.'s (2004) framework was a continuum based on how fixed or flexible learning styles were viewed. Coffield et al. (2004) grouped the identified models into the following five families in increasing order of flexibility: constitutionally based learning styles and preferences, cognitive structure, stable personality type, "flexible stable" (p. 12) learning preferences, and learning approaches and strategies. Theoretically, the controversy in learning styles involves whether or not the construct should be viewed as dynamic and can change for an individual over time (Maushak, Chen, Martin, Shaw, & Unfred, 2001). Pragmatically, learning styles are controversial because of the ever-expanding theoretical frameworks, instruments, and resulting commercialism of measurement instruments. All of these factors result in contradictory literature and debates concerning which frameworks or models are the best predictors of student

outcomes in education. One major implication is that sound research is still needed to resolve the contradictions and controversies of learning styles.

Explosive Growth of Distance Education

Almost simultaneous to the tremendous interest in learning styles, DE became a phenomenon in education. DE experienced explosive growth and involves an "estimated 12.153 million [post-secondary] students nationally" (Parsad & Lewis, 2008, p. 9). The popularity of DE in academic and corporate settings necessitates the need for study (Graham & Essex, 2001). Much early research focused on comparing DE against traditional education in what is known as the no significant difference phenomenon. Though challenged by some scholars as less successful based on failure rates (Rolfe, 2007), course grades (Edvardsson & Oskarsson, 2008), and a direct comparison of exams or tests (Bozkaya, 2001; Deka & McMurry, 2006), scholars have empirically demonstrated the no significant difference phenomenon (Glenn, 2001; Head, 2001; Hoban, Neu, & Castle, 2002; Spears et al., 2008).

Convergence of Learning Styles and Distance Education

Some scholars began exploring the convergence of learning styles and DE early (Brenner, 1997; Gee, 1990; Shih, Ingebritsen, Pleasants, Flickinger, & Brown, 1998), while other scholars (Battalio, 2009; Eom, Wen, & Ashill, 2006; Offir, Bezalel, & Barth, 2007; Manochehri, 2008; Shaw, 2012; Zacharis, 2010) did not contribute to the field until after the apparent legitimizing of DE through the consensus of the no significant difference phenomenon. The body of literature pertaining to learning styles and DE has continued to grow. Similar to the general learning styles literature, this has resulted in controversy and contradiction. Additionally, most of the literature and current paradigm explored the "meshing hypothesis"

(Pashler et al., 2008, p. 108) theory of learning styles. Many studies primarily advocated for either saturating courses (Bowen, 2006) or assessing and varying instruction to match individual learning styles (Buboltz, Wilkinson, Thomas, & Jenkins, 2001; Combs, 2001; Maushak et al., 2001; Rothenberger & Long, 2001; Walls, 2005), which has the same purpose as endorsing the meshing hypothesis. Consequently, there is an existing gap in the literature concerning the effects of subject matter as a moderating variable between students' learning styles and effectiveness of DE.

Going Beyond Existing Research

The following details the conceptual framework of this current study, which sought to extend the existing knowledge in this area by addressing the previously introduced research gap. There are very few studies (Brenner, 1997; Eom et al., 2006; Sahin, 2008) that utilized multiple courses in different disciplines when studying learning styles in DE. Very few studies even consider subject matter in discussions as Shaw (2012) considered, and no studies have been designed to specifically evaluate course context or subject matter as a moderating variable between students' learning styles and effectiveness of DE. This research topic is "frequently neglected" (Coffield et al., 2004, p. 122), which is disappointing considering that "optimal instructional method is likely to vary across disciplines" (Pashler et al., 2008, p. 116). This current study addressed this research gap and is grounded in previous quasi-experimental or correlational studies in the following manner. Many existing studies (Battalio, 2009; Beaumaster & Long, 2002; Gee, 1990; Offir et al., 2007; Rothenberger & Long, 2001; Shih et al., 1998; Spears et al., 2008; Zacharis, 2010) utilized achievement as a criterion variable. Other studies (Drago & Wagner, 2004; Miller, 1997; Manochehri, 2008; Yunfei & Simpson, 2002) utilized

satisfaction as a criterion variable. Identical to this current study, previous research (Cook, Gelula, Dupras, & Schwartz, 2007; Shaw, 2012) also used a combination of achievement and satisfaction as criterion variables. Additionally, the selection of the measurement instrument for the predictor variables of this current study was based on the following pertinent literature.

Ultimately learning styles can be attributed to Daniel 1:4 (Willems, 2011); however, there are currently at least 71 models (Coffield et al., 2004) in a seemingly ever expanding field. This includes some key theorists and models such as the Group Embedded Figures Test (GEFT), Dunn and Dunn's (1979) model, Canfield Learning Styles Inventory (CLSI), Kolb's (1984) Learning Style Inventory (LSI), Learning Styles Question (LSQ), and Felder and Solomon's (n.d.a.) Index of Learning Styles (ILS). Papp (2001) recommended the ILS as the primary instrument because of its predictive value with learning outcomes. The ILS was classified in Coffield et al.'s (2004) "flexible stable" (p. 12) learning preferences family, which was one of two families of learning styles recommended by these scholars. This instrument was appropriate for the DE context (Battalio, 2009). Additionally, there were indicators that the ILS has resulted in higher completion rates than other learning styles instruments because of its clarity and brevity (Zywno, 2003).

Problem Statement

The background discussed has demonstrated that although some scholars (Beyth-Marom, Saporta, & Caspi, 2005; Brenner, 1997) have contended that there is a lack of research available on learning styles and DE, this is simply not the case. The problem is not the lack of research, but rather the extensive amount of literature that has resulted in the description of this field of study as "opaque, contradictory and controversial" (Coffield et al., 2004, p. 2). Coffield et al.'s

(2004) description of this field of study accurately described the general problem of this current study. The problem is that this area of study indeed remains complex and steeped in controversy with no consensus among scholars concerning research results or pedagogical implications (Coffield et al., 2004; Graf & Kinshuk, 2007; Hosford & Siders, 2010; Santo, 2006). The specific problem and focus of this current study was the following. In spite of the large volume of contradictory and controversial literature concerning learning styles and DE, there are currently few studies that do not pertain to matching or meshing instruction to learning style. There is also an existing research gap concerning the effects of subject matter as a moderating variable between students' learning styles and effectiveness of DE. The proposed study is empirically significant for the following reasons. Battalio (2009) discussed conflicting research results that still exist even within studies having to do with learning styles and outcomes. Edvardsson and Oskarsson (2008) argued that achievement issues concerning distance education have not been resolved, while Henry (2008) argued for exploring relationships among learning styles and satisfaction in order to improve pedagogy. Pashler et al. (2008) alleged that optimal instruction and curriculum vary by subject matter. Consequently, this current study is empirically significant in that it attempted to provide clarity to conflicting results concerning learning styles and achievement and satisfaction with a specific focus on subject matter as a moderating variable.

Purpose Statement

As these problems imply, the purpose of this correlational study was to evaluate the effects of subject matter as a moderating variable between students' learning styles and effectiveness of DE. This current non-experimental research study was approached from a

quantitative perspective. Specifically, this correlational study was a "causal relationship" (Gall, Gall, & Borg, 2006, p. 337) study. The predictor variables corresponding to the four dimensions of learning styles as measured by the ILS were compared to the criterion variables of student satisfaction as measured by end-of-course surveys and student achievement as measured by course grade for undergraduate students at a higher education institution (HEI). The pseudonym used for this HEI was Christian University (CU). The predictor variables of learning styles were defined as "the ways in which individuals interpret, process, understand, and integrate information" (Maushak et al., 2001, p. 126). The criterion variable of effectiveness was generally defined as student satisfaction or student achievement. Student satisfaction was generally defined as a student's perceived satisfaction with a particular CU undergraduate course based on portions of a questionnaire. Student achievement was generally defined as the student's quantifiable performance in the same CU undergraduate course. The moderating variable of subject matter was operationally defined as the two samples drawn from either a Math or English online course at CU. The resulting correlation coefficients determined by statistical analysis of the predictor and criterion variables were further analyzed to determine if subject matter is a moderating variable of learning styles and student achievement or satisfaction. Extraneous variables such as gender, age, SAT scores, high school GPA, and college GPA were controlled for statistically.

Significance of the Study

As the background, problem, and purpose discussions introduced, this current study is significant as it explores a minority paradigm that suggests instruction should be matched to subject matter rather than individual student learning styles, as advocated by the meshing

hypothesis and the reoccurring themes and strategies of existing studies. This study is important to the organization and population for the following reason. If subject matter is a moderating variable of learning styles and effectiveness, curriculum design could be accomplished with interventions developed to assist all learners based on subject matter rather than individuals. This would be easier and more cost effective to implement than varying instruction according to individual learning styles. Unfortunately, research has indicated that theorists frequently ignore subject matter (Coffield et al., 2004). Pashler et al. (2008) alleged that optimal instruction and curriculum should vary for different subject matter. This study could provide empirical evidence of Pashler et al.'s (2008) assertion. As previously discussed, this current study is also empirically significant in that it attempted to provide clarity to conflicting results concerning learning styles and achievement and satisfaction. Achievement issues concerning distance education have not been resolved (Edvardsson & Oskarsson, 2008). Relationships should be explored among learning styles and satisfaction in order to improve pedagogy (Henry, 2008). This current study addresses all these concerns.

Research Question

The previously discussed problems and purposes resulted in the following research question for this current correlational study. Are potential relationships among students' learning styles and effectiveness in online education moderated by subject matter for undergraduate students at a private higher education institution? The following null hypotheses are based upon this research question, the variables under study, and the specific ILS framework for learning styles selected.

Hypotheses

In order to evaluate subject matter as a moderating variable, evaluating whether there were significant differences between the correlation coefficients of the four dimensions of the ILS and achievement or satisfaction was critical. Consequently, null hypotheses were utilized for this current study, as they were consistent with the research question, instrumentation, and data analysis of the current study. The following are the eight null hypotheses of this study.

1. The correlation between the Index of Learning Styles measure of active/reflective learning style and student achievement (measured by course grade) for students completing an English course does not differ significantly from that of students completing a Math course.
2. The correlation between the Index of Learning Styles measure of sensing/intuitive learning style and student achievement (measured by course grade) for students completing an English course does not differ significantly from that of students completing a Math course.
3. The correlation between the Index of Learning Styles measure of visual/verbal learning style and student achievement (measured by course grade) for students completing an English course does not differ significantly from that of students completing a Math course.
4. The correlation between the Index of Learning Styles measure of sequential/global learning style and student achievement (measured by course grade) for students completing an English course does not differ significantly from that of students completing a Math course.

5. The correlation between the Index of Learning Styles measure of active/reflective learning style and student satisfaction (measured by end-of-course surveys) for students completing an English course does not differ significantly from that of students completing a Math course.
6. The correlation between the Index of Learning Styles measure of sensing/intuitive learning style and student satisfaction (measured by end-of-course surveys) for students completing an English course does not differ significantly from that of students completing a Math course.
7. The correlation between the Index of Learning Styles measure of visual/verbal learning style and student satisfaction (measured by end-of-course surveys) for students completing an English course does not differ significantly from that of students completing a Math course.
8. The correlation between the Index of Learning Styles measure of sequential/global learning style and student satisfaction (measured by end-of-course surveys) for students completing an English course does not differ significantly from that of students completing a Math course.

Identification of Variables

As these hypotheses have indicated, the following are the predictor variables of this current study. The four dimensions of Felder and Solomon's (n.d.a.) ILS were the predictor variables. The first dimension of the ILS is the active/reflective dimension. Active learners process information by working with it, while reflective learners prefer to think it through (Felder & Solomon, n.d.b.). The second dimension of the ILS is the sensing/intuitive dimension.

Sensing learners prefer facts, details, established procedures, and pragmatism (Felder & Solomon, n.d.b.). Intuitive learners perceive the world through relationships, possibilities, abstractions, and innovations (Felder & Solomon, n.d.b.). The third dimension of the ILS is the visual/verbal dimension. Verbal learners prefer to receive information in the written or spoken form, while visual learners prefer receiving information by their sight (Felder & Solomon, n.d.b.). The fourth dimension of the ILS is the sequential/global dimension. Sequential learners prefer logical steps while global learners understand the big picture (Felder & Solomon, n.d.b.).

The two criterion variables for this current causal relationship study were student achievement and student satisfaction. Researchers stressed that the first and central issue that must be evaluated is student achievement (Eaton, 2001; Schoenfeld-Tacher & McConnell, 2001). Student achievement was operationally defined as students' final course grades. Concerning student satisfaction, Eom et al. (2006) articulated that this variable is one of two outcomes "widely cited as measures of the effectiveness of online education systems" (p. 216). Student satisfaction was operationally defined as a student's satisfaction with the course content as measured by an end-of-course survey internally developed by the research site. Although there were survey questions associated with faculty responsiveness, communication, feedback, and encouragement in this measurement instrument, only data from the eight questions concerning course content was utilized in the data analysis, as this current study focused on subject matter as a potential moderating variable.

As indicated, subject matter was a potential moderating variable between students' learning styles (as indicated by the four dimensions of the ILS) and student achievement and student satisfaction. This current study utilized existing sections of two courses (Mathematics

for Liberal Arts and Composition and Rhetoric) available as online courses at the research site. Consequently, subject matter was operationally defined as either Math or English. The intentional use and design of this study with two different subject matters resulted in essentially two different samples, which needed to be "reasonably homogeneous" (Gall et al., 2006, p. 338). Extraneous variables such as participants' age, gender, SAT scores, high school GPA, and college GPA were statistically analyzed in this study.

Definitions

The following definitions were pertinent to this current study and assisted in providing the context for all discussions.

Distance Education (DE): Defined by Parsad and Lewis (2008) "as a formal education process in which the students and instructor are not in the same place" (p. 1). Synchronous DE was "(real-time) communication between the instructor and student" (Hillstock, 2005, p. 139) where asynchronous DE was defined as "happening with a time-delay" (Hillstock, 2005, p. 139).

Learning styles: "Researchers agree that learning styles represent the ways in which individuals interpret, process, understand, and integrate information" (Maushak et al., 2001, p. 126). Other scholars have included the aspect of an individual's preference, ease, or even best way of learning in their definitions. Honey and Mumford (1992) defined learning styles as "a description of the attitudes and behaviors which determine an individual's preferred way of learning" (as cited in Graf & Kinshuk, 2007, p. 309). Similarly, Nilson (2010) defined learning styles as "different ways people learn most easily" (p. 229) and Drago and Wagner (2004) defined learning styles as "differences that exist between individuals in how they best learn" (p. 1).

Matching Hypothesis: The “meshing hypothesis” (Pashler et al., 2008, p. 108) or matching hypothesis was defined as the theory that “instruction should be provided in the mode that matches the learner’s style” (Pashler et al., 2008, p. 108).

Moderating Variable: A construct that affects the strength or direction of the relationship between predictor and criterion variables by “enhancing, reducing, or changing the influence of the predictor” (Fairchild & MacKinnon, 2009, p. 4).

CHAPTER TWO: REVIEW OF THE LITERATURE

In the last few decades, learning styles have become a highly influential area of study (Pashler et al., 2008), comprised of a large body of research (Coffield et al., 2004). However, this area of study has remained complex and steeped in controversy with no consensus among scholars concerning research results or pedagogical implications (Coffield et al., 2004; Graf & Kinshuk, 2007; Santo, 2006). Many issues have contributed to the "opaque, contradictory and controversial" (Coffield et al., 2004, p. 2) nature of this field of study, such as fragmented research, the continuum nature of learning styles, a vast number of classification models, the potential dynamic nature of individual learning styles, the potential bias of sample populations, and the commercialism of measurement instruments. Additionally a single definition of learning styles does not exist (Beyth-Marom et al., 2005; Graf & Kinshuk, 2007; Santo, 2006). The implication is that sound research in learning styles is still warranted. Contextually, the need to study learning styles in light of the conception of distance education (DE) has become greater than ever.

DE has experienced continuous growth (Neely & Tucker, 2010) and global expansion (Eaton, 2004), and has been utilized by an enormous number of institutions and individuals. Scholars have claimed that DE is now "mainstream" (Sahin, 2008, p. 123), while others have suggested that it has replaced traditional education (Spears et al., 2008). DE appears to be an educational process that is not diminishing and "dynamic in nature with constant technological changes" (Buboltz et al., 2001, p. 41) in our world that has been flattened by technology (Friedman, 2007). Similar to learning styles, DE has a commercial aspect as "a multi-billion dollar enterprise and the fastest growing segment of the education market" (United States

Distance Learning Association, 2009, New Facts and Quotes of Attribution section, para. 1) involving two-thirds of degree-granting postsecondary institutions with an estimated 12.153 million students nationally (Parsad & Lewis, 2008, p. 9). The context of this current literature review and study was higher education. Graham and Essex (2001) contended that the popularity of DE in academic and corporate settings necessitied the need for study.

Fortunately, scholars began studying DE early after conception. Kerka's (1989) work, which was significant to this current study, was based on the theoretical framework that "communications technologies (CT)" (p. 2) could be a moderating variable that positively correlates instruction or motivation to learning. Much research has been focused on comparison of DE against traditional education in what is known as the no significant difference phenomenon. Though challenged by some scholars as less successful based on failure rates (Rolfe, 2007), course grades (Edvardsson & Oskarsson, 2008), or a direct comparison of exams or tests (Bozkaya, 2001; Deka & McMurry, 2006), scholars have empirically demonstrated the no significant difference phenomenon (Glenn, 2001; Head, 2001; Hoban et al., 2002; Spears et al., 2008). In fact, many studies reported a significant difference in performance in favor of DE (Jones, 1999; MacFarland, 2006; Magagula & Ngwenya, 2004; Schoenfeld-Tacher & McConnell, 2001). Additionally, a meta-analysis such as Shachar and Neumann's (2003) research covered the time period between1990 and 2002, demonstrating "that students engaged in DE academically outperform their F2F counterparts" (p. 13).

With the apparent legitimizing of DE through the consensus of the no significant difference phenomenon, scholars have focused attention on studying learning styles in the context of DE (Battalio, 2009; Beaumaster & Long, 2002; Eom et al., 2006; Offir et al., 2007;

Manochehri, 2008; Rothenberger & Long, 2001; Roy, 2006; Shaw, 2012; Zacharis, 2010), whether synchronous or asynchronous. Though some scholars began exploring the convergence of learning styles and DE early (Brenner, 1997; Gee, 1990; Shih et al., 1998), there is still criticism concerning the lack of research in this area (Beyth-Marom et al., 2005; Brenner, 1997). However, that is simply not the problem. The problem is that there is a large volume of research concerning learning styles and DE embedded in controversy and contradictions. Some contemporary scholars have challenged that there was little or no evidence to incorporate learning styles in education (Cook et al., 2007; Pashler et al., 2008). Fortunately, there is still scholarly interest in research involving learning styles and DE.

Although there is a large amount of literature in this area of study, most of the literature and current paradigm explored the "meshing hypothesis" (Pashler et al., 2008, p. 108) theory of learning styles that stated, "instruction should be provided in the mode that matches the learner's style" (Pashler et al., 2008, p. 108). Consequently, there is an existing research gap concerning the effects of subject matter as a moderating variable between students' learning styles and the effectiveness of DE. A moderating variable is one that affects the strength or direction of the relationship between predictor and criterion variables by "enhancing, reducing, or changing the influence of the predictor" (Fairchild & MacKinnon, 2009, p. 4). The purpose of this current study was to address this specific research gap. With the tremendous growth of DE and the infusion of learning styles in this context, responsible education professionals must critically evaluate whether learning styles should be considered and how they should be considered in relation to DE.

The current literature review has provided a theoretical framework for this current study, including the theoretical framework of learning styles, the meshing hypothesis, and the specific conceptual framework of this current study. This literature review also details how the current study was grounded in the existing quantitative studies that evaluated learning styles and achievement or satisfaction (or a combination thereof) in DE. This literature review also introduces the methodological basis upon which the current study was grounded. However, in contrast to the existing body of research recommendations which primarily advocated for either matching or saturating learning styles as implications for pedagogy (Coffield et al., 2004), this current study is significant as it explored a minority paradigm that suggested instruction should be matched to subject matter rather than individual student learning styles in order to maximize the effectiveness of DE.

Theoretical Framework

As introduced, this literature review presented the theoretical framework of learning styles, the meshing hypothesis, and the specific conceptual framework of this current study. The following theoretical framework for learning styles will discuss the origins of this field of study, key theorists and models, and evaluative work. Both the origins and key theorists and models validated Coffield et al.'s (2004) description concerning the results of the existing body of research as "fragmentation, with little cumulative knowledge and cooperative research" (p. 1).

Learning Styles

As previously defined, "learning styles represent the ways in which individuals interpret, process, understand, and integrate information" (Maushak et al., 2001, p. 126). Other scholars included the aspect of an individual's preference, ease, or even best way of learning in their

definitions (Drago & Wagner, 2004; Honey & Mumford, 1982; Nilson, 2010). The diversity in how this construct is defined is likely a result of the equally diverse fields of study including psychology, sociology, business, and education, which have explored this construct.

Origin. As definitions for learning styles and fields of study are diverse, there are also fragmented and conflicting accounts concerning the origin of learning styles. Pashler et al. (2008) traced the contemporary origin of learning styles to "the psychiatrist and psychoanalyst C.G. Jung (1964)" (p. 107) and the associated Myers-Brigg Type Indicator (MBTI) test, which began to be popular in the 1940s (Pashler et al., 2008). However, Buboltz et al. (2001) attributed the origin of learning or cognitive styles to Allport (1937). There are even conflicting accounts concerning the ultimate origin of learning styles. Attributed to the second century A.D. ancient Greek scholar Hippocrates, the four humors doctrine was further developed by Galen (Nutton, 2005). This was the origin of the original temperament, trait, or type theory of learning styles. Other scholars attributed the author of Daniel 1:4 (NIV) as the ultimate origin of learning styles, dating from approximately the sixth century B.C. (Willems, 2011).

Key theorists and models. In addition to the MBTI model, there are numerous other learning style models. The following are some key theorists and models of learning styles that have proliferated contemporary literature. These models were some of the earliest and most popular learning style models discovered during this literature review. One of the earliest models was the GEFT developed by Witkin, Oltman, Raskin, & Karp (1971). The GEFT determined if an individual was field-dependent or field-independent.

> …field-dependent learners tend to approach a problem in a more global way, are socially oriented, prefer collaboration, and are extrinsically motivated. In contrast, field-

> independent learners tend to approach a problem more analytically, rely on self-structured situations, prefer competition, and are intrinsically motivated. (Shih et al., 1998, p. 359)

Dunn and Dunn (1979) also had a model based on environmental, emotional, sociological, and physical elements. The environmental elements referred to the physical environment, such as noise, lighting, and temperature (Dunn & Dunn, 1979). The emotional elements referred to motivation factors (Dunn & Dunn, 1979). The sociological elements referred to whether students preferred to work independently, as a group, or a combination of the two (Dunn & Dunn, 1979). The physical elements referred to the preference of intake, which were categorized as visual, auditory, tactile, or kinesthetic (Dunn & Dunn, 1979). In an apparent follow-up model, Fleming and Mills' (1992) were attributed with the visual, auditory, read/write, and kinesthetic (VARK) model of learning styles, which were based on this "preferred physical sense involved in learning" (Nilson, 2010, p. 232).

Another early learning style model was the Canfield Learning Styles Inventory (CLSI) developed by Canfield in 1980. Canfield (1980) grouped learners into nine categories: "social…independent…applied…conceptual…neutral preference… social/applied…social/conceptual…independent/applied… independent/conceptual" (as cited in Gee, 1990, p. 5). These categories primarily dealt with the sociological preferences of learners.

Another learning style model dealing with learning preferences and one of the more frequently utilized models was Kolb's (1984) LSI. This model was actually developed in the early 1970s (Coffield et al., 2004). Kolb (1984) discussed the framework of this model in terms of the experiential learning epistemology founded in Lewin, Dewey, and Piaget. Kolb's (1984)

model presented the learning process as cyclical, evolving from "four different kinds of abilities—*concrete experience* abilities (CE), *reflective observation* abilities (RO), *abstract conceptualization* abilities (AC), *and active experimentation* (AE) abilities" (p. 30). Kolb (1984) subsequently categorized learners as accommodators, divergers, convergers, or assimilators. Based on Kolb's (1984) work, Honey and Mumford (1982) developed the LSQ due to issues with face validity (Coffield et al., 2004, p. 72). Similar to Kolb's (1984) model, the LSQ categorized learners as pragmatists, theorists, reflectors, or activists (Honey & Mumford, 1982).

Felder and Solomon's (n.d.) ILS, which was derived from Felder and Silverman's (1988) work with engineering students (Nilson, 2010), was another popular learning style model. The ILS was based on how information was processed, received, perceived, or understood (Hosford & Siders, 2010; Nilson, 2010). According to this model, information is processed either actively or reflectively (Hosford & Siders, 2010; Nilson, 2010). Learners have preferences receiving information either verbally or visually (Hosford & Siders, 2010; Nilson, 2010). Regarding perception, learners favor either sensing or intuition (Hosford & Siders, 2010; Nilson, 2010). Information is understood either from a sequential or global perspective (Hosford & Siders, 2010; Nilson, 2010). The ILS results were presented on four bi-polar scales consisting of positive odd numbers from one to 11 and corresponding to the previously summarized dimensions. Numerous scholars have used the following specific procedure in their studies. The bi-polar scales of the ILS were commonly re-coded to corresponding positive and negative odd numbers (Cook et al., 2007; Henry, 2008; Van Zwanenberg et al., 2000; Zywno, 2003). The validity and reliability of the ILS has been supported in certain contexts (Cook, 2005; Hosford &

Siders, 2010). Additionally, Felder and Spurlin (2005) argued for the validity and reliability of the ILS.

The previously discussed models and key theorists are only some of the ever-expanding models of learning styles. In fact, Coffield et al. (2004) already identified 71 different models in their milestone work. Maushak et al. (2001) astutely warned that different instruments and schema "complicate the comparisons of the resulting data" (p. 123). Consequently, with the ever-expanding body of fragmented literature and sometimes overlapping contradictory frameworks and instruments for learning styles, critically evaluating and comparing the numerous learning style models to determine their appropriate use in education is critical. The following are two significant scholarly attempts to accomplish this difficult, if not impossible, task.

Evaluative work. Papp's (2001) study was very relevant to this current study. Papp (2001) compared five learning style inventories in order to determine which model was most suitable for predicting student readiness for distance education. Papp (2001) compared the LSI, Approaches and Study Skills Inventory for Students (ASSIST), ILS, LSQ, and "the Academic Self-Efficacy Scale (Eachus, 1993)" (p. 17). The majority of these models have been discussed as key models of learning styles. However, Tait and Entwistle's (1996) ASSIST model required a brief introduction as it was highly recommended by Coffield et al. (2004). ASSIST was based on approaches to learning which can either be deep, surface, or strategic (Coffield et al., 2004). Of the five models that Papp (2001) compared, Felder and Solomon's (n.d.) ILS and Kolb's (1984) LSI were reported to be the two best predictors of learning outcomes. Unfortunately, a

significant weakness of Papp (2001) was the poorly specified method of analysis and the small sample size from which the results were based.

Fortunately, Coffield et al.'s (2004) subsequent work allowed for some conclusions to be drawn concerning comparison of multiple models of learning styles. Coffield et al.'s (2004) work was perhaps one of the most significant works pertinent to this current study. Coffield et al. (2004) put forth a literature review that identified 71 existing models of learning styles, evaluated in detail 13 of those models, and provided a theoretical framework to classify learning style models. In their evaluation of learning styles, Coffield et al. (2004) focused extensively on reliability and validity issues. Although not evaluated, the GEFT and ILS were listed and categorized by Coffield et al. (2004) according to their subsequently discussed continuum. Of the models already introduced in this current literature review, the following models were specifically evaluated and compared in Coffield et al.'s (2004) work: Dunn and Dunn (1979), ASSIST, LSQ, LSI, and the MBTI. As seen, the LSI, ASSIST, and LSQ overlapped in Papp's (2001) and Coffield et al.'s (2004) work. Of all 13 models evaluated, Coffield et al. (2004) recommended Allinson and Hayes' (1996) Cognitive Style Index (CSI) as the "best psychometric credentials" (p. 139) based on internal consistency, test-retest reliability, construct validity, and predictive validity, and deemed it "a suitable research instrument for studying educational management" (p. 139). Coffield et al. (2004) also recommend ASSIST as potentially useful in higher education as "an important aid for course, curriculum and assessment design" (p. 139). Among other models, Coffield et al. (2004) recommended discontinuing use of Dunn and Dunn (1979), LSI, and LSQ. Hence, the contradiction in this field of study is evident

again as Papp (2001) recommended the use of the LSI and stated the ASSIST model was not one of the best predictors of learning outcomes in DE.

Fortunately, Coffield et al.'s (2004) theoretical framework to classify learning style models as a continuum allowed some conclusions to be drawn in spite of the contradicting evaluative work concerning learning styles. Coffield et al.'s (2004) continuum was based on how flexible and changing learning styles are viewed. Coffield et al. (2004) identified the following five families of learning style models: constitutionally-based learning styles and preferences, cognitive structure, stable personality type, "flexible stable" (p. 12) learning preferences, and learning approaches and strategies. Coffield et al. (2004) was critical of models in the constitutionally-based learning styles and preferences, which viewed learning styles as fixed and unchanging. Their recommended learning style instruments were found in the last two families of learning styles, which have been deemed more flexible. The ASSIST was in the learning approaches and strategies family (Coffield et al., 2004). The CSI and ILS were in the "flexible stable" (Coffield et al., 2004, p. 12) learning preferences family.

Meshing Hypothesis

Although there are numerous learning style models with sometimes overlapping and sometimes contradictory frameworks and instruments, "the most common" (Pashler et al., 2008, p. 105) hypothesis or "one of the most common recommendations" (Coffield et al., 2004, p. 122) in research that utilized these models was the previously defined meshing hypothesis (Pashler et al., 2008). This appears to be the case with the current literature review in the context of learning styles and DE (Battalio, 2009; Buboltz et al., 2001; Combs, 2001; Gee, 1990; Maushak et al., 2001; Rothenberger, & Long, 2001; Walls, 2005).

However, this meshing hypothesis was strongly contradicted by some contemporary scholars (Coffield et al., 2004; Pashler et al., 2008).

> The one implication for practice which is repeated throughout the literature on learning styles is that it is the responsibility of teachers, tutors and managers to adapt their teaching style to accommodate the learning style of their students or staff members. But such an unqualified exhortation is both unhelpful and unrealistic…Despite the strong convictions with which these ideas are promoted, we failed to find a substantial body of empirical evidence that such strategies have been tried and found successful. Advice of this type strikes practitioners as unworkable and so it tends to remain untested. (Coffield et al., 2004, p. 126)

Coffield et al. (2004) based this criticism on conflicting research, complexity of interactions between other constructs, complexity of the construct of learning, and the fact that the meshing hypothesis was pragmatically unrealistic.

Pashler et al. (2008) also contended there was no empirical basis for this hypothesis. However, their criticism was primarily based on the lack of "methodologically sound studies" (Pashler et al., 2008, p. 105) that supported the hypothesis. Pashler et al. (2008) essentially presented that causation had to be demonstrated by an experimental research design. Specifically, it required a "crossover interaction" (Pashler et al., 2008, p. 109) research design that needed to include the following criteria. Students needed to be divided into multiple groups based on learning styles (Pashler et al., 2008). Subjects must be assigned randomly to at least two learning methods and be given the same test of achievement (Pashler et al., 2008). The experiment must show a difference in test results between the learning method of one learning

style group compared to the other learning style group or groups (Pashler et al., 2008). Pashler et al.'s (2008) literature review in this framework only reported one study (Sternberg, Grigorenko, Ferrari, & Clinkenbeard, 1999), which offered only "tenuous evidence" (Pashler et al., 2008, p. 112) that supported the meshing hypothesis. However, Pashler et al. (2008) reported three studies (Cook, Thompson, Thomas, & Thomas, 2009; Constantinidou & Baker, 2002; Massa & Mayer, 2006) that contradicted the meshing hypothesis that had strong methodology. This current literature review added Cook et al. (2007) as another study with strong methodology that contradicted the meshing hypothesis.

Cook et al. (2007) used experimental research methodology with "a randomized, controlled, post-test only trial using a factorial design" (p. 899). One of Cook et al.'s (2007) independent variables was matched or mismatched learning styles. The dependent variables of Cook et al.'s (2007) study were course outcomes and course satisfaction (Cook et al., 2007). The population was medical students at two different medical schools in the United States, and the context was web-based courses (Cook et al., 2007). The specific learning styles instrument and framework was Felder and Solomon's (n.d.) ILS (Cook et al., 2007). Course satisfaction was determined by a survey given to students at the end of the course (Cook et al., 2007). Cook et al. (2007) reported that "the difference in course ratings between matched (8.0 ± 0.2) and mismatched (7.5 ± 0.3) learners was not significant (P ¼ 0.16)" (p. 901), and concluded that "findings suggest that adaptations based on CLSs [learners' cognitive or learning styles] may be less useful than previously thought" (p. 904).

Conceptual Framework of Current Study

The previous discussions concerning the theoretical framework of the meshing hypothesis and learning styles illustrated that there is an existing research gap. There are few studies of learning styles and DE that do not pertain to matching or meshing instruction to learning styles. Additionally, the literature reviews of Coffield et al. (2004) and Pashler et al. (2008) provided a specific concept in need of further exploration. Coffield et al. (2004) stated, "We would add another factor which is frequently neglected by the learning theorists: subject matter" (p. 122). Pashler et al. (2008) expanded on this criticism as follows:

> An obvious point is that the optimal instructional method is likely to vary across disciplines. For instance, the optimal curriculum for a writing course probably includes a heavy verbal emphasis, whereas the most efficient and effective method of teaching geometry obviously requires visual–spatial materials. Of course, identifying the optimal approach for each discipline is an empirical question, and we espouse research using strong research methods to identify the optimal approach for each kind of subject matter. (p. 116)

Consequently, Coffield et al. (2004) and Pashler et al. (2008) provided the conceptual framework of this current study concerning the research gap and whether instruction should be matched to subject matter rather than individual student learning styles. Specifically, this current study attempted to address whether subject matter was a moderating variable between students' learning styles and effectiveness of DE. For studies that reported no correlation between learning styles and satisfaction, perhaps the results would have been different had subject matter been explored as a moderating variable. For studies that reported a correlation between learning

styles and achievement or satisfaction, perhaps subject matter was a moderating, mediating, or intervening variable of that relationship.

There are likely many reasons that this research gap still exists in spite of the enormous size of the literature on learning styles. However, convenience sampling where "the researcher selects a sample that suits the purposes of the study and that is convenient" (Gall et al., 2006, p. 175) is one probable explanation for the existing research gap. Many researchers did not have the experience or access to multiple fields of discipline and the multiple subjects that would be necessary to address this research gap. As this literature review has illustrated, most research in this area was conducted with convenience sampling of learners in one course of study in a particular discipline.

Existing Research Recommendations

If scholars explored this existing research gap, perhaps there would be more clarity and consensus rather than the status quo as articulated by Coffield et al. (2004): "After more than 30 years of research, no consensus has been reached about the most effective instrument for measuring learning styles and no agreement about the most appropriate pedagogical interventions" (p. 138). Santo's (2006) conclusions aligned with Coffield et al.'s (2004) criticisms. Santo (2006) developed a literature review of learning styles and DE. Santo (2006) evaluated whether learning styles were related to "student success" (p. 74), including the criterion variables of achievement and satisfaction. Santo (2006) discussed several learning styles models including the LSI, GEFT, MBTI, ILS, and LSQ. Santo (2006) concluded that the construct of learning styles was "vague" (p. 85). Instruments tended to be self-assessments with low reliability and validity, results of studies were conflicting, and these issues became even

more complicated in the context of DE (Santo, 2006). Interestingly, there were two common themes concerning pedagogical implications or recommendations that permeated the learning styles and DE literature in spite of the vagueness, lack of agreement, and lack of consensus. Although they had the same purpose of endorsing the meshing hypothesis, they differed in their recommendations. The two different themes or strategies were to either saturate a course to accommodate for all possible learning styles or to vary instruction according to individual learning styles.

Saturate

Some scholars recommend saturating DE courses so that all learning styles were accommodated. Coffield et al. (2004) referred to this as "a type of 'pedagogic sheep dip,' where teaching strategies aimed explicitly to touch upon all styles at some point" (p. 3). The following study was an example of this, but appeared to have little empirical evidence to support this strategy and theme of literature. Bowen (2006) advocated for saturation and stated that "distance learning students benefit best from a successful blend of various learning strategies" (p. 8). Bowen (2006) appeared to be primarily heuristic in nature. The theoretical framework of this study appeared to be Fleming and Mills' (1992) VARK model, as the author discussed visual, auditory, and kinesthetic learners. Bowen (2006) cited very little empirical evidence throughout the work.

Vary Instruction

In contrast to saturating a course, the second theme was recommending that instruction be varied and matched to individual learning styles. This theme had many advocates (Combs, 2001; Rothenberger & Long, 2001; Walls, 2005). With technological advancements such as adaptive

hypermedia, this recommendation may be easier to implement in DE. However, the empirical evidence did not necessarily support this. As previously discussed, Pashler et al. (2008) provided a benchmark of "crossover interaction" (p. 109) experimental research designs that should be utilized to support this recommendation. The following studies did not follow this research design, and their recommendations to match instruction should be questioned based on Pashler et al. (2008). Additionally, their recommendation to match instruction should be further challenged based on whether their recommendation even logically followed the results of their research. Specifically, literature that was not a research study or studies that reported no significant correlation lacked a logical basis to recommend matching instruction to learning styles.

No logical basis to recommend matching. Combs (2001) presented a design for a web course that was based on assessing a student's learning style and designing the course "in such a way that students can easily choose which sections they need to attend at any given point in their study" (p. 320). The theoretical framework of project design and implementation was based on "Newton's Second Law: F=ma" (Combs, 2001, p. 317). Attempting to apply Newton's second law to human behavior was a weakness of this work. Although Combs (2001) made reference to Kolb's (1984) LSI, the learning styles framework appeared to be the Felder and Solomon's (n.d.) ILS. Combs (2001) offered no empirical evidence to support the recommendation to match instruction to students' learning styles.

Walls (2005) conducted a literature review that also advocated for integrating learning styles with numerous methods, including matching instruction to learning styles. Primarily, Walls (2005) advocated for the use of small groups and threaded online discussions in order to

promote interaction and deep learning. Relative to this current discussion, Walls (2005) advocated to "incorporate individual student learning styles into the instructional design of their online/distance education courses" (Abstract section, para. 1). Specifically, Walls (2005) advocated for determining students' learning styles based on an instrument and framework such as the MBTI, and then designing courses to meet students' needs. The only support provided for this recommendation was Roeger's (1999) work, which appeared to be heuristic in nature as Roeger did not conduct a research study.

Maushak et al. (2001) conducted another literature review that also advocated for varying instruction. Specifically, Maushak et al. (2001) advocated for using the web environment to vary instruction so that it was matched to different learning styles. Maushak et al. (2001) appeared to have been influenced by Dunn and Dunn (1979). However, the researchers cited very little empirical evidence to support this meshing hypothesis recommendation. Additionally, the authors failed to consider subject matter.

Buboltz et al. (2001) advocated that the "instructor can get a feel for the cognitive/learning styles of the students and tailor the instruction and presentation of materials to meet their individual needs" (p. 147). Though claiming to be a literature review, Buboltz et al. (2001) included very few sources in their references. Buboltz et al. (2001) explicitly referred to Dunn and Dunn (1979). Unfortunately, Buboltz et al. (2001) provided no empirical data to support their advocacy for the meshing hypothesis, and certainly none that would meet the rigorous criteria explained by Pashler et al. (2008).

Rothenberger and Long (2001) conducted a quantitative research study rather than a literature review or heuristic work. The predictor variable of this study was learning styles, and

the criterion variable was academic achievement as measured by gain scores calculated from pre-tests and post-tests. The learning styles framework was the LSI. However, the results also did not support matching instruction to learning styles. Although the researchers hypothesized that learning styles were correlated to academic achievement, they reported that, "…there was no correlation between students and achievement in either delivery format based on their classification on the learning style inventory" (Rothenberger & Long, 2001, p. 132). In spite of these results, Rothenberger and Long (2001) still recommended incorporating learning styles in DE by varying instruction. In addition to not being a "crossover interaction" (Pashler et al., 2008, p. 109) experimental research design, Rothenberger and Long (2001) had a low sample size with an overwhelming majority of females in the sample. Especially pertinent to the current literature review, Rothenberger and Long's (2001) study was based on a pretest posttest of two groups (distance education versus traditional) in the same course. Consequently, they appeared to have used convenience sampling and did not consider subject matter in their research.

Logical basis with questionable empirical evidence. In contrast to the previously discussed literature that had no apparent logical basis to recommend matching instruction to learning styles, Gee (1990) developed a quantitative study that reported a correlation between learning styles and performance. Gee's (1990) study was based on the CLSI. The theoretical framework of Gee (1990) involved analysis of the predictor variable of learning styles and the criterion variables of "individual academic achievement, attitude toward the learning environment, and course completion rates" (p. 4). Gee (1990) reported that "learning style preferences may affect academic achievement and attitude of students involved in distance education settings" (p. 10), and recommended assessing student learning styles and "designing

new, novel methods of instruction using technology that will support and enhance individual student needs" (p. 11). There were several significant weaknesses concerning Gee's (1990) study. The sample was low (n=26). Additionally, the sample was 100% female and tremendously (89% and 100%) "Anglo" (Gee, 1990, p. 6), for both the on-campus and distance education students, respectively. The researcher's field of expertise appeared to be in elementary education. Significant to this current literature review, Gee's (1990) work was based on a single higher education course at Texas Tech University. Although Gee (1990) may have a logical basis for recommending matching due to the results of the study, the recommendation should still be considered tenuous, as it was not based on the "crossover interaction" (Pashler et al., 2008, p. 109) experimental research design.

Existing Research Basis

In contrast to the existing research recommendations of saturation or variation, which appeared to have weak empirical support and little consensus beyond advocating for the meshing hypothesis, there also appeared to be consensus concerning the existing research basis for evaluating learning styles in DE. Specifically, the criterion or dependent variables for this area of study almost always was academic achievement or satisfaction. The validity of measurement remained paramount in any quantitative research evaluation. Researchers have stressed that the first and central issue that must be evaluated is student achievement (Eaton, 2001; Schoenfeld-Tacher & McConnell, 2001). Concerning student satisfaction, Eom et al. (2006) articulated that this variable is one of two outcomes, "widely cited as measures of the effectiveness of online education systems" (p. 216). For the context of this current study, effectiveness was defined as

satisfaction or academic achievement. The following discussions also introduce the related literature with regards to the methodology upon which this current study was grounded.

Achievement

Winnie and Nesbit (2010) stated, "'Extensive' significantly understates the scope of research relevant to a psychology of academic achievement" (p. 654). However, existing research in this area pragmatically utilized multiple measurements for this construct, including final grades, course completion rates, pre-test/post-test gains, grades on individual assignments, and grade point average (GPA). Although the following studies utilized different learning styles frameworks, they all utilized achievement as a criterion variable. In addition to Gee's (1990) study, only two other studies (Battalio, 2009; Offir et al., 2007) reported an association between learning styles and academic achievement.

Association. Battalio's (2009) research was quantitative and based on the ILS learning styles model. This study evaluated learning styles as the predictor variable and nine different measures of achievement as criterion variables, including "semester grade" (Battalio, 2009, p. 77). Battalio's (2009) work was one of the only two studies in the current literature review that utilized achievement as a criterion variable and reported an association. Battalio (2009) further reported that reflective learners performed the best and stated that "given this sample of 120 students, data suggest that learning styles are associated with student success in distance education" (p. 80). Battalio (2009) did not consider subject matter as a variable. The study utilized a convenience sample of students from different sections of an "English 202 Technical Communication" (p. 74) course.

Offir et al. (2007) conducted a mixed method study based on the MBTI that also utilized a convenience sample. This study involved 77 higher education students in Israel. The single subject matter studied was archaeology. Offir et al. (2007) reported a significant correlation between extrovert/introvert measurement of the MBTI and achievement. Offir et al. (2007) measured achievement with the students' final exam scores for the course (Offir et al., 2007). In contrast to these studies that reported an association between learning styles and achievement, numerous studies reported no significant correlation.

No significant correlation. Shih et al. (1998) conducted a correlational study based on the GEFT learning styles framework. Among other multiple predictor variables and criterion variables, learning styles were analyzed against achievement. Achievement was measured by the students' course grades (Shih et al., 1998). The sample of this study was 99 students from Iowa State University enrolled in Web-based courses (Shih et al., 1998). The return rate of both the GEFT and additional questionnaire was 79% and 75%, respectively (Shih et al., 1998). The collected data were analyzed statistically with SPSS (Shih et al., 1998). Shin et al. (1998) reported that "…no significant differences were found on the respondents' overall achievement scores by learning styles" (p. 362), and concluded that "different types of students using different learning styles can learn equally well in Web-based courses" (p. 363). Significant to this current literature review, Shih et al.'s (1998) study was based on two courses, Zoology and Biology, in the same discipline at Iowa State University.

Beaumaster and Long (2002) conducted a correlational study based on the LSI learning styles framework. The study compared DE against traditional education. Beaumaster and Long (2002) reported no correlation between learning styles and achievement. They based this finding

on their theoretical framework of the following predictor variables: "student learning style, student perceptions upon entering an online course, technological skills, design of the online course, and instructor learning style" (Beaumaster & Long, 2002, p. 82). The criterion variable of this study was academic achievement, which was measured by course grades. The weaknesses of this study was a low sample size and an "extremely low, only 28%" (Beaumaster & Long, 2002, p. 86), return rate for the LSI surveys. Additionally, this study did not consider subject matter as a variable. The study sample was from a single course.

Zacharis's (2010) work was a quasi-experimental study based on the LSI framework. Zacharis analyzed learning style and achievement. The two predictor variables were learning styles and course delivery method, online verses traditional (Zacharis, 2010). The criterion variable was achievement based on course grades (Zacharis, 2010). Zacharis (2010) reported no significant difference in achievement between traditional education and DE in terms of learning styles. This study was based on a single course of "Introduction to Programming using Java - COMP 120" (Zacharis, 2010, p. 591).

Unlike the previous three studies discussed, Spears et al. (2008) utilized two frameworks, LSI and GEFT, for learning styles. Spears et al.'s (2008) research was a quasi-experimental study that analyzed learning styles and achievement. The researchers reported no relationship between learning styles and achievement as measured by final course grades (Spears et al., 2008). This study had a low sample size (n=27). Additionally, this study also utilized a convenience sample—"dental hygiene students at the University of Maryland Dental School" (Spears et al., 2008, p. 1).

Satisfaction

As opposed to academic achievement, the following studies utilized satisfaction as the criterion variable. The following studies also utilized different learning styles frameworks. There appeared to be no consensus concerning the results, as some studies determined no significant correlation while other studies contradicted those results.

No significant correlation. Miller's (1997) research was an early correlational study that evaluated learning styles and satisfaction. Miller's (1997) work was based on the GEFT learning styles framework. Data for the predictor variable of satisfaction was gathered by a mailed questionnaire with a very good return rate of 83.8%. Unfortunately, the return rate for both the questionnaire and the GEFT was 46.6%. The data were analyzed in SPSS. Miller (1997) concluded that, "although the orientation of this group, particularly the female students, to a more field-independent cognitive style was noted, field-depended learners were equally satisfied with videotape delivery of instruction when compared with their field-independent counterparts" (p. 213). Miller's (1997) study only involved one field of study, the professional agriculture degree program of a midwestern land-grant university.

Manochehri (2008) conducted another quasi-experimental study that analyzed learning styles and satisfaction in comparison to traditional education and DE. Manochehri (2008) reported no significant difference. The predictor variable of learning styles utilized the LSI framework (Manochehri, 2008). The criterion variable of course satisfaction was determined by a course evaluation survey which "measured the student's attitude toward the learning program (methods)" (Manochehri, 2008, p. 224). This instrument appeared to be a questionnaire specifically designed for the course or the university. Manochehri (2008) reported that "…there

was no significant difference in student satisfaction based on their learning style" (p. 221). The participants in Manochehri's (2008) work were from a single college algebra course.

Correlation. In contradiction to Manochehri's (2008) study also based on the LSI, Yunfei and Simpson (2002) reported a correlation between learning styles and satisfaction. Yunfei and Simpson (2002) investigated the relationship between the predictor variables of learning style, hits, readings, and postings against the criterion variable of enjoyment, which was measured by a questionnaire that appeared to be specifically designed for the course. This correlational study included a sample of 169 students attending courses completely through the Internet. Participants of this study were from a single discipline of study and appeared to be from a single course. The data were then analyzed in SPSS. Yunfei and Simpson (2002) reported, "learning style was most significant in explaining enjoyment level" (p. 9). They further suggested "class participation, however, has a weak negative impact on enjoyment level" (Yunfei & Simpson, 2002, p. 10). Yunfei and Simpson (2002) recommended that educators "incorporate students' learning styles into pedagogical design of their courses to maximize their students' success" (p. 11).

Drago and Wagner (2004) reported a correlation between learning styles and satisfaction. Drago and Wagner (2004) used a correlational design to determine if there was a relationship between learning styles and satisfaction. Drago and Wagner's (2004) work was based on the VARK learning styles framework. Drago and Wagner (2004) measured satisfaction with a questionnaire that appeared to be specifically designed for the research. Their study involved different courses within the same field of study. Unfortunately, Drago and Wagner (2004) did not provide these details. However, Drago and Wagner (2004) did state that their sample for the

study consisted of graduate students from “11 MBA management courses” (p. 4) offered by “a large midwestern university” (p. 4).

Both Achievement and Satisfaction

Shaw (2012) was an example of a study that used both achievement and satisfaction as criterion variables. Shaw’s (2012) quantitative research utilized “a quasi-experimental research method” (p. 114) with a predictor variable of learning styles as measured by the LSI. The criterion variable of performance was further subdivided to both course score and course satisfaction (Shaw, 2012). Shaw (2012) measured course score by a final exam. Course satisfaction was measured by questionnaires after completion of the experiment (Shaw, 2012, p. 114). Though Shaw’s (2012) questionnaire for measuring satisfaction appeared to be designed by the researcher, it was based on other previously designed and published satisfaction instruments. The population was higher education students from Tamkang University in Taiwan, and the context was a traditional course supported with an “online forum” (Shaw, 2012, p. 114). Shaw (2012) reported that, “Our results support the notion that learning styles and participation types significantly influence learning scores, but they do not significantly influence satisfaction” (p. 117). Shaw (2012) was based on a sample from a single programming course. Especially significant to the current research study, Shaw (2012) reported that, “Our results corroborate the important conclusion that actual practice in programming language learning is superior to just watching information in an online forum” (p. 117). This indicated that although subject matter was not a variable evaluated in Shaw’s (2012) study, it was considered in the discussion.

Related Methodology

In addition to the related literature regarding achievement and satisfaction, there was a basis in the existing literature upon which the methodology of the current study was grounded. Glatthorn and Joyner (2005) articulated that the quantitative perspective utilized by the current study was consistent with a positivist epistemology. Taking into account moderating effects, which was the purpose of this current study, Steel and Kammeyer-Mueller (2002) stated that estimating and interpreting these effects was "one of the most problematic issues" (p. 96) in current meta-analysis research. The researchers subsequently discussed the advantages and disadvantages of four primary methods for dealing with moderating effects and evaluated the accuracy of these methods. Even though bivariate correlational statistics was not the most accurate method as evaluated by these researchers, it also was not the least accurate method (Steel & Kammeyer-Mueller, 2002). Regarding specific bivariate correlational statistics that could be used in estimating moderation in meta-analysis, Sanchez-Meca and Marin-Martinez (1998) described a method that begins with conventional statistical tests, such as the product-moment correlation, and follows up with tests for statistical significance such as conventional t-tests.

However, there were several scholars that recommended the z-test over the conventional t-test. Hittner, May, and Silver (2003) recommended both the t-test and z-test in a comparison against six other statistical tests when considering Type I errors and statistical power simultaneously, but detailed the slight advantage that the z-test had over the t-test with regards to statistical power. Meng, Rosenthal, and Rubin (1992) also recommended the Fisher r to z transformation compared to t-tests with regards to normality, small sample sizes, or extreme

sample correlations. Kendall and Stuart (1979) and Fisher (1954) argued that the Fisher r to z transformation was frequently used in practice due to non-normal sample distributions (as cited in Overton, 1998). Tremendously pertinent was Driskell, Willis, and Cooper (1992), whose research was a meta-analysis that specifically utilized bivariate correlations followed by the Fisher r to z transformation. Concerning the applicability of the Fisher r to z transformation for other correlation coefficients, the following literature was pertinent to this current study. Wang (2012) stated, "the Spearman's ρ is the ordinary Pearson's correlation coefficient" (p. 1). For Kendall's tau, Pearson's correlation coefficient can be calculated with "Kendall's formula (1970, p. 126)" (as cited in Walker, 2003, p. 4).

Multiple Subject Matter

Though presumably the meta-analysis previously discussed in related methodology involved a variety of subject matter, all other previously discussed research studies involved only one course or courses in a single discipline. The following studies potentially involved courses in multiple disciplines; although some were only assumed while one study explicitly provided that detail. Unfortunately, none of the following studies attempted to evaluate subject matter as a variable.

Assumed to Involve Multiple Disciplines

Eom et al. (2006) conducted quantitative research that examined six predictor variables including learning styles against the criterion variables of "students' satisfaction" (p. 215) and "perceived learning outcomes" (p. 215). Learning styles in the study were based on the VARK (Eom et al., 2006). Satisfaction was based on a questionnaire designed specifically for the study and founded "the commonly administered IDEA (Individual Development & Educational

Assessment) student rating systems developed by Kansas State University" (Eom et al., 2006, p. 222). The hypothesis concerning learning styles was that "students with visual and read/write learning styles will experience a higher level of user satisfaction" (p. 219). Eom et al. (2006) sent surveys to 1,854 online higher education students and received 397 responses. The data were statistically analyzed by the partial least squares (PLS) methodology (Eom et al., 2006). Eom et al. (2006) determined that all six criterion variables including learning styles "significantly influenced students' satisfaction" (p. 228), and only learning styles and instructor feedback were correlated to perceived learning outcomes. Eom et al.'s (2006) sample consisted of "students enrolled in Web-based courses with no on campus meetings" (p. 222). Although not explicitly stated, the researcher inferred that the web-based courses cross disciplines as 1,854 surveys were sent with 397 responses. Unfortunately, Eom et al. (2006) did not design the study to evaluate subject matter as a potential moderating variable.

Sahin (2008) conducted another quantitative study that presumably included multiple disciplines, as the study solicited the participation of "all" (p. 128) instructors "at a Midwestern state university" (p. 124), resulting in participation from five different courses and 279 students. Sahin (2008) analyzed learning styles and satisfaction. The theoretical framework was the LSI learning styles model. Satisfaction was measured by a previously developed but unpublished instrument. The author hypothesized that in a rigidly structured distance education course, students with AC preference would be more satisfied than students with CE preference. The sample of the study consisted of students in "Web-based courses" (Sahin, 2008, p. 124). Data were statistically analyzed in SPSS. Sahin (2008) reported that learning styles were correlated to satisfaction. "This study found that students' preference of AC positively correlated with the

perceptions of authentic learning and active learning. CE preference negatively correlated with active learning" (Sahin, 2008, p. 133). This study did involve several other predictor variables other than learning styles. Unfortunately, Sahin (2008) also did not design the study to evaluate subject matter as a potential moderating variable.

Explicitly Involved Multiple Disciplines

In contrast to Sahin (2008) and Eom et al. (2006), Brenner's (1997) sample explicitly included students enrolled in multiple courses that spanned numerous disciplines, including humanities and social sciences, business, math and science, and engineering. Brenner's (1997) work was a quantitative study based on the GEFT learning styles framework. Brenner's (1997) context was a community college. The theoretical framework of this study was based on the predictor variables of learning style, gender, and age, compared with the criterion variable of academic achievement operationally defined by course grades. The sample was 154 community college students from Southwest Virginia. Brenner (1997) hypothesized that field independent students would be more successful in DE courses that are self-directed. Brenner's (1997) hypothesis was disproved; learning styles were not correlated to successful completion of DE courses. Unfortunately, Brenner (1997) did not design the study to evaluate multiple disciplines as a potential moderating variable.

Summary

As the previous discussions have demonstrated, there are very few studies (Brenner, 1997; Eom et al., 2006; Sahin, 2008) that utilized multiple courses in different disciplines when studying learning styles in DE. Very few studies consider subject matter in discussions, as Shaw (2012) considered, and no studies were designed to specifically evaluate course context or

"subject matter" (Coffield et al., 2004, p. 122) as a moderating variable between students' learning styles and effectiveness of DE, which was the conceptual framework of this study. This research topic was "frequently neglected" Coffield et al., 2004, p. 122), which was disappointing considering that "optimal instructional method is likely to vary across disciplines" (Pashler et al., 2008, p. 116). This current study addressed this research gap and was grounded in the existing research basis of quasi-experimental or correlational studies which utilized achievement (Battalio, 2009; Beaumaster & Long 2002; Gee, 1990; Offir et al, 2007; Rothenberger & Long, 2001; Shih et al., 1998; Spears et al., 2008; Zacharis, 2010), satisfaction (Drago & Wagner, 2004; Miller, 1997; Manochehri, 2008; Yunfei & Simpson, 2002), or a combination thereof (Cook et al., 2007; Shaw, 2012) as criterion variables whether they reported a significant correlation or not. This current study was also grounded in the existing research methodology (Driskell et al., 1992). The following reasons explain the importance of research in this area.

Learning styles have "acquired great influence within the education field" (Pashler et al., 2008, p. 105) in spite of the vagueness, complexity, controversy, contradiction, and lack of consensus among scholars concerning research results or pedagogical implications (Coffield et al., 2004; Graf & Kinshuk, 2007; Santo, 2006). The implication is that sound research in learning styles is still warranted. Though some people have attributed learning styles to Daniel 1:4 (Willems, 2011), there are now at least 71 different models (Coffield et al., 2004) in a seemingly ever expanding field. This includes some key theorists and models such as the GEFT, Dunn and Dunn's (1979), CLSI, LSI, LSQ, and ILS. Though some scholars' (Coffield et al., 2004; Papp, 2001) work to compare and contrast multiple models has appeared to be contradictory and inconclusive, the research has shown that the recommended learning style

instruments were found in the last two families of Coffield et al.'s (2004) continuum of learning styles. The ASSIST was in the learning approaches and strategies family (Coffield et al., 2004). The CSI and ILS were in the "flexible stable" (Coffield et al., 2004, p. 12) learning preferences family.

With the growing context of DE, which has an estimated 12.153 million post-secondary students nationally (Parsad & Lewis, 2008, p. 9), and the consensus concerning the no significant difference phenomenon (Glenn, 2001; Head, 2001; Hoban et al., 2002; Spears et al., 2008), there was a need to critically evaluate whether learning styles should be considered in the instructional design of DE. There was already a significant body of research in this area. However, most of the literature and current paradigm explored the "meshing hypothesis" (Pashler et al., 2008, p. 108) theory of learning styles that stated, "instruction should be provided in the mode that matches the learner's style" (Pashler et al., 2008, p. 108). Additionally, the current literature primarily advocated for either saturating courses (Bowen, 2006) or assessing and varying instruction to match individual learning styles (Buboltz et al., 2001; Combs, 2001; Maushak et al., 2001; Rothenberger & Long, 2001; Walls, 2005), although this was the same as endorsing the meshing hypothesis. Additionally, much of the existing research that recommended varying instruction had no logical or empirical basis for such a recommendation. In contrast to these two reoccurring themes and strategies, this current study was significant as it explored a minority paradigm that suggested instruction should be matched to subject matter rather than individual student learning styles in order to maximize the effectiveness of DE as measured by achievement. If subject matter is a moderating variable of learning styles and effectiveness, curriculum design could be accomplished with interventions designed to assist all learners.

CHAPTER THREE: METHODOLOGY

As previously discussed, the conceptual framework of this current study attempted to address the research gap of whether instruction should be matched to subject matter rather or to individual student learning styles. Specifically, the current study attempted to discover whether potential relationships between students' learning styles and effectiveness were moderated by the subject matter of the course. This current study was approached from a quantitative perspective and was consistent with a positivist epistemology (Glatthorn & Joyner, 2005). The research design, questions and hypotheses, participants, setting, instrumentation, procedures, and data analysis are discussed in detail in this chapter.

Design

This current non-experimental research study is a correlational study. The context, purposes, and the number of variables involved provided the rationale for the selection of a correlational design. Correlational studies are "highly useful" (Gall et al., 2006, p. 336) for educational problems, one of which is the context of this current research study. As the purpose of correlational studies is to "discover" (Gall et al., 2006, p. 332) potential relationships between variables, the selection of this design was appropriate for the current study. The specific design of the current correlational study is a causal relationship study, which serves as one of the "two major purposes" (Gall et al., 2006, p. 337) for correlational studies. "The primary purpose of causal relationship studies is to identify the causes and effects of important educational phenomena…" (Gall et al., 2006, p. 337). Specifically, the primary purpose of this current study was to analyze the effects of subject matter as a moderating variable. In order to accomplish this, the strength of relationships between variables was highly pertinent because moderating

variables affect the strength or direction of relationships between predictor and criterion variables (Fairchild & MacKinnon, 2009). Gall et al. (2006) stated that determining the "degree of the relationship" (p. 336) was another advantage of correlational designs. Finally, using the correlational research design was advantageous as the current study attempted to evaluate the potential relationship between multiple variables (Gall et al., 2006; Glatthorn & Joyner, 2005). The ability to evaluate multiple variables in a single study is the primary advantage of correlational studies as compared to causal-comparative or experimental designs (Gall et al., 2006).

Questions and Hypotheses

The following is the research question for this current study. Are potential relationships among students' learning styles and effectiveness in online education moderated by subject matter for undergraduate students at a private higher education institution? There was little rationale for the use of directional hypotheses for the current correlational study. As the literature review revealed, some studies reported an association between learning styles and academic achievement (Battalio, 2009; Gee, 1990; Offir et al., 2007; Shaw, 2012) while other studies contradicted those results (Beaumaster & Long 2002; Cook et al., 2007; Rothenberger & Long, 2001; Shih et al., 1998; Spears et al., 2008; Zacharis, 2010). Similarly, some studies reported a correlation between learning styles and satisfaction (Drago & Wagner, 2004; Eom et al., 2006; Sahin, 2008; Yunfei & Simpson, 2002) while others contradicted those results (Manochehri, 2008; Miller, 1997; Shaw, 2012). The differing frameworks for learning styles that were utilized further complicated interpretation of these already conflicting results. Unfortunately, Battalio (2009) and Cook et al. (2007), whose studies were based on the same

measurement instrument for learning styles as the current study, were also among the studies that contradicted each other. Consequently, there was minimal rationale for using directional hypotheses for this current study. Additionally, using two-tailed tests and the corresponding null hypotheses in statistical analyses was deemed "far more common" (Howell, 2011, p. 178). Null hypotheses are especially pertinent as the main purpose of this current study was to evaluate subject matter as a moderating variable.

As previously defined, a moderating variable is one that affects the strength or direction of the relationship between predictor and criterion variables by "enhancing, reducing, or changing the influence of the predictor" (Fairchild & MacKinnon, 2009, p. 4). For example, subject matter would be a moderating variable for this current study if results demonstrated that the strength or direction of the relationship between the visual/verbal dimension of the ILS and achievement was different for a Math versus English course. In order to evaluate subject matter as a moderating variable, evaluating whether there were significant differences between the correlation coefficients of the four dimensions of the ILS and achievement or satisfaction was critical. Consequently, null hypotheses were utilized for this current study, as they were consistent with the research question, instrumentation, and data analysis of the current causal relationship study. The following are the eight null hypotheses of this study.

1. The correlation between the Index of Learning Styles measure of active/reflective learning style and student achievement (measured by course grade) for students completing an English course does not differ significantly from that of students completing a Math course.

2. The correlation between the Index of Learning Styles measure of sensing/intuitive learning style and student achievement (measured by course grade) for students completing an English course does not differ significantly from that of students completing a Math course.
3. The correlation between the Index of Learning Styles measure of visual/verbal learning style and student achievement (measured by course grade) for students completing an English course does not differ significantly from that of students completing a Math course.
4. The correlation between the Index of Learning Styles measure of sequential/global learning style and student achievement (measured by course grade) for students completing an English course does not differ significantly from that of students completing a Math course.
5. The correlation between the Index of Learning Styles measure of active/reflective learning style and student satisfaction (measured by end-of-course surveys) for students completing an English course does not differ significantly from that of students completing a Math course.
6. The correlation between the Index of Learning Styles measure of sensing/intuitive learning style and student satisfaction (measured by end-of-course surveys) for students completing an English course does not differ significantly from that of students completing a Math course.
7. The correlation between the Index of Learning Styles measure of visual/verbal learning style and student satisfaction (measured by end-of-course surveys) for

students completing an English course does not differ significantly from that of students completing a Math course.

8. The correlation between the Index of Learning Styles measure of sequential/global learning style and student satisfaction (measured by end-of-course surveys) for students completing an English course does not differ significantly from that of students completing a Math course.

Participants

The participants of this study were selected from a population of a higher education institution. This current causal relationship study utilized convenience sampling, as the researcher works at the research site. The sampling procedure also involved cluster sampling. This current study utilized existing sections of two courses (Mathematics for Liberal Arts and Composition and Rhetoric) available as online courses offered by the higher education institution. The Dean of the College of General Studies recommended these courses. Students self-select into open sections of these two courses each term. These two courses were selected for the following reasons. Mathematics for Liberal Arts and Composition and Rhetoric involve different disciplines and subject matter. However, both these courses are required general education courses at the research site. Additionally, both courses are lower level courses that have high enrollment through multiple sections each term. High enrollment was an important factor, as a minimum of 30 participants is desired for correlational studies (Gall et al., 2006). The target sample size was 30 participants from each subject matter with a total of 60 participants. Invitations to participate in the current study were sent electronically to students

enrolled in online sections of Mathematics for Liberal Arts and Composition and Rhetoric. Participants voluntarily selected to participate in the current causal relationship study.

Setting

The pseudonym for the selected research site for this current causal relationship study was the Christian University (CU). CU had an "accessible population" (Gall et al., 2006). The researcher has been employed for over a decade at CU, and has a positive relationship with the research site, which research has deemed critical to successful studies (Gall et al., 2006). The positive relationship was especially important as the current study involved participants from multiple disciplines. CU is a private university located in the southeastern United States with a residential enrollment of 12,600 students and an online student population of over 80,000. CU is a private, religious, co-educational, and comprehensive higher education institution. The population consisted of a diverse student body in terms of geographical location and gender. The online student body is 39% male and 61% female and is located in all 50 states and 95 countries. At CU, DE is conducted in the form of online courses and residential intensives. There are no hybrid courses or blended courses at CU. The current causal relationship study utilized multiple sections of two online courses (Mathematics for Liberal Arts and Composition and Rhetoric) at CU. The testing locations varied as all instruments were web-based and were administered online with participants self-selecting their individual location of testing.

Instrumentation

The following describes the instruments that were utilized for this current causal relationship study. Felder and Solomon's (n.d.a.) ILS was utilized to measure the predictor

variables. The criterion variables were measured by course grades and an end-of-course survey internally developed by the research site.

Predictor Variables

Felder and Solomon's (n.d.a) ILS, which was derived from Felder and Silverman's (1988) work with engineering students (Nilson, 2010), was the instrument used to measure the predictor variables of learning styles. The ILS was based on how information is processed, received, perceived, or understood (Hosford & Siders, 2010; Nilson, 2010). According to this model, information is processed either actively or reflectively (Hosford & Siders, 2010; Nilson, 2010). Active learners process information by working with it, while reflective learners prefer to think through it first (Felder & Solomon, n.d.b). Learners prefer to receive information either verbally or visually (Hosford & Siders, 2010; Nilson, 2010). Verbal learners prefer to receive information in the written or spoken form, while visual learners prefer receiving information by their sight (Felder & Solomon, n.d.b). Regarding perception, learners favor either sensing or intuition (Hosford & Siders, 2010; Nilson, 2010). Sensing learners prefer facts, details, established procedures, and pragmatism (Felder & Solomon, n.d.b). Intuitive learners perceive the world through relationships, possibilities, abstractions, and innovations (Felder & Solomon, n.d.b). In the ILS framework, information was understood from either a sequential or global perspective (Hosford & Siders, 2010; Nilson, 2010). Sequential learners prefer logical steps, while global learners understand the big picture (Felder & Solomon, n.d.b).

Felder and Solomon's (n.d.a) 44 item questionnaire is available online. The instrument results in a score on a bi-polar scale for each of the four previously discussed dimensions. The four scales are bi-polar, centered at zero, and include positive odd numbers from one to 11

originating from the center of the scale. This instrument was appropriate for use in the current causal relationship study as it was the primary instrument recommended by Papp (2001) for its predictive value with learning outcomes. The ILS was classified in Coffield et al.'s (2004) "flexible stable" (p. 12) learning preferences family, which was one of two families of learning styles recommended by these scholars. This instrument was appropriate for the DE context (Battalio, 2009). Additionally, there were indications that the ILS resulted in higher completion rates than other learning styles instruments because of its clarity and brevity (Zywno, 2003).

Though Van Zwanenberg, Wilkinson, and Anderson (2000) were critical of the reliability of the ILS in terms of internal consistency with coefficients ranging from 0.41 to 0.65 for the four dimensions, other scholars (Cook, 2005; Hosford & Siders, 2010; Zywno, 2003) supported the validity and reliability of the ILS. For internal consistency, Cook (2005) reported Cronbach's alphas ranging from 0.61 to 0.78. Hosford and Siders (2010) reported Cronbach's alphas ranging from 0.62 to 0.76. Zywno (2003) reported Cronbach's alphas ranging from 0.530 to 0.697. For test-retest reliability, Zywno (2003) reported that the ILS had "strong to moderate reliability of all scales" (p. 12) based on Paired-Samples t-tests analyses of data. Hosford and Siders (2010) reported "moderate to high stability of responses for all dimensions" (p. 302) based on statistical analysis with Pearson correlation coefficients. Cook (2005) also reported "moderate to high" reliability for all dimensions except the visual/verbal based on the Pearson's correlation coefficient comparison of the ILS and a variant of the MBTI. Zywno (2003) also concluded that the ILS had construct validity for engineering students based on an ANOVA, convergent evidence, and discriminant evidence. Cook (2005) also provided convergent and discriminant evidence of construct validity for the active/reflective and sensing/intuitive

dimensions of the ILS for postgraduate medical students. Hosford and Siders (2010) suggested an interrelationship between the sensing/intuitive and sequential/global dimensions of the ILS given to undergraduate medical students. Felder and Spurlin (2005) also supported the validity and reliability of the ILS based on results from other studies in addition to the ones already discussed.

However, the support for the validity and reliability of the ILS should be critically considered for this current study. The ILS was intended to characterize learning styles and not predict academic achievement (Zywno, 2003). The previous reliability discussions appeared to be based on different standards. Gall et al. (2006) recommended minimum reliability coefficients of 0.80 for research purposes. Tuckman (1999) recommended reliability coefficients be at least 0.75 for achievement tests and 0.50 for attitude tests. Additionally, the use of Cronbach's alpha for determining internal consistency should be viewed tenuously. Van Zwanenberg et al. (2000) conceded that the statistical use of the Cronbach's alpha was "difficult at best" (p. 370) given the bi-polar scales of the ILS. Gall et al. (2006) did not recommend Cronbach's alpha for items that are "scored dichotomously" (p. 202). Unfortunately, the ILS was based on dichotomous questions and all analyses previously presented regarding the internal consistency of the ILS were based on Cronbach's alpha. Consequently, use of the ILS for analysis of the criterion variable of achievement for this current study should be considered tenuously. However, the ILS should be considered both reliable and valid in the analysis of the criterion variable of satisfaction as an attitude test.

Criterion Variables

The following instruments measured the criterion variables of student achievement and satisfaction. Gall et al. (2006) stated concerning data collection for causal relationship studies that "the only requirement is that the data must be in quantifiable form" (p. 338). Consequently, using final course grades as the instrument of measurement for the criterion variable of student achievement was appropriate. Student achievement was operationally defined as students' course grades. Student achievement was measured by the final course grade as recorded in Blackboard, the course management system (CMS) utilized by CU. Additionally, a majority of the studies (Battalio, 2009; Beaumaster & Long, 2002; Brenner, 1997; Shih et al., 1998; Spears et al., 2008; Zacharis, 2010) that utilized academic achievement as a criterion variable measured this construct with course grades.

Satisfaction was measured by an end-of-course survey utilized by CU for all DE courses. The university designed this instrument. There were six questions concerning satisfaction with the faculty member regarding responsiveness, communication, feedback, and encouragement. There were eight questions concerning satisfaction with course content. These fourteen questions were answered on the following Likert scale: (A) Strongly Disagree; (B) Disagree; (C) Agree; or (D) Strongly Agree. The final four questions of the end-of-course survey were open-ended questions where respondents could provide subjective comments concerning the strengths and areas of improvement for the faculty member and course content. Only data from the eight questions concerning course content was utilized in the data analysis of this current quantitative study, as it focused on subject matter as a potential moderating variable. The rationale for the use of the end-of-course survey for this current study was as follows. None of the studies

identified in the literature review that utilized satisfaction as a criterion variable measured this construct with a standardized test or previously developed and published measurement instrument in its entirety (Drago & Wagner, 2004; Eom et al., 2006; Manochehri, 2008; Sahin, 2008; Yunfei & Simpson, 2002). Sahin's (2008) instrument for satisfaction was a previously developed but unpublished instrument. Eom et al. (2006) and Shaw (2012) used questionnaires specifically tailored by the researchers but based on previously designed and published instruments. However, these researchers still did not use the previously developed and published measurement instruments in their entirety. There appeared to be face validity for the eight satisfaction questions for the end-of-course survey utilized by CU for all DE courses. As a measure of internal consistency, Cronbach's alpha was calculated from 1,000 random responses from various sections of courses at the research site with data from the spring 2013 semester. The reliability coefficient was calculated to be 0.966 which indicated that the instrument had high internal consistency. Additionally, satisfaction was quantifiable in this manner, which met the data collection requirements of a causal relationship study (Gall et al., 2006).

Procedures

Approval for this current study was obtained from the Institutional Review Board (IRB). After approval from the IRB, the following procedures were utilized for eliciting participants, administration of the ILS, and data collection. These procedures were provided in detail in order to ensure future potential replication of this current causal relationship study.

Eliciting Participants

The participants of this study were selected from CU. This current study utilized existing sections of two courses (Mathematics for Liberal Arts and Composition and Rhetoric), online

courses offered by CU. Preliminary administrative approval was provided for the use of these courses. Students had the option of self-selecting into open sections of these two courses each term. There were usually over 60 sections of Composition and Rhetoric and 30 sections of Mathematics for Liberal Arts offered as DE courses each semester. The Mathematics for Liberal Arts sections were offered in a 16-week online format. Composition and Rhetoric sections were offered in an 8-week online format during three different terms each semester. Each section of Mathematics for Liberal Arts and Composition and Rhetoric was capped at 25 students. These two courses were also offered residentially in the traditional format. However, invitations to participate in the current study were sent electronically to students enrolled in online sections of Mathematics for Liberal Arts and Composition and Rhetoric for the same semester, as the context of the current study was DE. The invitation to participate included the information necessary for informed consent to be granted by the participants. This included information about the purposes of the study, the ILS, other data that would be collected (demographic data, end-of-course survey results, final course grades), and the right to withdraw from the study. The invitation to participate also detailed the need for students to complete the end-of-course survey made available by the university for all students at the end of online courses. The invitation to participate in the current study was sent to students during the second week of the courses. A reminder email was sent one week later to elicit participants.

Administration of the ILS

The web-based version of the ILS was administered to voluntary participants during the second week of their course. The link for the ILS was provided with the invitation to participate. Participants were requested to provide the results of their ILS, student identification number, and

indicate their consent to participate. The participants were requested to provide this information through an electronic survey that was reviewed by the researcher.

Data Collection

Other data including the participants' age, gender, SAT scores, high school GPA, and college GPA were obtained through existing institutional records by the students' identification number. The researcher reminded the participants two weeks before the end of the courses to complete the end-of-course survey once it was made available by the university. The course or courses that the participants completed (Mathematics for Liberal Arts and Composition and Rhetoric) was obtained through existing institutional records. The participants' final course grades were also obtained through institutional records. The data from the participants' end-of-course surveys were obtained with the assistance of the university Information Technology (IT) department after course completion.

Data Analysis

Bivariate correlational statistics were utilized for this current study. Bivariate correlations are one method of dealing with moderators in the context of meta-analysis (Steel & Kammeyer-Mueller, 2002). Meta-analysis often attempts to compare correlations statistically, which was tremendously pertinent to this current study due to its focus on subject matter as a moderating variable. Bivariate correlations for Institutional Effectiveness based on extensive discussions concerning the purposes, instruments, and data were collected for this current causal relationship study. Sanchez-Meca and Marin-Martinez (1998) described a specific method of data analysis for meta-analysis, which began with conventional statistical tests such as the product-moment correlation and followed up with tests for statistical significance such as

conventional t-tests. This method was utilized for this current study, but modified as follows. Bivariate correlations of Spearman's rho or Kendall's tau (depending on sample size) were utilized in lieu of the product-moment correlation because of the type of scores subsequently discussed. In lieu of conventional t-tests, z-tests were utilized as subsequently discussed.

Although multiple regression provided an alternative method of data analysis, this method was not utilized for the current study because of the following reasons. Gall et al. (2006) detailed that multiple regression resulted in a multitude of statistics and equations that were counterproductive for this current study. Gall et al. (2006) also explained that the "objective" (p. 356) and advantage of multiple regression was its ability to predict the influence of multiple prediction variables as related to each criterion variable. However, the main purpose of this current study was not the predictive ability of the ILS as influenced by "some or all" (p. 356) of the prediction variables. As the research question indicated, the primary purpose of this study was the focus on subject matter as a moderating variable. This required a specific focus on correlation coefficients between individual dimensions of the ILS and individual criterion variables. Moderation depended upon whether there was a significant difference in correlation coefficients for corresponding potential relationships between each dimension of the ILS and each criterion variable. This was based on the definition of moderation provided by Fairchild and MacKinnon (2009). This analysis was consistent with the null hypotheses of this current study. Use of bivariate correlation coefficients allowed for the focus on one influence variable and its prediction ability for each criterion variable (Gall et al., 2006). Consequently, the best data analysis method for this current study was the use of a series of individual bivariate correlation calculations to determine whether or not subject matter was a moderating variable.

The following specific tests and bivariate correlations statistics were planned for this current study due to the consistency with the research question, hypotheses, and type of data collected.

Tests for Homogeneity

Concerning causal relationship studies, Gall et al. (2006) articulated, "it is very important to select a group of participants who are reasonably homogeneous" (p. 338). Consequently, the use of essentially two different samples (participants drawn from either Mathematics for Liberal Arts or Composition and Rhetoric) because of the focus on the potential moderation effect of subject matter required tests for homogeneity of the sample groups. The ILS was based on the ordinal scale (only odd numbers from one to 11 were possible with no decimal results). Therefore, the homogeneity of the four dimensions of the ILS should not be determined by t-tests which require an assumption that obtained scores "form an interval or ratio scale" (Gall et al., 2006, p. 315). The use of a nonparametric test such as the Mann-Whitney U test was appropriate in this situation. Additionally, research indicated that the use of nonparametric tests is "particularly" (Gall et al., 2006, p. 327) appropriate when assumptions of a normal distribution are violated. This offered the additional advantage in the event that the population was not normally distributed with regards to the dimensions of the ILS. Nonparametric tests such as the Mann-Whitney U test should be used for "measures that yield categorical or rank scores" (Gall et al., 2006, p. 325). In contrast to the use of the Mann-Whitney U test for analysis of the homogeneity of the four dimensions of the ILS, t-tests were used for analysis of age, SAT scores, high school GPA, and college GPA, as these variables form interval or ratio scales. The Pearson Chi-Square test was used to test for equality between the two samples with regards to gender as a categorical score.

Bivariate Correlations

For the previously discussed tests for homogeneity and for the following bivariate correlation coefficients, the scales of the ILS were re-coded as follows. The bi-polar scales of the ILS, which consisted of positive odd numbers from one to 11, were re-coded to corresponding positive and negative odd numbers. Scholars have used this identical procedure in previous studies (Cook et al., 2007; Henry 2008; Van Zwanenberg et al., 2000; Zywno, 2003). The criterion variable of satisfaction was measured by the mean of the eight course content questions obtained from the participant's end of course survey. The criterion variable of achievement was measured by the final course grade based on the following coding. A grade of A was coded as 4.0. A grade of B was coded as 3.0. A grade of C was coded as 2.0. A grade of D was coded as 1.0. A failure to complete the course whether with a grade of F or withdrawal was coded as 0.0.

Based on the previously discussed numeric values, the following bivariate correlation techniques were utilized for analyzing the correlation between the four dimensions of the ILS and student satisfaction or achievement. Student satisfaction was based on a Likert scale, which was considered to be ordinal. As previously discussed, the dimensions of the ILS were also considered ordinal scales. The data for achievement measured by final course grades was manipulated as rank scores. Consequently, use of the Rank-difference correlation (rho), otherwise known as Spearman's rho, was appropriate for analysis of the relationship between the four dimensions of the ILS and student satisfaction or achievement. Alternatively, Kendall's tau was utilized only if sample sizes were less than 10 (Gall et al., 2006). However, an additional step of converting Kendall's tau to Pearson's Product-moment correlation coefficient, r, was

needed and possible. The formula, $r = \sin (3.141592654 * \tau * 0.5)$, was used to convert Kendall's tau to Pearson's r (as cited in Walker, 2003, p. 4).

Fisher's r to z Transformation

Once Spearman's rho was determined for each of the eight possible relationships corresponding to the four dimensions of the ILS and two different criterion variables, Fisher's r to z transformation was used to calculate values for z. Although this statistical procedure is normally used with Pearson's r, it can be used with Spearman's rho since "Spearman's ρ is the ordinary Pearson's correlation coefficient" (Wang, 2013, p. 1). The z-test was then used to analyze the eight null hypotheses of this current study to determine whether or not subject matter was a moderating variable. Hittner et al. (2003) recommended both the t-test and z-test in a comparison against six other statistical tests when considering Type I errors and statistical power simultaneously. However, Hittner et al. (2003) detailed the slight advantage that the z-test had over the t-test with regards to statistical power. Meng et al. (1992) also recommended the Fisher r to z transformation in lieu of t-tests when considering normality, small sample sizes, or extreme sample correlations. Kendall and Stuart (1979) and Fisher (1954) argued that the Fisher r to z transformation was "often" (as cited in Overton, 1998, p. 358) used in practice due to non-normal sample distributions. Driskell et al. (1992) was an example of a meta-analysis that specifically utilized the proposed methodology of bivariate correlations followed by the Fisher r to z transformation.

CHAPTER FOUR: FINDINGS

As previously discussed, the conceptual framework of this current study attempted to address the research gap regarding whether instruction should be matched to subject matter or individual student learning styles. Specifically, the current study attempted to determine whether potential relationships between students' learning styles and effectiveness were moderated by the subject matter of the course. In order to accomplish this purpose, data were collected and analyzed as described in chapter three and elaborated on in this chapter. The following findings have been presented and categorized as descriptive statistics, tests for homogeneity and irregularity in data, and findings concerning the null hypotheses.

Descriptive Statistics

In the fall of 2013, there were 38 sections of Mathematics for Liberal Arts with 841 enrolled students. There were 41 sections of Composition and Rhetoric with 869 students enrolled in the B term. The Composition and Rhetoric course was also offered in the C and D terms of the same fall semester, but these sections were not invited to participate, as there was already a comparable amount of students in each of the courses that had received an invitation to participate in the current study. Electronic invitations to participate were sent through Blackboard announcements and a follow-up email was sent to all students. For the Mathematics for Liberal Arts course, 87 students responded to the invitation to participate in the study, which resulted in a 10.34% response rate. For the Composition and Rhetoric course, 81 students responded to the invitation to participate, which resulted in a 9.32% response rate. There were 14 participants from the Mathematics for Liberal Arts course who provided consent but did not complete the ILS instrument. There were 26 participants from the Composition and Rhetoric

course who provided consent but did not complete the ILS instrument. The participants that did not complete the ILS survey were considered to have withdrawn from this study. There were 73 Mathematics for Liberal Arts participants that completed the study and 55 ENGL101 participants that completed the study. The data for the following statistical analyses were obtained from the completed responses and institutional records through the assistance of the university Information Technology (IT) department after course completion.

All data were analyzed with IBM SPSS Version 21. As previously discussed in chapter 3, the ILS data were re-coded to corresponding positive and negative odd numbers ranging from one to 11 based on previous studies (Cook et al., 2007; Henry 2008; Van Zwanenberg et al., 2000; Zywno, 2003). For this current study, the reflective, intuitive, verbal, and global dimensions were coded as positive scores. The active, sensing, visual, and sequential dimensions were coded as negative scores. The criterion variable of achievement measured by the final course grade was based on the following coding. A grade of A was coded as 4.0. A grade of B was coded as 3.0. A grade of C was coded as 2.0. A grade of D was coded as 1.0. A failure to complete the course whether with a grade of F or withdrawal from the course was coded as 0.0. The satisfaction data were re-coded as follows. A response of strongly disagree was coded as 1. A response of disagree was coded as 2. A response of agree was coded as 3. A response of strongly agree was coded as 4. Values were not assigned and excluded for not applicable responses. The criterion variable of mean satisfaction was calculated by the mean of the eight re-coded satisfaction responses.

The data collected resulted in comprehensive data for all 128 participants with regards to gender, age, undergraduate GPA, ILS data, and course grades. The high school GPA data were

available for 19 participants (nine from Mathematics for Liberal Arts and 10 from Composition and Rhetoric), while the SAT scores were only available for eight participants (three from Mathematics for Liberal Arts and five from Composition and Rhetoric) in the current study. This data resulted in the descriptive statistics for undergraduate GPA, age, high school GPA, and SAT scores as shown by Table 1.

Table 1

Comparison of Group Statistics for Indicated Variables

Variable	Groups	N	Mean	Std. Deviation	Std. Error Mean
UG_GPA	Math	73	3.30	.595	.070
	English	55	3.22	.692	.093
Age	Math	73	39.2	12.66	1.48
	English	55	38.8	13.90	1.87
HS_GPA	Math	9	2.89	.575	.192
	English	10	2.86	.498	.158
SAT_VERBAL	Math	3	666.7	20.82	12.02
	English	5	598.0	66.86	29.90
SAT_MATH	Math	3	560.0	26.46	15.28
	English	5	512.0	109.18	48.83
SAT_WRITING	Math	3	543.3	35.12	20.28
	English	4	530.0	58.31	29.15

The comprehensive data for the ILS and course grades resulted in the scatter plots shown by Figure 1, Figure 2, Figure 3, and Figure 4. For course satisfaction, only seven participants completed the end of course surveys for the Composition and Rhetoric course as shown by Figure 5, Figure 6, Figure 7, and Figure 8. However, 54 participants completed the end of course surveys for the Mathematics for Liberal Arts course as represented in the same figures.

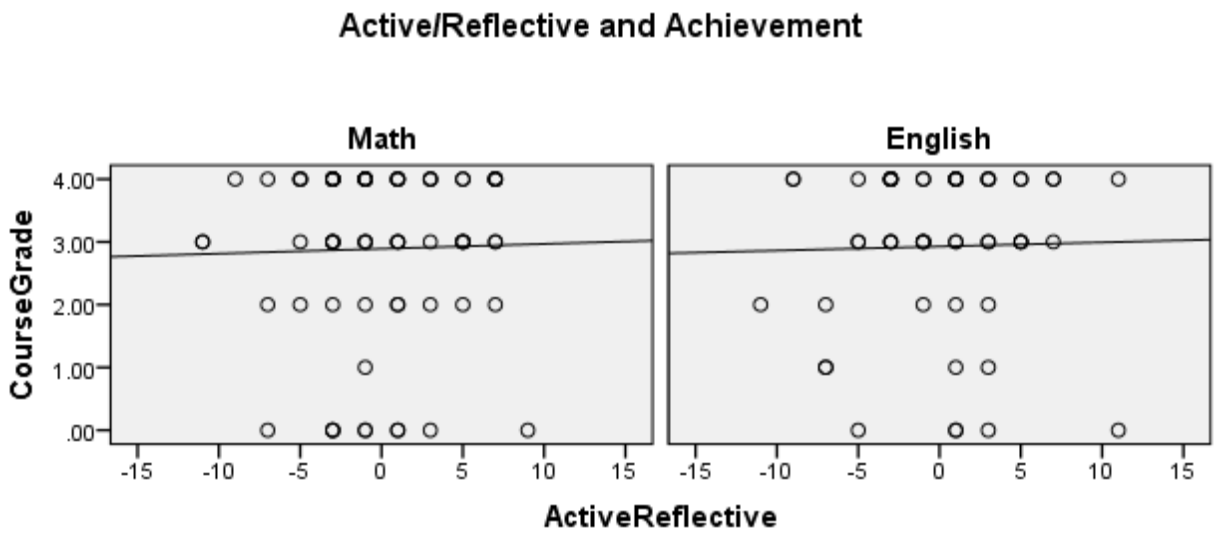

Figure 1. Active/Reflective and achievement scatter plot (2013). This figure illustrates the scatter plot of the active or reflective dimension of the ILS and course achievement by comparison groups.

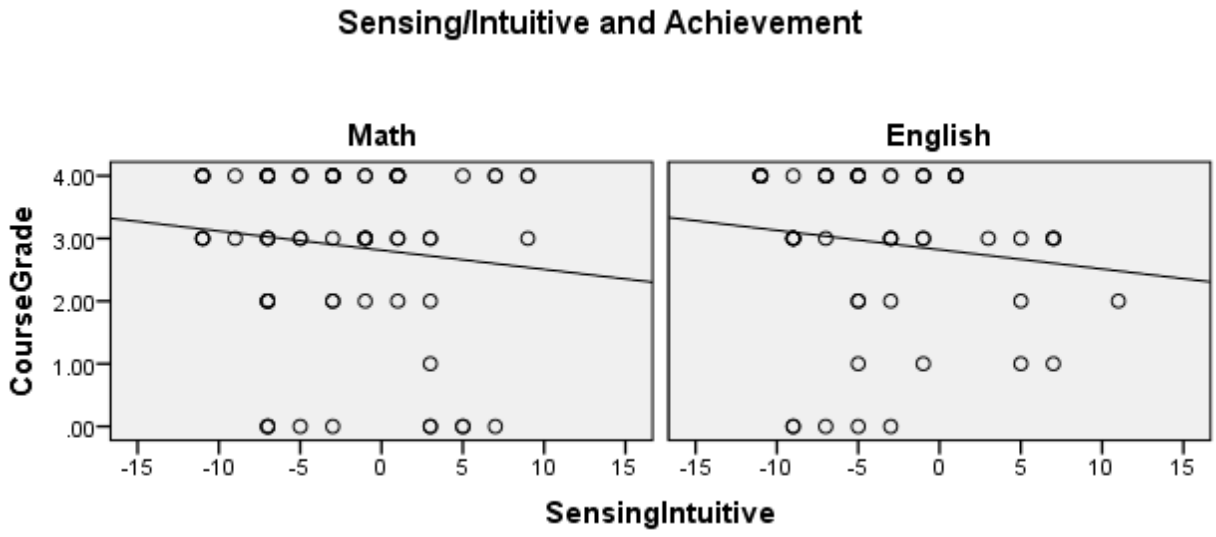

Figure 2. Sensing/Intuitive and achievement scatter plot (2013). This figure illustrates the scatter plot of the sensing or intuitive dimension of the ILS and course achievement by comparison groups.

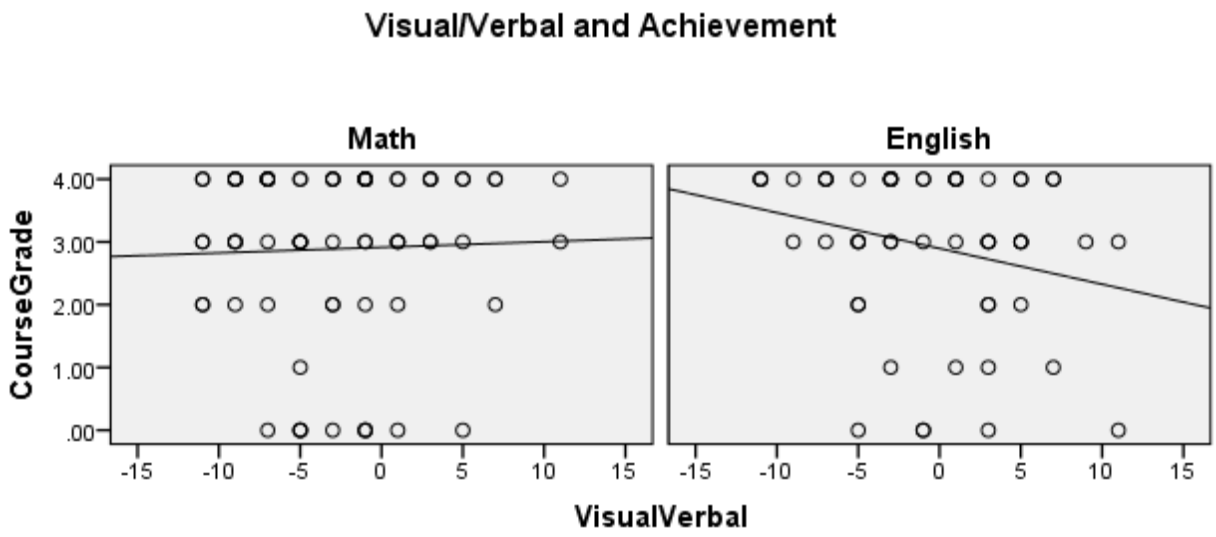

Figure 3. Visual/Verbal and achievement scatter plot (2013). This figure illustrates the scatter plot of the visual or verbal dimension of the ILS and course achievement by comparison groups.

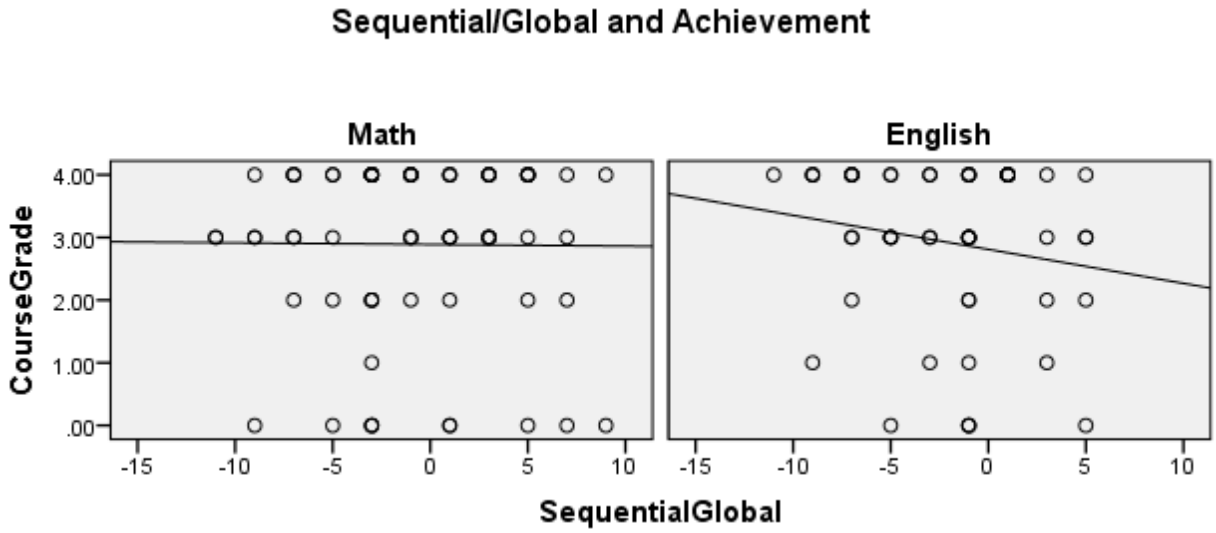

Figure 4. Sequential/Global and achievement scatter plot (2013). This figure illustrates the scatter plot of the sequential or global dimension of the ILS and course achievement by comparison groups.

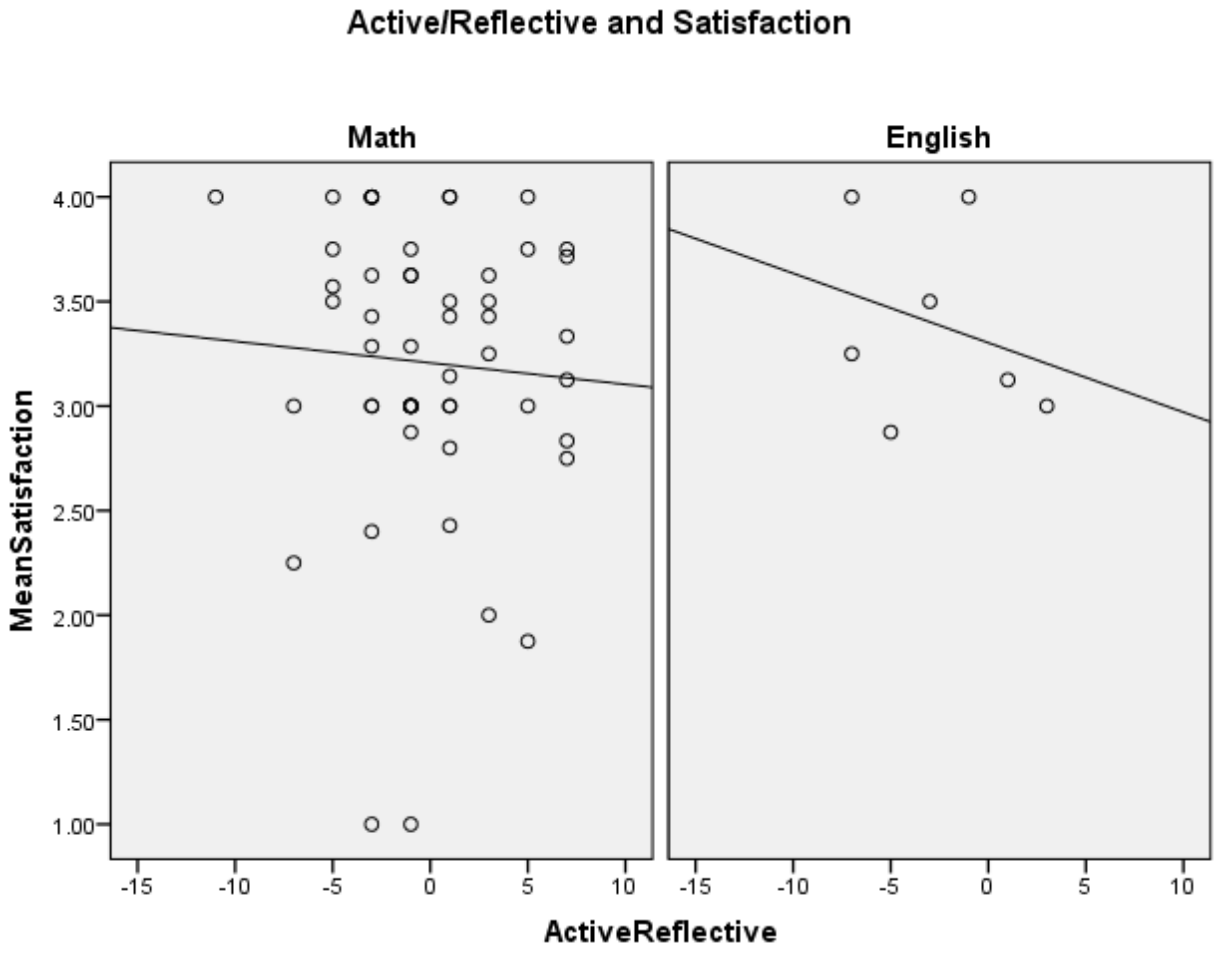

Figure 5. Active/Reflective and satisfaction scatter plot (2013). This figure illustrates the scatter plot of the active or reflective dimension of the ILS and course satisfaction by comparison groups.

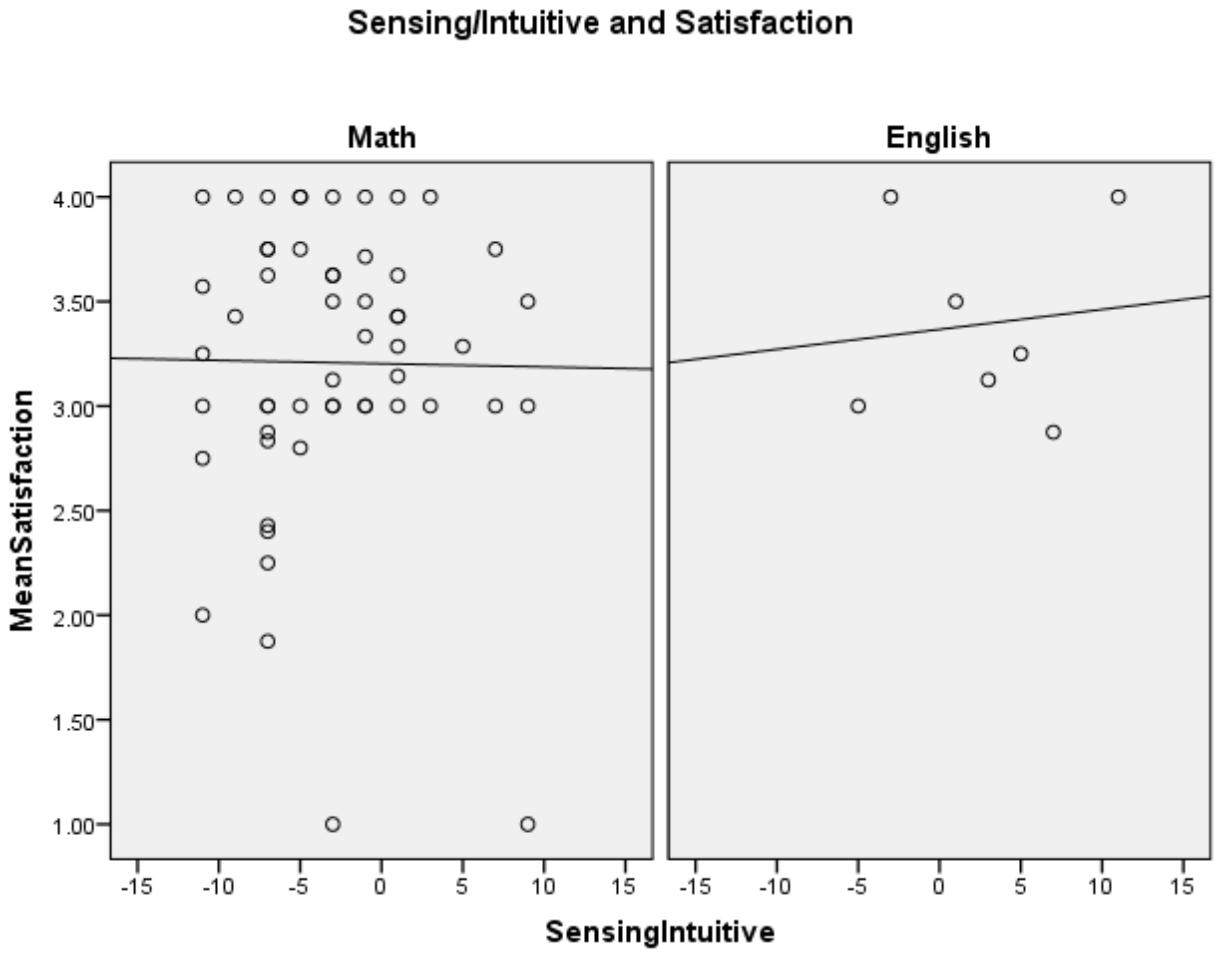

Figure 6. Sensing/Intuitive and satisfaction scatter plot (2013). This figure illustrates the scatter plot of the sensing or intuitive dimension of the ILS and course satisfaction by comparison groups.

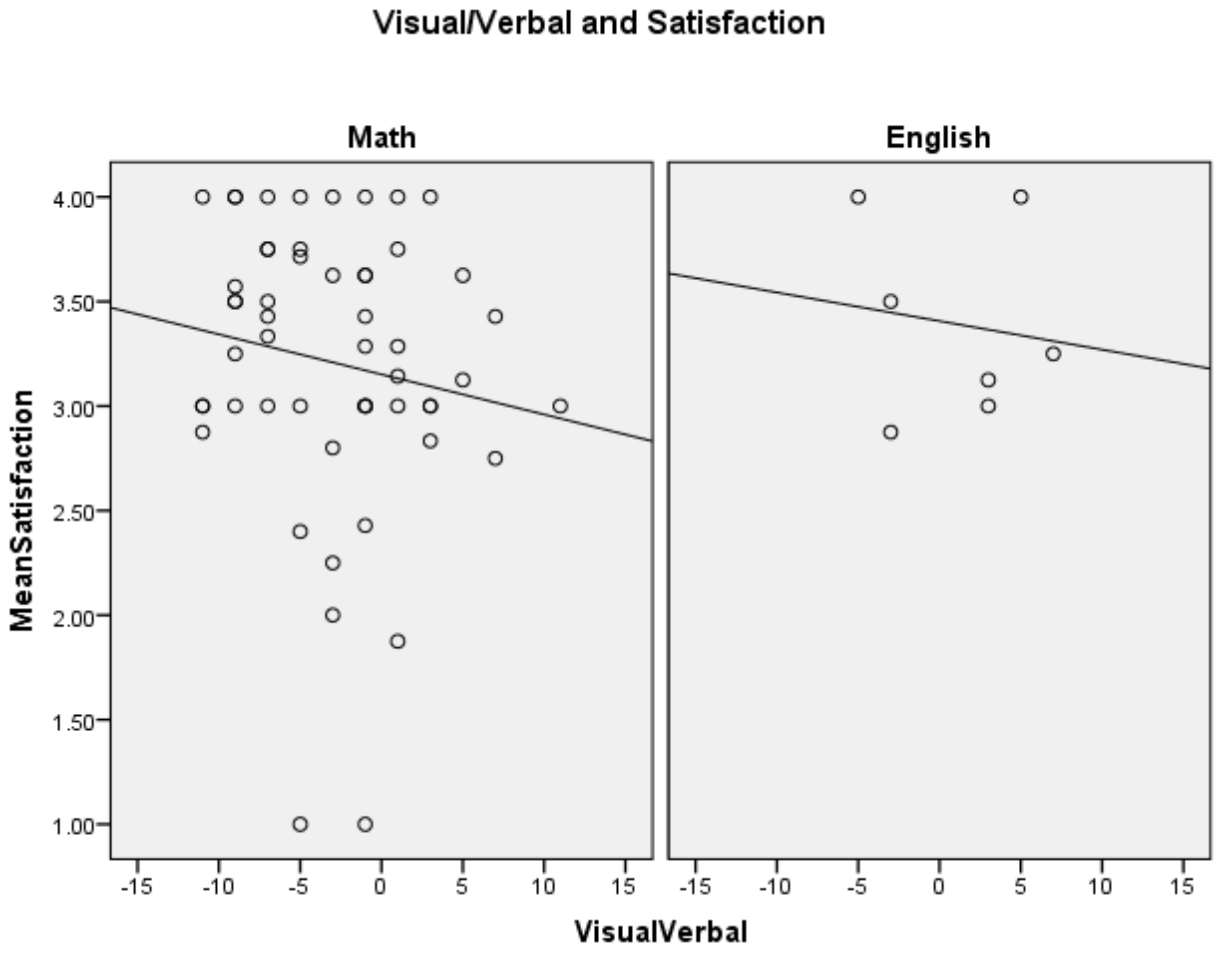

Figure 7. Visual/Verbal and satisfaction scatter plot (2013). This figure illustrates the scatter plot of the visual or verbal dimension of the ILS and course satisfaction by comparison groups.

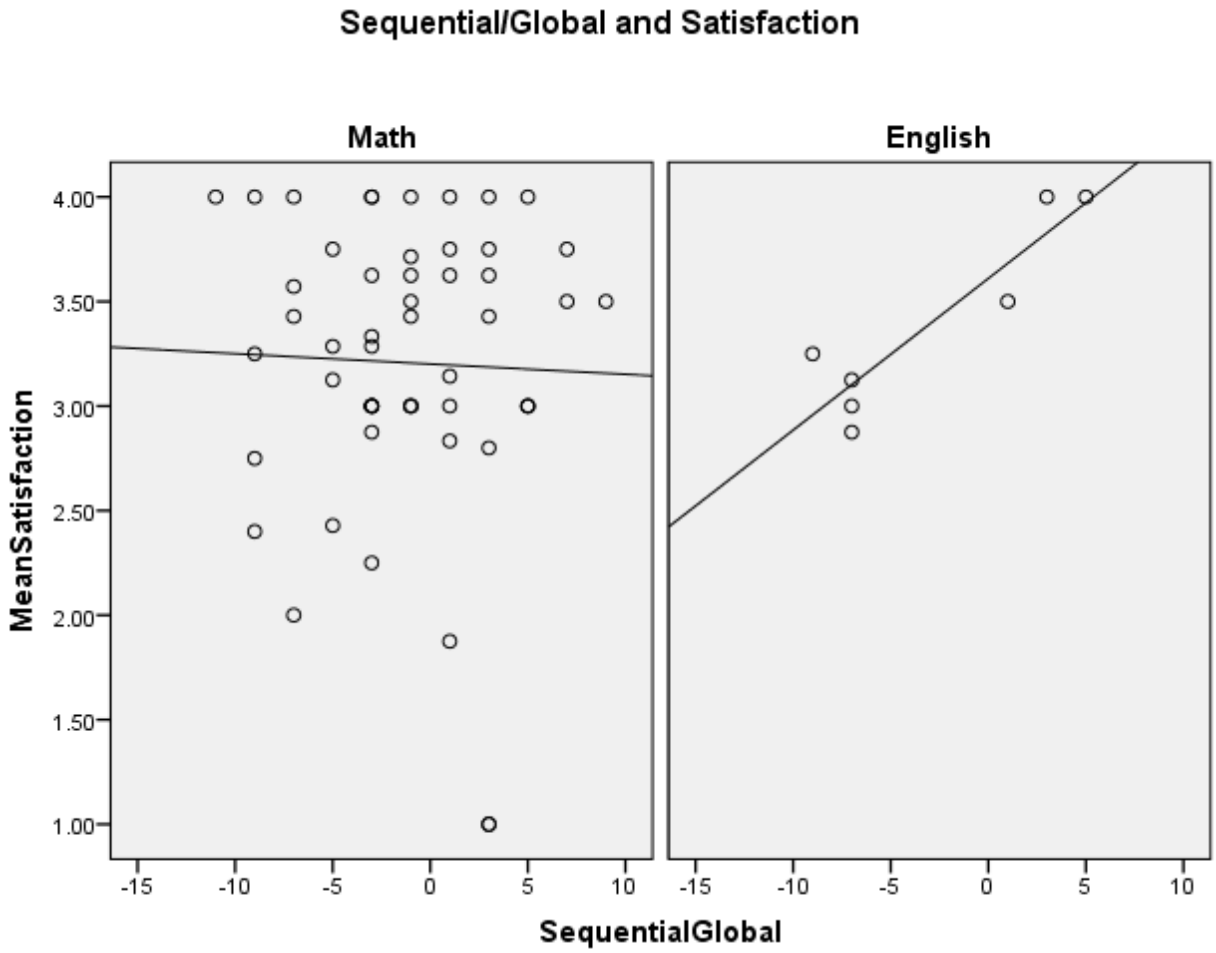

Figure 8. Sequential/Global and satisfaction scatter plot (2013). This figure illustrates the scatter plot of the sequential or global dimension of the ILS and course satisfaction by comparison groups.

Tests for Homogeneity and Irregularity in Data

The following tests for homogeneity were performed in order to determine whether or not the two comparison groups of Mathematics for Liberal Arts and Composition and Rhetoric were comparable. Determining whether or not the two comparison groups were comparable was essential, since this study attempted to isolate for causal effects. Specifically, the purpose of this study was to determine whether or not subject matter was the cause of moderating effects between students' learning styles and effectiveness. Consequently, these findings were an

integral part of subsequent findings concerning the specific null hypotheses of the current study. These findings for the tests for homogeneity established the basis for subsequent discussions of the findings concerning the null hypotheses of the current study.

Specific Homogeneity Tests

The following were the findings for the specific tests for homogeneity utilized for the current study. T-tests were utilized for undergraduate GPA, age, high school GPA, and SAT scores because of the interval or ratio scales of these variables. The t-tests resulted in the data presented in Table 2.

Table 2

T-tests Equal Variances Assumed

					95% Confidence Interval of the Difference	
Variable	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
UG_GPA	126	0.463	0.084	0.114	-0.142	0.310
Age	126	0.867	0.396	2.358	-4.269	5.062
HS_GPA	17	0.916	0.026	0.246	-0.493	0.546
SAT_VERBAL	6	0.144	68.667	40.821	-31.219	168.553
SAT_MATH	6	0.495	48.000	66.051	-113.62	209.620
SAT_WRITING	5	0.743	13.333	38.442	-85.485	112.151

Note. All confidence intervals contained zero thus there is no significant difference in the means.

Table 2 demonstrated that there are no significant differences in the means for several variables (undergraduate GPA, age, high school GPA, SAT VERBAL, SAT MATH, SAT WRITING) based on t-tests. All confidence levels contained zero and no p-value was significant at $\alpha = 0.05$. The t-test results for high school GPA data were based on 19 participants (nine from Mathematics for Liberal Arts and 10 from Composition and Rhetoric). The t-tests results for the

SAT scores were based on eight participants (three from Mathematics for Liberal Arts and five from Composition and Rhetoric) in the current study. So, the t-test findings for these two variables could be viewed dubiously due to the low N.

Table 3 shows the results of the follow-up Mann-Whitney U tests that were conducted to compare against the results of the t-tests for high school GPA and SAT scores due to the low N for these variables. Table 3 showed that these variables have respective U values of 0.720, 0.143, 0.786, and 0.857, which were not significant at $\alpha = 0.05$. The additional nonparametric Mann-Whitney U tests supported that there were no significant differences for high school GPA, SAT VERBAL, SAT MATH, or SAT WRITING.

Table 3
Mann-Whitney U Test for High School GPA and SAT Scores

Variable	Sig.
HS_GPA	0.720
SAT_VERBAL	0.143
SAT_MATH	0.786
SAT_WRITING	0.857

Consequently, both comparison groups were comparable with regards to high school GPA and SAT scores based on consistent results from the independent samples t-tests and the Mann-Whitney U tests. In contrast to the low N for high school GPA and SAT scores, the t-tests for undergraduate GPA and age were based on N = 128. Consequently, the results of the t-tests for these two variables were reliable and both comparison groups were comparable with regards to undergraduate GPA and age.

The gender data were analyzed with the Pearson Chi-Square test for equality among the two samples because they were categorical scores. The minimum expected count was 20.20. No

cells had an expected count less than five. The Chi-Square test resulted in a Chi-square value of 1.401 with a degree of freedom of one and a p-value of 0.237. Table 4 below summarized the gender comparison of both groups.

Table 4

Gender Comparison Groups Cross-tabulation

Subhead	Gender	Math n(%)	English n(%)	Total
	F	43(58.9)	38(69.1)	81
	M	30(41.1)	17(30.9)	47
Total		73(100.0)	55(100.0)	128

Gender was comparable for the Mathematics for Liberal Arts and Composition and Rhetoric groups. Table 4 showed that 58.9% of the Mathematics for Liberal Arts group was female while 41.1% of the group was male. This was in contrast to the 69.1% of females in the Composition and Rhetoric group and 30.9% male participants. In spite of this apparent difference, the Pearson Chi-Square test resulted in a p-value of 0.237, which was not significant at $\alpha = 0.05$. Consequently, both groups were once again comparable when gender was analyzed.

The nonparametric Mann-Whitney U test was utilized to determine homogeneity of the Mathematics for Liberal Arts and Composition and Rhetoric groups for the four dimensions of the ILS. The results shown by Table 5 were supplemented by additional analysis presented by Table 6, Table 7, and Figure 9. Table 5 showed no significant differences between comparison groups for the active/reflective, sensing/intuitive, or sequential/global dimensions of the ILS. The corresponding U values of 0.890, 0.279, and 0.134 were not significant at $\alpha = 0.05$. Consequently, both groups were comparable with regards to three of four dimensions of the ILS.

Table 5
Mann-Whitney U Test for Homogeneity between Comparison Groups

ILS Dimension	Sig.
ActiveReflective	0.890
SensingIntuitive	0.279
VisualVerbal	0.034*
SequentialGlobal	0.134

*. Significant at .05

Table 6

Comparison of Group Statistics for the Visual/Verbal Dimension of the ILS

ILS dimension	Groups	N	Mean	Std. Deviation	Std. Error Mean
VisualVerbal	Math	73	-2.64	5.43	0.64
	English	55	-0.56	5.53	0.75

Table 7

Frequency of Scores for the Visual/Verbal Dimension of the ILS

	Visual/Verbal	Math	English	Total
Subhead	score	n	n	n
	-11	6	3	9
	-9	8	2	10
	-7	8	4	12
	-5	10	7	17
	-3	7	8	15
	-1	13	5	18
	1	7	6	13
	3	5	8	13
	5	4	6	10
	7	3	3	6
	9	0	1	1
	11	2	2	4
Total		73	55	128

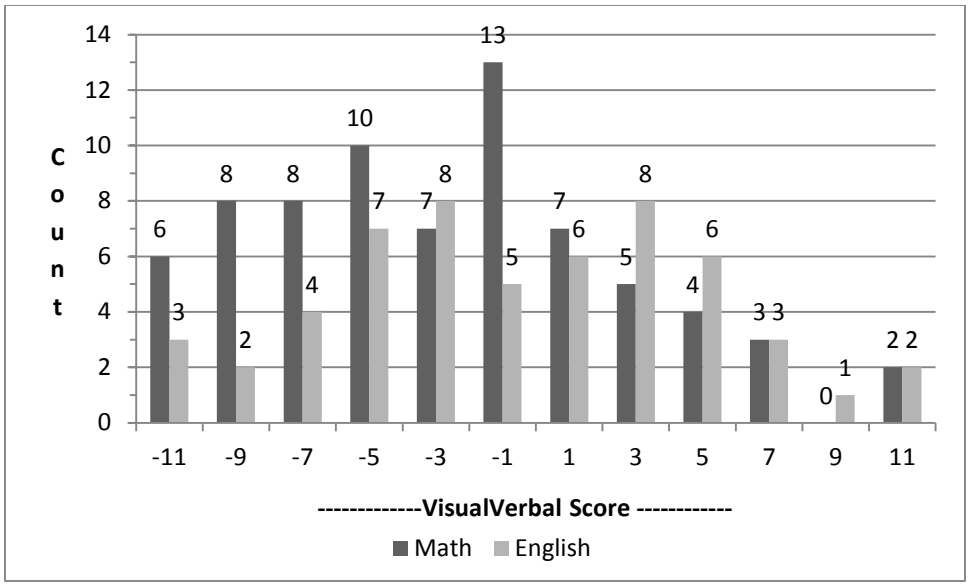

Figure 9. Distribution of scores for the visual/verbal dimension of the ILS (2013). This figure illustrates a comparison of the distribution of scores for the visual/verbal dimension of the ILS.

Both sample groups (Mathematics for Liberal Arts and Composition and Rhetoric) were comparable as only one of 11 variables had a statistically significant difference. The findings for the bivariate correlations and resulting comparisons were more critically examined for the visual/verbal dimension of the ILS, as the single variable for the two comparison groups was not statistically equal. This potentially affected two of the eight null hypotheses of this current study. The findings are discussed below in regards to this irregularity in data.

Irregularity in Data

As the findings in Table 5 demonstrated, there was only one area of concern with the homogeneity of the two sample groups (Mathematics for Liberal Arts and Composition and Rhetoric). Table 5 showed that there was a statistically significant difference with the visual/verbal dimension of the ILS between the two comparison groups. The U value of 0.034 for the visual/verbal dimension was significant at $\alpha = 0.05$. Table 6 showed that the Mathematics for Liberal Arts comparison group was more significantly visual learners than the

Composition and Rhetoric group, with a mean of -2.64 compared to a mean of -0.56. Figure 9 demonstrated this finding graphically with a comparison of the distribution of scores for the visual/verbal dimension of the ILS. Table 7 detailed the specific counts for each score.

Findings Concerning the Null Hypotheses

With the exception of the one area of irregularity, the findings of the tests for homogeneity determined that both the Mathematics for Liberal Arts and Composition and Rhetoric groups were comparable. With this foundation established, the following findings pertaining directly to the eight null hypotheses of this study were analyzed with bivariate correlations. The following specific bivariate correlation techniques were utilized for comparing the correlation coefficients of the two comparison groups with regards to the four dimensions of the ILS and student satisfaction or achievement. The primary difference in analysis between the criterion variable of achievement and satisfaction was the specific correlation coefficient utilized for statistical analysis.

Null Hypotheses for Achievement

The Rank-difference correlation (rho), otherwise known as Spearman's rho, was used for analysis of the relationship between the four dimensions of the ILS and achievement because of the sufficient N for both comparison groups. These four relationships were illustrated by Figures 1 through 4 and pertained to the first four null hypotheses of this current study. Additional statistical analysis resulted in the following. Table 8 below summarized the results of Spearman's rho, Fisher r to z transformations, and z-tests for the four dimensions of the ILS and achievement.

Table 8

Spearman Rho Comparison for ILS Dimensions and Achievement

ILS Dimension	Group	Spearman Rho	N	z	*p*-value (two-tailed)
Active/Reflective	MATH	0.010	73	-0.21	0.8337
	ENGLISH	0.048	55		
Sensing/Intuitive	MATH	-0.082	73	0.53	0.5961
	ENGLISH	-0.178	55		
Visual/Verbal	MATH	0.052	73	1.66	0.0969
	ENGLISH	-0.246	55		
Sequential/Global	MATH	0.039	73	1.07	0.2846
	ENGLISH	-0.155	55		

Specifically, the Fisher r to z transformations and z-tests were calculated as follows. The Spearman's Rho from Table 8 and the corresponding N for each comparison group was used to calculate a z-value and p-value through Lowry (2013). The following were the findings of these statistical analyses as they pertained to the first four null hypotheses of the current study.

The first null hypothesis of the current study was:

1. The correlation between the Index of Learning Styles measure of active/reflective learning style and student achievement (measured by course grade) for students completing an English course does not differ significantly from that of students completing a Math course.

Figure 1 illustrated that the correlation coefficients of both comparison groups were similar, if not identical. The corresponding bivariate statistical analysis and Fisher r to z comparison followed by the z-test substantiated this observation. For the active/reflective dimension and achievement, the use of Lowry (2013) with Spearman's rho of 0.010 and N = 73 for the Mathematics for Liberal Arts group and Spearman's rho of .048 and N =55 for the Composition and Rhetoric group resulted in the z-value of -0.21 and a two-tailed p-value of 0.834, which was not statistically significant. Consequently, the first null hypothesis was retained. The correlation

between the ILS measure of active/reflective learning style and student achievement (measured by course grade) for students that completed an English course did not differ significantly from that of those students that completed a Math course.

The second null hypothesis of the current study was:

2. The correlation between the Index of Learning Styles measure of sensing/intuitive learning style and student achievement (measured by course grade) for students completing an English course does not differ significantly from that of students completing a Math course.

Figure 2 showed that the correlation coefficients of both comparison groups were similar, if not identical. For this sensing/intuitive dimension and achievement, the use of Lowry (2013) with Spearman's rho of -0.082 and N = 73 for the Mathematics for Liberal Arts group and Spearman's rho of -.178 and N =55 for the Composition and Rhetoric group resulted in a z-value of 0.53 and a two-tailed p-value of 0.596, which was not statistically significant. Consequently, the second null hypothesis was retained. The correlation between the ILS measure of sensing/intuitive learning style and student achievement (measured by course grade) for students that completed an English course did not differ significantly from that of those students that completed a Math course.

The third null hypothesis of the current study was:

3. The correlation between the Index of Learning Styles measure of visual/verbal learning style and student achievement (measured by course grade) for students completing an English course does not differ significantly from that of students completing a Math course.

Figure 3 indicated that the correlation coefficients of both comparison groups with regards to the visual/verbal dimension might not be similar. However, statistical analysis determined otherwise. For this visual/verbal dimension and achievement, the use of Lowry (2013) with Spearman's rho of 0.052 and N = 73 for the Mathematics for Liberal Arts group and Spearman's rho of -0.246 and N =55 for the Composition and Rhetoric group resulted in a z-value of 1.66 and a two-tailed p-value of 0.097, which was not statistically significant. The third null hypothesis was retained. The correlation between the ILS measure of visual/verbal learning style and student achievement (measured by course grade) for students that completed an English course did not differ significantly from that of those students that completed a Math course.

The fourth null hypothesis of the current study was:

4. The correlation between the Index of Learning Styles measure of sequential/global learning style and student achievement (measured by course grade) for students completing an English course does not differ significantly from that of students completing a Math course.

Similar to the findings of the visual/verbal dimension of the ILS, Figure 4 indicated that the correlation coefficients of both comparison groups with regards to the sequential/global dimension might not be similar. However, statistical analysis also determined otherwise. For the sequential/global dimension and achievement, the use of Lowry (2013) with Spearman's rho of 0.039 and N = 73 for the Mathematics for Liberal Arts group and Spearman's rho of -0.155 and N =55 for the Composition and Rhetoric group resulted in a z-value of 1.07 and a two-tailed p-value of 0.285, which was not statistically significant. The fourth null hypothesis was retained. The correlation between the ILS measure of sequential/global learning style and student

achievement (measured by course grade) for students completing an English course did not differ significantly from that of those students that completed a Math course.

Null Hypotheses for Satisfaction

In contrast to the use of Spearman's Rho for the first four null hypotheses, Kendall's tau was more appropriate for analyzing the relationship between the four dimensions of the ILS and satisfaction because of the insufficient N for the Composition and Rhetoric comparison group. As previously discussed, Kendall's tau was recommended for sample sizes less than N = 10 (Gall et al., 2006). Table 9 showed the results for Kendall's tau and converted r based on Kendall's formula (as cited in Walker, 2003, p. 4). Table 9 also summarized the results of the Fisher r to z transformations and z-tests for the four dimensions of the ILS and satisfaction.

Table 9
Kendall Tau to Pearson Product-moment Conversion and Mean Satisfaction

ILS Dimension	Group	Tau	Converted r	N	z	*p*-value (two-tailed)
Active/Reflective	MATH	-0.087	-0.136	54	0.51	0.6101
	ENGLISH	-0.250	-0.383	7		
Sensing/Intuitive	MATH	0.064	0.100	54	0.19	0.8493
	ENGLISH	0.000	0.000	7		
Visual/Verbal	MATH	-0.125	-0.195	54	-0.38	0.7039
	ENGLISH	0.000	0.000	7		
Sequential/Global	MATH	0.020	0.031	54	-2	0.0455
	ENGLISH	0.580	0.790	7		

Specifically, the Fisher r to z transformations and z-tests were calculated as follows. The converted r from Table 9 and the corresponding N for each comparison group was used to calculate a z-value and p-value through Lowry (2013). The following were the findings for comparing the correlation coefficients of the two comparison groups and pertained to the last four null hypotheses of the current study. Figures 5 through 8 also illustrated these four relationships.

The fifth null hypothesis of the current study was:

5. The correlation between the Index of Learning Styles measure of active/reflective learning style and student satisfaction (measured by end-of-course surveys) for students completing an English course does not differ significantly from that of students completing a Math course.

Figure 5 illustrated that the correlation coefficients of both comparison groups were similar. The corresponding bivariate statistical analysis and Fisher r to z comparison followed with the z-test substantiated this observation. For the active/reflective dimension and satisfaction, the use of Lowry (2013) with a converted r of -0.136 and N = 54 for the Mathematics for Liberal Arts group and a converted r of -0.383 and N =7 for the Composition and Rhetoric group resulted in a z-value of 0.51 and a two-tailed p-value of 0.610, which was not statistically significant. Consequently, the fifth null hypothesis was retained. The correlation between the Index of Learning Styles measure of active/reflective learning style and student satisfaction (measured by end-of-course surveys) for students that completed an English course did not differ significantly from that of those students that completed a Math course.

The sixth null hypothesis of the current study was:

6. The correlation between the Index of Learning Styles measure of sensing/intuitive learning style and student satisfaction (measured by end-of-course surveys) for students completing an English course does not differ significantly from that of students completing a Math course.

Figure 6 also illustrated that the correlation coefficients of both comparison groups were similar. For this sensing/intuitive dimension and satisfaction, the use of Lowry (2013) with a converted r

of 0.100 and N = 54 for the Mathematics for Liberal Arts group and a converted r of 0.000 and N =7 for the Composition and Rhetoric group resulted in a z-value of 0.19 and a two-tailed p-value of 0.849, which was not statistically significant. Consequently, the sixth null hypothesis was retained. The correlation between the Index of Learning Styles measure of sensing/intuitive learning style and student satisfaction (measured by end-of-course surveys) for students that completed an English course did not differ significantly from that of those students that completed a Math course.

The seventh null hypothesis of the current study was:

7. The correlation between the Index of Learning Styles measure of visual/verbal learning style and student satisfaction (measured by end-of-course surveys) for students completing an English course does not differ significantly from that of students completing a Math course.

Figure 7 also illustrated that the correlation coefficients of both comparison groups were similar. For this visual/verbal dimension and satisfaction, the use of Lowry (2013) with a converted r of -0.195 and N = 54 for the Mathematics for Liberal Arts group and a converted r of 0.000 and N =7 for the Composition and Rhetoric group resulted in a z-value of -0.38 and a two-tailed p-value of 0.704, which was not statistically significant. Consequently, the seventh null hypothesis was retained. The correlation between the Index of Learning Styles measure of visual/verbal learning style and student satisfaction (measured by end-of-course surveys) for students that completed an English course did not differ significantly from that of those students that completed a Math course.

The eighth null hypothesis of the current study was:

8. The correlation between the Index of Learning Styles measure of sequential/global learning style and student satisfaction (measured by end-of-course surveys) for students completing an English course does not differ significantly from that of students completing a Math course.

In contrast to retaining the null hypotheses for the first seven null hypotheses, Figure 8 showed that the correlation coefficients appeared to be dissimilar. The corresponding bivariate statistical analysis and Fisher r to z comparison followed with the z-test substantiated this observation. For the sequential/global dimension and satisfaction, the use of Lowry (2013) with a converted r of 0.031 and N = 54 for the Mathematics for Liberal Arts group and a converted r of 0.790 and N =7 for the Composition and Rhetoric group resulted in a z-value of -2.00 and a two-tailed p-value of 0.046, which was statistically significant. Consequently, the eighth null hypothesis was rejected. The correlation between the Index of Learning Styles measure of sequential/global learning style and student satisfaction (measured by end-of-course surveys) for students that completed an English course differed significantly from that of those students that completed a Math course.

Validity of the ILS Instrument

Though not originally planned for and detailed by the methodology in chapter three, the following nonparametric bivariate correlations presented by Table 10 were performed with SPSS for the current study. The correlations were performed with Spearman's rho due to the ordinal scales of the ILS dimensions. The findings presented in Table 10 below were pertinent to the validity of the ILS instrument because they demonstrated the apparent independence of the constructs measured by the ILS.

Table 10

Nonparametric Bivariate Correlations of Spearman's Rho for ILS Dimensions

ILS Dimension	Subhead	ActiveReflective	SensingIntuitive	VisualVerbal	SequentialGlobal
ActiveReflective	Correlation Coefficient	1.000			
	Sig. (2-tailed)	.			
SensingIntuitive	Correlation Coefficient	-.070	1.000		
	Sig. (2-tailed)	.429	.		
VisualVerbal	Correlation Coefficient	.324**	.031	1.000	
	Sig. (2-tailed)	.000	.728	.	
SequentialGlobal	Correlation Coefficient	.023	.490**	-.111	1.000
	Sig. (2-tailed)	.793	.000	.213	.

**. Correlation is significant at the 0.01 level (2-tailed).

Summary of Results

The descriptive statistics of this chapter showed a low response rate for the current study of 10.34% for Mathematics for Liberal Arts students and 9.32% for Composition and Rhetoric students. The current study used two different samples because of the focus on the potential moderation effect of subject matter. Determining whether or not the two comparison groups were comparable was essential since this study attempted to isolate for causal effects. The specific tests for homogeneity demonstrated that both sample groups (Mathematics for Liberal Arts and Composition and Rhetoric) were "reasonably homogeneous" (Gall et al., 2006, p. 338) since only one of 11 variables analyzed had a statistically significant difference. This irregularity in data pertained only to the visual/verbal dimension of the ILS. There were no significant differences for the following variables: undergraduate GPA, age, high school GPA, SAT VERBAL, SAT MATH, SAT WRITING, gender, active/reflective dimension of the ILS, sensing/intuitive dimension of the ILS, and sequential/global dimension of the ILS. Following the tests for homogeneity, the eight null hypotheses of this current study were evaluated with

bivariate correlation techniques, followed by Fisher r to z and z-tests. Seven of the eight null hypotheses were retained. The correlation between the Index of Learning Styles measure of all four dimensions (active/reflective, sensing/intuitive, visual/verbal, and sequential/global) of learning style and student achievement (measured by course grade) for students that completed an English course did not differ significantly from that of those students that completed a Math course. The correlation between the Index of Learning Styles measure of three dimensions (active/reflective, sensing/intuitive, and visual/verbal) of learning style and student satisfaction (measured by end-of-course surveys) for students that completed an English course did not differ significantly from that of those students that completed a Math course. However, the eighth null hypothesis was rejected. The correlation between the Index of Learning Styles measure of sequential/global learning style and student satisfaction (measured by end-of-course surveys) for students that completed an English course differed significantly from that of those students that completed a Math course. Additional bivariate correlations of the four dimensions of the ILS instrument performed with the data of this current study showed that the ILS appeared to be a valid instrument because of the apparent independence of the constructs measured by the ILS.

CHAPTER FIVE: DISCUSSION

The following summary, discussion, limitations, implications, and recommendations were derived from the findings of the current study, which attempted to determine whether the potential relationships between students' learning styles and effectiveness were moderated by the subject matter of the course. With regards to the purpose of the current study, the findings and discussions demonstrated that subject matter was a moderating variable for learning styles and effectiveness only with regards to the sequential/global dimension of the ILS and course satisfaction. The following summary of findings provides the foundation for the subsequent discussions of the current causal relationship study.

Summary of Findings

The findings of chapter four showed a low response rate for the current study of 10.34% for Mathematics for Liberal Arts students and 9.32% for Composition and Rhetoric students. However, the number of participants in each sample for the current study exceeded the minimum of 30 participants desired for correlational studies (Gall et al., 2006). The current study used two different samples because of the focus on the potential moderation effect of subject matter. Tests for homogeneity of the sample groups assisted in minimizing threats to internal validity. Determining whether or not the two comparison groups were comparable was essential since this study attempted to isolate for causal effects. Specifically, the purpose of this study was to determine whether or not subject matter was the cause of moderating effects between students' learning styles and effectiveness.

The tests for homogeneity for the current study demonstrated that both the Mathematics for Liberal Arts and Composition and Rhetoric groups were comparable. Table 2 showed that

there were no significant differences in the means for several variables (undergraduate GPA, age, high school GPA, SAT VERBAL, SAT MATH, and SAT WRITING) based on independent samples t-tests. Nonparametric Mann-Whitney U tests were necessary because of the low N for high school GPA and SAT scores. These tests also supported the conclusion of the t-tests that there were no significant differences for high school GPA, SAT VERBAL, SAT MATH, or SAT WRITING for the two comparison groups. The Pearson Chi-Square test showed that gender was also comparable for the two sample groups. The Mann-Whitney U test results of Table 5 showed that the two sample groups were comparable in three of the four dimensions of the ILS (active/reflective, sensing/intuitive, and sequential/global). As Table 5 illustrated, there was only one area of concern with regards to the homogeneity of the two sample groups. There was a statistically significant difference in the visual/verbal dimension of the ILS between the two comparison groups. This irregularity in data will be discussed in more detail subsequently as a limitation of the current study. However, both sample groups (Mathematics for Liberal Arts and Composition and Rhetoric) were clearly comparable and "reasonably homogeneous" (Gall et al., 2006, p. 338) since only one of 11 variables analyzed had a statistically significant difference. These findings for the tests for homogeneity were integral and established the basis for discussions concerning the eight specific null hypotheses of the current study.

The eight null hypotheses of the current study were evaluated with bivariate correlation techniques followed with Fisher r to z and z-tests. This first four relationships between the dimensions of the ILS and achievement for the two comparison groups were analyzed with Spearman's rho due to the scales of the instrument and sufficiency of the N values. For the active/reflective dimension and achievement, the z-value was computed to be -0.21 with a

resulting two-tailed p-value of 0.834, which was not statistically significant. For the sensing/intuitive dimension and achievement, the z-value was computed to be 0.53 with a resulting two-tailed p-value of 0.596, which was not statistically significant. For the visual/verbal dimension and achievement, the z-value was computed to be 1.66 with a resulting two-tailed p-value of 0.097, which was not statistically significant. For the sequential/global dimension and achievement, the z-value was computed to be 1.07 with a resulting two-tailed p-value of 0.285, which was also not statistically significant. Consequently, the first four null hypotheses were retained. The correlation between the Index of Learning Styles measure of all four dimensions (active/reflective, sensing/intuitive, visual/verbal, and sequential/global) of learning style and student achievement (measured by course grade) for students completing an English course did not differ significantly from that of those students that completed a Math course.

The last four relationships between the dimensions of the ILS and satisfaction for the two comparison groups were analyzed with Kendall's tau, followed by conversion with Lowry (2013) before Fisher r to z and z-tests. Kendall's tau was appropriate because of the scales of the ILS instrument and low N values. For the active/reflective dimension and satisfaction, the z-value was computed to be 0.51 with a resulting two-tailed p-value of 0.610, which was not statistically significant. For the sensing/intuitive dimension and satisfaction, the z-value was computed to be 0.19 with a resulting two-tailed p-value of 0.849, which was not statistically significant. For the visual/verbal dimension and satisfaction, the z-value was computed to be -0.38 with a resulting two-tailed p-value of 0.704, which was not statistically significant. Consequently, the correlation between the Index of Learning Styles measure of three dimensions

(active/reflective, sensing/intuitive, and visual/verbal) of learning and student satisfaction (measured by end-of-course surveys) for students that completed an English course did not differ significantly from that of those students that completed a Math course.

In contrast to these results, the z-value was computed to be -2.00 with a resulting two-tailed p-value of 0.046 for the sequential/global dimension and satisfaction, which was statistically significant. Consequently, the eighth null hypothesis was rejected. The correlation between the Index of Learning Styles measure of sequential/global learning style and student satisfaction (measured by end-of-course surveys) for students that completed an English course differed significantly from that of those students that completed a Math course.

Discussion of Findings

Rejection of the eighth null hypothesis meant that the current study reported similar results as Gee (1990) and Sahin (2008). Gee (1990) was a quantitative study based on the CLSI learning styles framework that reported a correlation between learning styles and performance. Sahin (2008) was based on the LSI learning styles framework, and reported that learning styles were correlated to satisfaction. As Figure 8 and Table 9 of the current study demonstrated, there was a high correlation (converted r of 0.790) in the Composition and Rhetoric group between the sequential/global dimension of the ILS and course satisfaction. The global learners were more satisfied with the course than the sequential learners. Sequential learners who understood information from logical or sequential steps (Felder & Solomon, n.d.b) were not as satisfied with the Composition and Rhetoric course. While Pashler et al. (2008) conjectured that, "the optimal curriculum for a writing course probably includes a heavy verbal emphasis" (p. 116), this study showed that optimal curriculum for an English course needs to consider the sequential/global

aspects of students' learning styles. The specific implications of this are subsequently discussed. However, the following immediate discussions pertain to the purpose of the current study, which was to determine if subject matter was a moderating variable of learning styles and student achievement and satisfaction.

As the current study reported, the correlation between the Index of Learning Styles' measure of sequential/global learning style and student satisfaction (measured by end-of-course surveys) for students that completed an English course differed significantly from that of those students that completed a Math course. Specifically, there was a high correlation (converted r of 0.790) in the Composition and Rhetoric group and a very low correlation (converted r of 0.031) in the Mathematics for Liberal Arts group with regards to the sequential/global dimension of the ILS and course satisfaction. As the tests for homogeneity (including no significant difference between groups in the sequential/global dimension of the ILS) for these two groups demonstrate homogeneity, subject matter is likely a cause of moderating effects between the sequential/global dimension of the Index of Learning Styles and student satisfaction. This means that subject matter needs to be considered in DE course designs in terms of the sequential/global dimension of the Index of Learning Styles.

As Coffield et al. (2004) perceptively described, the problem of current research is its neglect of the effects of subject matter. The current study was one of very few studies (Brenner, 1997; Eom et al., 2006; Sahin, 2008) that utilized multiple courses in different disciplines when studying learning styles in DE. This problem resulted in the following research question for this current study. Are potential relationships among students' learning styles and effectiveness in online education moderated by subject matter for undergraduate students at a private higher

education institution? The current study was designed to specifically evaluate course context or subject matter as a moderating variable between students' learning styles and effectiveness of DE. The previously presented findings for the current study demonstrated that subject matter did not appear to be a moderating variable in seven of eight relationships, but did appear to be a moderating variable in the sequential/global dimension of the Index of Learning Styles and student satisfaction. This was empirically significant to Henry's (2008) recommendation to explore relationships among learning styles and satisfaction in order to improve pedagogy.

The following are other conclusions regarding the significance of findings of the current study. While the current study sought to explore the minority paradigm that suggested instruction should be matched to subject matter rather than individual student learning styles in order to maximize the effectiveness of DE, the findings suggested otherwise. Curriculum design did not appear to need interventions designed to assist all learners based on subject matter with one exception—the sequential/global dimension of the Index of Learning Styles. As Pashler et al. (2008) argued for "using strong research methods to identify the optimal approach for each kind of subject matter" (p. 116), this current study identified an optimal approach to designing English courses with regards to the sequential/global dimension of the Index of Learning Styles, which affected student satisfaction. The specific pedagogical implications are subsequently discussed after presenting some limitations to this current study.

Limitations

The following are the limitations regarding this current study as they pertain to threats to external validity, threats to internal validity, or instrument reliability. The primary threat to external validity for this current study was caused by the low response rate of this current study

for both comparison groups. As detailed, the Mathematics for Liberal Arts course had a response rate of 10.34%, and the Composition and Rhetoric course had a response rate of 9.32%. "Nonresponse in surveys may be thought of as a pre-study attrition. This makes nonresponse error akin to selection bias in experiments…" (Sivo, Saunders, Chang, & Jiang, 2006, p. 354). This limitation was classified as a threat to external validity (Sivo et al., 2006) and resulted in a "population validity" (Gall et al., 2006, p. 389) issue regarding the ability to generalize the results of this study to a larger population. This problem also may present an issue regarding the inability to statistically reject the null hypotheses (Gall et al., 2006; Sivo et al., 2006). The inability to statistically reject the null hypotheses potentially affected the results of all null hypotheses of this current study. In other words, subject matter may indeed have been a moderating variable for the first seven null hypotheses, but the low response rates prevented detection of these relationships. Additionally, this threat to external validity could also have negated the finding to reject the eighth null hypothesis that the correlation between the Index of Learning Styles' measure of sequential/global learning style and student satisfaction (measured by end-of-course surveys) for students that completed an English course did not differ significantly from that of those students that completed a Math course.

Concerning threats to internal validity, the lack of random assignment to both comparison groups was a threat to internal validity known as "differential selection" (Gall et al., 2006, p. 386). However, the extensive tests for homogeneity adequately controlled for this potential limitation in all but the following area for this current study. Subject matter did not appear to be a moderating variable with regards to the visual/verbal dimension of the ILS and achievement or satisfaction. If the results had shown that subject matter was a moderating variable which

affected the strength or direction of relationships, then the lack of homogeneity between comparison groups for the visual/verbal dimension of the ILS as shown by Table 5, Table 6, and Figure 9 would be a source of significant concern. Whether it was the lack of homogeneity or the different subject matter that was the causation of the differences would have been unclear. However, the limitation that is currently present is that the lack of homogeneity in this dimension of the ILS could have affected the correlation relationships, subsequently masking a statistically significant difference in correlation coefficients between comparison groups with regards to the visual/verbal dimension of the ILS and achievement or satisfaction. In other words, subject matter could have been a moderating variable in the visual/verbal dimension and achievement or satisfaction, but was possibly masked by the nonhomogeneous comparison groups regarding this specific ILS dimension.

Another threat to internal validity present in this current study was the attrition or "experimental mortality" (Gall et al., 2006, p. 386) regarding students who withdrew from the study or did not complete the instrument used for satisfaction data. As the findings detailed, there were 14 participants from the Mathematics for Liberal Arts course who provided consent but did not complete the ILS instrument. There were 26 participants from the Composition and Rhetoric course who provided consent but did not complete the ILS instrument. Additionally, a larger weakness of this study was that only seven participants from the Composition and Rhetoric comparison group completed the satisfaction instrument at the end of their course. This especially exacerbated the previously discussed limitation regarding the inability to statistically reject the null hypotheses (Gall et al., 2006; Sivo et al., 2006). This means that the low response rate for the Composition and Rhetoric course and the low N for satisfaction for that group made

the results of the last four null hypotheses dubious, including not being able to reject the null hypotheses for the active/reflective, sensing/intuitive, and visual verbal dimensions of the ILS. However, the findings of the eighth null hypotheses were also made suspect. This was confounded by the final threat to internal validity present in this current study which concerned determining whether both comparison groups were "reasonably homogeneous" (Gall et al., 2006, p. 338). The use of the Mann-Whitney U tests because of the low N for high school GPA and SAT scores was another limitation of the current study.

Regarding instrument reliability, the ILS did not have good reliability. The highest Cronbach's alphas ranging from 0.61 to 0.78 were reported by Cook (2005). Hosford and Siders (2010) reported Cronbach's alphas ranging from 0.62 to 0.76. Zywno (2004) reported Cronbach's alphas ranging from 0.530 to 0.697. Van Zwanenberg et al. (2000) reported coefficients ranging from 0.41 to 0.65. Gall et al. (2006) recommended minimum reliability coefficients of 0.80 for research purposes, and Tuckman (1999) recommended reliability coefficients be at least 0.75 for achievement tests and 0.50 for attitude tests. Consequently, most of the reliability coefficients for the ILS instrument were below the minimum recommended by both Tuckman (1999) and Gall et al. (2006). Additionally, the use of Cronbach's alpha for determining internal consistency should be viewed tenuously. Van Zwanenberg et al. (2000) stated that the statistical use of the Cronbach's alpha was "difficult at best" (p. 370) given the bi-polar scales of the ILS. Gall et al. (2006) did not recommend Cronbach's alpha for items that are "scored dichotomously" (p. 202). Unfortunately, the ILS was based on dichotomous questions and all analyses previously presented regarding the internal consistency of the ILS were based on

Cronbach's alpha. Consequently, the reliability of the ILS instrument with regards to internal consistency should be considered a limitation of this current study.

Implications

In consideration of the limitations and findings of this current study, the following are the implications of this current causal relationship correlational study. As previously discussed, the conceptual framework of this current study attempts to address the research gap of whether instruction should be matched to subject matter rather than individual student learning styles. As subject matter does not appear to be a moderating variable in seven of eight relationships due to the findings of retaining the null hypotheses, the implication of this research is that course designers for DE generally do not need to match curriculum to subject matter with regards to the four dimensions of the ILS in course designs. However, there are specific implications regarding rejection of the eighth null hypothesis concerning differences between comparison groups in the sequential/global dimension of the ILS and course satisfaction. As Figure 8 and Table 9 demonstrate, there is a high correlation (converted r of 0.790) in the Composition and Rhetoric group between the sequential/global dimension of the ILS and course satisfaction. The global learners are more satisfied with the course than the sequential learners. Sequential learners who understand information from logical or sequential steps (Felder & Solomon, n.d.b) are not as satisfied with the Composition and Rhetoric course. These findings imply that DE course designers of English courses should take extra precautions to present material in logical or sequential steps. However, the implication concerning course design for English courses is tenuous because of the already discussed limitations. The limitations of this current study state that a higher response rate for both comparison groups as well as a higher N for the Composition

and Rhetoric group is highly desirable. Whether subject matter is indeed a moderating variable, especially with regards to the ILS dimensions and course satisfaction, is inconclusive.

Recommendations for Future Research

The previously discussed limitations of this current study result in the following recommendations for future research. Replication studies should be conducted to determine whether or not subject matter is conclusively a moderating variable with regards to learning styles and effectiveness in DE. These studies can be varied by selection of different samples from different courses as well as a different educational setting such as a public undergraduate institution. Studies can also be completed from a population inclusive of multiple institutions, which would better control for threats to external validity. Utilizing a different framework or model for learning styles other than the ILS framework can also benefit future studies. Other studies can be designed to specifically address the low response rate for comparison groups. For example, response rate may be increased through compensation, such as monetary compensation for participation. Future studies can also be designed to ensure a higher completion of end-of-course satisfaction surveys. Tests for homogeneity can be more effectively analyzed. For example, undergraduate GPA can be further differentiated as either English course GPA versus Math course GPA to more accurately determine homogeneity among comparison groups. Though pragmatically difficult, perhaps future studies can utilize the "experimental research" (Glatthorn & Joyner, 2005) design to evaluate whether subject matter affects the relationships between learning styles and course achievement or course satisfaction. The options are almost unlimited and are bounded primarily by the creativity of scholars and willingness of educational institutions to endorse such research. However, future research is necessary to continue

addressing the existing research gap concerning the effects of subject matter as a moderating variable between students' learning styles and effectiveness of DE.

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Appendix A: End of Course Survey

Rate the following as: Strongly Disagree, Disagree, Agree, Strongly Agree or Not Applicable.

* The faculty member responded to my questions in a timely manner (24-48 hours).	A) Strongly Disagree B) Disagree C) Agree D) Strongly Agree E) Not Applicable
* The faculty member provided interaction and responses in various communication forums throughout the course (email, phone calls, discussion boards, etc.)	A) Strongly Disagree B) Disagree C) Agree D) Strongly Agree E) Not Applicable
* The faculty member posted grades on assignments within one week of the project's due date.	A) Strongly Disagree B) Disagree C) Agree D) Strongly Agree E) Not Applicable
* The faculty member provided quality and beneficial comments on written assignments.	A) Strongly Disagree B) Disagree C) Agree D) Strongly Agree E) Not Applicable
* The faculty member provided encouragement within his/her communications throughout the course.	A) Strongly Disagree B) Disagree C) Agree D) Strongly Agree E) Not Applicable
* Overall, the experience with this faculty member was positive.	A) Strongly Disagree B) Disagree C) Agree D) Strongly Agree E) Not Applicable
* The text(s) and course content provided me with the necessary information related to the course topics and objectives.	A) Strongly Disagree B) Disagree C) Agree D) Strongly Agree

	E) Not Applicable
* The text(s) and course content provided a good balance between theoretical and practical information.	A) Strongly Disagree B) Disagree C) Agree D) Strongly Agree E) Not Applicable
* The text(s) and course content were sufficient in preparing me for the learning activities and successful completion of assignments.	A) Strongly Disagree B) Disagree C) Agree D) Strongly Agree E) Not Applicable
* The assignment instructions gave clear expectations.	A) Strongly Disagree B) Disagree C) Agree D) Strongly Agree E) Not Applicable
* The amount of reading and number of assignments were appropriate for this course.	A) Strongly Disagree B) Disagree C) Agree D) Strongly Agree E) Not Applicable
* The course enabled me to develop a more complete Christian worldview.	A) Strongly Disagree B) Disagree C) Agree D) Strongly Agree E) Not Applicable
* The course enabled me to develop my communication skills.	A) Strongly Disagree B) Disagree C) Agree D) Strongly Agree E) Not Applicable
* The course enabled me to develop my critical thinking skills.	A) Strongly Disagree B) Disagree C) Agree D) Strongly Agree E) Not Applicable

* Please describe the strengths of the faculty member.

* Please describe the recommendations you would suggest to improve the faculty member's performance as an instructor.

* Please describe the strengths of the course content.

* Please describe the recommendations you would suggest to improve the course content.

Submit

* required

Wu, Darren C (Center for Christian/Community Service)

From:	Wheeler, Bill (Institutional Effectiveness Admin)
Sent:	Wednesday, March 12, 2014 10:54 PM
To:	Wu, Darren C (Center for Christian/Community Service)
Cc:	Gentala, Luke Ashley (Admin Information Management); Barton, David M (Institutional Effectiveness Admin)
Subject:	Re: Request for minor changes to your submission

Darren,
Request approved to include the survey items as an appendix to your dissertation.

Sent from my iPhone

On Mar 12, 2014, at 10:14 AM, "Wu, Darren C (Center for Christian/Community Service)" <dcwu@liberty.edu> wrote:

> Dr. Wheeler-
> Use of some specific LUO end-of-course survey data was already approved and provided through the IRB and Mr. Larry Shackleton. It was used in my dissertation, but now I'm requesting permission to include a copy of the actual questions we use in the LUO end-of-course survey as an appendix to my dissertation (attached as Appendix A [pp. 122 -124]). I apologize for including such a long document for you, but am providing it for context of my permission request. May I have permission to place the LUO end-of-course survey questions in my dissertation as Appendix A?
>
> Thanks,
> **Darren Wu, Ed.D.**
> *Assistant Professor and CSER Coordinator*
> **Center for CSER**
>
> **(434) 582-2416**
>
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Appendix B: IRB Approval Letter

LIBERTY UNIVERSITY.
INSTITUTIONAL REVIEW BOARD

August 6, 2013

Darren C. Wu
IRB Exemption 1647.080613: Learning Styles, Subject Matter, and Effectiveness in Undergraduate Distance Education

Dear Darren,

The Liberty University Institutional Review Board has reviewed your application in accordance with the Office for Human Research Protections (OHRP) and Food and Drug Administration (FDA) regulations and finds your study to be exempt from further IRB review. This means you may begin your research with the data safeguarding methods mentioned in your approved application, and that no further IRB oversight is required.

Your study falls under exemption category 46.101 (b)(2,4), which identifies specific situations in which human participants research is exempt from the policy set forth in 45 CFR 46

> (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless:
> (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.
>
> (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects.

Please note that this exemption only applies to your current research application, and that any changes to your protocol must be reported to the Liberty IRB for verification of continued exemption status. You may report these changes by submitting a change in protocol form or a new application to the IRB and referencing the above IRB Exemption number.

If you have any questions about this exemption, or need assistance in determining whether possible changes to your protocol would change your exemption status, please email us at irb@liberty.edu.

Sincerely,

Fernando Garzon, Psy.D.
Professor, IRB Chair
Counseling

(434) 592-4054

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