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INVESTIGATING THE KOLB LEARNING STYLE INVENTORY’S IPSATIVE SCORES USING SEMANTIC DIFFERENTIAL AND LIKERT SCALING

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INVESTIGATING THE KOLB LEARNING STYLE INVENTORY’S IPSATIVE SCORES USING SEMANTIC DIFFERENTIAL AND LIKERT SCALING

By

Grace Eleanor Jamieson

THESIS

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SIGNATURE APPROVAL FORM

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ABSTRACT

INVESTIGATING THE KOLB LEARNING STYLE INVENTORY’S IPSATIVE SCORES USING SEMANTIC DIFFERENTIAL AND LIKERT SCALING

By

Grace Eleanor Jamieson

This thesis sought to examine the feasibility of using Likert and Semantic Differential scales as alternative scale formats with the Kolb Learning Style Inventory (LSI) 2005 (v. 3.1). Scaling features were investigated. The Kolb LSI ipsative scores were compared to the Likert and Semantic Differential scales, which unlike ipsative scores, have the potential to produce normative results. Two hypotheses examined whether the Kolb LSI scores are a function of the group and whether learning style scores obtained from the restructured 48-item Likert and Semantic Differential surveys corresponded to those obtained on the Kolb LSI. The sample included post-secondary elementary education, secondary education, and general education students. Construct validity was present between the three scales on the dimensions of learning styles, learning modes, and bi-polar dimensions. Evidence for a new learning style categorized as “balanced” was observed on results from the Likert and Semantic Differential instruments. The “balanced” learning style falls very close to or on the Kolb axes, rather than within a learning styles quadrant. The results support continued exploration of using different measurement scales that do not produce ipsative scores to measure learning styles, although only 47% of the Kolb learning styles matched the learning styles determined by alternative measures. No evidence was found to support that learning style scores are a function of the group.
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This thesis follows the format prescribed by the sixth revised edition of the Publication Manual of the American Psychological Association.
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Chapter One: Introduction

The theory of learning styles and its practical application to a learning environment have been debated for over fifty years, beginning with the introduction of Bloom’s Taxonomy (Bloom, Engelhart, Frost, Hill, & Krathwohl, 1956). Bloom’s Taxonomy remains a well-known way of examining or describing learning objectives, but the taxonomy did not have an accompanying instrument to measure the effectiveness of learning objectives or learning styles. Six years later, the Myers-Briggs Type Indicator (MBTI) instrument (Myers & Briggs, 1962), one of the first psychometric personality instruments, appeared and examination of the relationship between personality types and learning was possible (see Fox, 1993).

During the 1970’s and 1980’s a number of learning style instruments were developed, including the Kolb Learning Style Inventory, Canfield Learning Style Inventory, Anthony Gregorc Style Delineator, and the Honey-Mumford Learning Styles Questionnaire. Each of these instruments approached the topic of learning styles in different ways, and the validity and reliability of these instruments has been the subject of significant research. The research on applying learning styles to classroom settings has had varying results.

There is debate in the research literature regarding the evidence of learning styles and the usefulness of applying teacher or student learning styles in the classroom. Cassidy (2004) provided an overview and brief description of 23 measurement instruments designed to assess learning styles, some of which have been used in educational settings. He presented a taxonomy of the specific learning style models each
instrument attempted to measure. Other researchers have not seen the importance of or
evidence for a relationship between learning styles and the insight afforded to individuals
to play to their strengths (Franklin, 2006; Kostovich, Poradzisz, Wood, & O’Brien, 2007;
Yildirim, Acar, Bull, & Sevinc, 2008).

One attempt to use learning styles to enhance academic achievement compared
the effects of teaching using traditional methods to a learning-style centered approach in
a middle school classroom (Farkas, 2003). The Learning Style Inventory developed by
Dunn and Dunn (1992) was used to determine a student’s learning style or preference.
The learning-style centered approach used a Multisensory Instructional Package (MIP) to
teach the Holocaust. The learning-style centered approach to instruction about the
Holocaust was found to be more effective than traditional methods of teaching, due to
higher levels of student engagement and interest in the lesson.

Matthews (1996) investigated the relationship between perceived academic
achievement and learning style preferences of high school students (N = 6,218) using the
Kolb LSI-1985 instrument. Students were not randomly assigned. Student self-ratings of
perceived academic achievement were compared to the Kolb LSI scores. A significant
relationship between learning style (i.e., accommodating, diverging, assimilating, and
converging) and perceived academic achievement was found, with Convergers (M =
3.60) having the highest mean scores on self-ratings. Significant results were also found
across race, gender, and grade level. A review of the literature shows that the Kolb LSI is
commonly used in educational settings and is a well-researched learning style assessment
tool. The Kolb has received mixed research support for over 30 years.
The remaining part of this chapter will provide an overview of the Kolb LSI, attendant key terms, theoretical framework and background information, purpose of study, research questions, and assumptions. This chapter also contains extensive sections on measurement scales.

**Background of Problem**

One of the concerns raised about the Kolb LSI is the use of a forced-choice format and the limitation or constraints this places on the participant to select a valid response (Anastasi, 1968). Currently, the Kolb LSI instrument is a 12-item survey containing 12 sentence-stems and 4 corresponding response statements. A participant must rank the four response statements in order of Least Like Me to Most Like Me, thus placing constraints on the selection process. The Kolb LSI is a forced-choice scale requiring a participant to rank four responses in order of Least Like Me to Most Like Me. A forced-choice scale format, forces a participant to select between two or more descriptive phrases that are equally acceptable and may be equally desirable or undesirable. The selection of one item constrains the participant’s selection of another item where both items are equally acceptable (Anastasi, 1968).

A second concern raised in the research literature is that the measures produced by the Kolb LSI instrument are ipsative, which are unique to the individual, time consuming for teachers to calculate, and cannot be extrapolated to a larger population. Ipsative scores are not normative and pose a problem for researchers. There is debate in the literature about the extent of the meaning and relevance of ipsative scores to describe
how a different sample might respond to the same instrument, due to the individual nature of responses.

The Kolb LSI results ipsative scores are best applied at the individual level and are not generalized to a broader level, such as the class or school level because of the forced-choice, individual nature of the scale. Some researchers have suggested the reliability and validity of the results might be more acceptable if the Kolb LSI data were normative (Duff, 2004; Geiger, Boyle, & Pinto, 1993; Loo, 1999).

Theoretical Framework

This thesis will focus on Kolb’s Experiential Learning Theory (ELT) as measured using the Kolb LSI instrument (Kolb, 2007). The Kolb LSI has undergone five revisions since its introduction in 1971. A concern continually brought up in the research literature is the degree to which reliable and valid results should be accepted at face value due to the instrument producing ipsative scores. The literature has shown mixed results regarding the instruments’ reliability and validity, but Kolb and Kolb (2005) claim that a significant majority of the research papers have found the instrument to be reliable and valid. In the selected articles reviewed for this study, few of the Kolb LSI articles discussed the validity and reliability of the Kolb LSI instrument.

Key Terms

The following terms are used throughout this thesis.

*Bi-polar Dimensions.* The Kolb LSI contains two bi-polar dimensions that measure an individual’s preference for learning. The bi-polar dimension is a combination
score and both scores are polar opposite in meaning. The first bi-polar dimension is AC-CE and measures an individual’s preference of Abstract Conceptualization over Concrete Experience and the second bi-polar dimension is AE-RO and measures an individual’s preference of Active Experimentation over Reflective Observation (Kolb, 2007).

**Ipsative Scores.** An ipsative score is a by-product of individual sub-test scores, which are not expressed in absolute terms, but are expressed in terms of their relative strength to one another. Ipsative scores do not contain a range of responses of equal distance from one another, such as interval scale scores. Ipsative scoring is individual in nature and yields data that do not lend themselves to being included in a normative sample (Anastasi, 1968; Baron, 1996).

**Kolb Learning Styles.** The Kolb LSI contains four learning styles, which are calculated by graphing the results of the two bi-polar dimensions. The learning styles are Accommodating, Diverging, Assimilating, and Converging (Kolb, 2007).

**Learning Modes.** The Kolb LSI has four learning modes. A learning mode measures a person’s learning orientation. The four learning modes include CE = Concrete Experience, RO = Reflective Observation, AC = Abstract Conceptualization, and AE = Active Experimentation (Kolb, 2007).

**Learning Styles.** The term learning styles, also referred to as learning preferences, has many definitions and learning style types. Learning style describes the approach an individual takes to learning and studying. Two approaches to learning include the deep processing and surface processing of information (cf. Woolfolk, 2007).
**Likert Scale.** A Likert scale contains a declarative statement followed by a response option. Responses usually are selected using a 5-point or 7-point scale. The scale contains two polar opposite ends (i.e., strongly disagree and strongly agree) and can include a neutral midpoint. Likert scores are ordinal measures, but are sometimes treated incorrectly as interval data, as there is debate about whether there are equal intervals between data points on the scale.

**Non-parametric Statistics.** A non-parametric test is considered to be distribution free and no assumptions are made about the population parameters. Making a determination of whether parametric or non-parametric statistical tests should be used is based on the level of measurement. Non-parametric statistical techniques analyze nominal and ordinal/rank-order data (Sheskin, 2007).

**Semantic Differential Scale.** The Semantic Differential scale is a 7-point scale and the intervals between data points fall along a continuum. On opposite ends of the continuum, an adjective or descriptor is placed and its opposite corollary adjective is placed at the other end of the continuum. A participant is presented with a response statement and selects as to the degree he or she agrees with the statement. The adjectives on opposite ends of the continuum guide the participant’s decision. Semantic Differential scores are treated as ordinal measures for statistical analysis (DeVellis, 2003).
Kolb Learning Style Inventory

The Kolb Learning Style Inventory (LSI) was developed by David A. Kolb in 1971 and updated in 1976 to measure learning style preferences of individual learners. Kolb LSI is a 12-item forced-choice instrument with each item having four corresponding response statements. The instrument identifies four different types of learners (i.e., Accommodators, Divergers, Convergers, and Assimilators) and a preferred learning mode of each individual learner (i.e., Active Experimentation [AE] – doing; Concrete Experience [CE] – feeling; Reflective Observation [RO] – watching; and Abstract Conceptualization [AC] – thinking). The inventory also contains two bi-polar dimensions (i.e., [AC – CE] – perceiving dimension and [AE – RO] – processing dimension) (Loo, 2004).

The Kolb LSI, in a variety of forms has been around for about thirty-five years and has contributed to several research studies, evaluating and examining the use of the Kolb LSI-1985, Kolb LSI-1993 and the Kolb LSI-1999, and the most recent edition, version 3.1, the Kolb LSI-2005. Over the past twenty years, measuring the effectiveness of the Kolb Learning Style Inventory (LSI) has produced mixed results to predict academic success based on learning style.

The Kolb LSI-1976 contained nine items and due to low reliability coefficients, the instrument was revised. The Kolb LSI-1985 now contained 12 items and the language was simplified to a seventh grade level. Internal reliability of the revised LSI remained high in studies undertaken by independent researchers (Kayes, 2005; Veres, Sims, & Locklear, 1991). Kolb (1984) found the four learning dimensions had significant internal
consistency with Cronbach’s alphas ranging from .73 to .83. However, the test-retest reliability remained low (Kolb & Kolb, 2005). The Kolb LSI-1993 was a research version of the random format inventory and changes were finalized in the 1999 edition. The major change to the revised Kolb LSI-1999 was to randomize and codify the response set. Items from the same scale or constructs (i.e., CE – Concrete experience; RO – Reflective observation; AC – Abstract conceptualization; and AE – Active experimentation) were no longer located in the same column. The rationale for these changes was to reduce response-set bias and to increase test-retest reliability (Kayes, 2005).

The Kolb LSI is a self-scoring instrument and uses a forced choice format whereby an individual has to select one of four learning modes (i.e., CE; RO; AC; AE) which best represents her or his response to one of the 12-item stems. Forced-choice responses result in ipsative scores, which do not lend themselves to normative data. An ipsative score is expressed not in absolute terms, nor does an ipsative score contain a range of responses of equal distance from one another, such as interval scaling. Ipsative scoring is individual in nature and does not lend itself to being evaluated in the same way as normative samples (Anastasi, 1968). Since quantitative analyses are predicated on analyzing normative samples, ipsative scores become difficult to analyze. By converting the Kolb LSI inventory into a survey with similar items, each item would contain two opposite sentence stems and would have a seven-point Likert response scale or Semantic Differential continuum. A Likert scale would provide ordinal data, which could be accommodated in a normative sample, and the problems inherent in statistically analyzing ipsative scores would not be a problem (Duff, 2004).
Measurement Scales

Conducting any form of attitude measurement requires the development of an instrument containing scales and the instrument takes the form of an index (e.g., inventories, tests or questionnaires). A scale contains four measurement criteria: (1) Unidimensionality (i.e., data measures a single or dominant trait); (2) Qualification (i.e., data could be compared); (3) Quantification (i.e., variables are measured in common units) and (4) Linearity (i.e., data is positioned on a line or a scale) (Cavanagh & Romanoski, 2006).

Stevens (1946) was the first researcher to identify the four scale levels of measurement used today and the attendant statistical techniques associated with each measurement level. The four levels of measurement in order of complexity are nominal, ordinal, interval, and ratio. Nominal measures are categorical in nature (e.g., numbering soccer players for identification purposes), and the statistical techniques associated with this level include the specification of the number of cases, mode, and contingency correlations. Ordinal measures make a determination of greater or less, and median and percentiles are acceptable statistical techniques. Interval measures make a determination of the equality of intervals and differences, and the statistical techniques of mean, standard deviation, rank-order correlation, and product-moment correlations are acceptable. The final level is ratio, which makes a determination of the equality of ratios and a coefficient of variation is one appropriate statistical technique.

The majority of results from attitude measurement studies take the form of ordinal or interval measures, but some researchers treat ordinal data as interval data, which
violates parametric statistical assumptions. Nevertheless, some researchers have used advanced statistical techniques to analyze ordinal data anyway (Churchill, Jr., 1999).

Scaling is the means of quantifying subjective participant responses and a researcher can use one of four scale formats when constructing a measurement instrument. The four scale formats include: (1) Guttman scaling, (2) Thurstone, (3) Likert, and (4) Semantic Differential (O’Connor, 2006). The focus of this study will be on the Likert and Semantic Differential scales.

**Likert Scaling**

Rensis Likert originally developed the Likert scale in 1932. Currently, Likert scaling is widely used in a variety of disciplines conducting attitude measurement research. The Likert scale typically is designed as a 5-point scale. Participants are asked to indicate their level and intensity of agreement or disagreement on a question, and the midpoint scale position is neutral. Likert results are treated as ordinal data. There has been some controversy about the reliability of results obtained from Likert Scales. One way researchers have tried to increase the reliability of results is by using negatively worded item statements in the questionnaire, but negatively worded statements can result in cognitive complexity. Despite the questions regarding the reliability of results obtained from Likert scales, the Likert scale is the most widely used scale and results are easy to score (Hodge & Gillespie, 2003). A 7-point Likert scale was used in this study (see Table 1).
Table 1

Example of the Structure of the Likert Scale Administered in the Study

<table>
<thead>
<tr>
<th></th>
<th>Very Strongly Disagree</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Undecided</th>
<th>Agree</th>
<th>Strongly Agree</th>
<th>Very Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>When I prepare for a test, I like to work in a group.</td>
<td>VSD</td>
<td>SD</td>
<td>D</td>
<td>U</td>
<td>A</td>
<td>SA</td>
</tr>
<tr>
<td>2.</td>
<td>I learn best by taking copious notes during lectures.</td>
<td>VSD</td>
<td>SD</td>
<td>D</td>
<td>U</td>
<td>A</td>
<td>SA</td>
</tr>
</tbody>
</table>


Semantic Differential Scale

Osgood, Suci, and Tannenbaum (1957) developed the Semantic Differential scale to measure the connotative meaning of concepts within a semantic space represented by a 7-point continuum containing two bi-polar ends. The direction and the distance from the origin (i.e., midpoint of the scale) can ascertain measurements within the semantic space. The direction signifies which polar end has been selected and the distance identifies the extremeness of the selected scale position. Meaning could be measured by evaluating a series of differentiated judgments through identifying the quality and intensity of the meaning.

Osgood et al. (1957) investigated the utility of a 5-point or 7-point scale when designing the Semantic Differential scale. The five alternative scale was found to be weak due to adult participants requesting a more exact differential (e.g., somewhat – 5-point vs. slightly – 7-point) but younger participants worked best with the 5-point scale.
The 7-point scale was finally settled upon, as all seven alternatives were used with equal frequency (Osgood et al., 1957).

Osgood et al. (1957) developed two formats of the Semantic Differential scale. The first format design had the concept followed by one bipolar opposite end, then the continuum and followed by the other bipolar opposite, all on one line. This format would be used to evaluate individual judgments not related to one another. The second format design placed the concept at the top of the continuum and then a list of bipolar opposite ends. This design allowed researchers to evaluate a number of judgments all related to one concept. For the purposes of this study, the first format design is being utilized (see Figure 1).
Figure 1. Semantic Differential Scale

If you feel that the concept is very closely related to one end of the scale you should place your check-mark as follows:

Like me \( X \):\( ______\):\( ______\):\( ______\):\( ______\):\( ______\):\( ______\):\( ______\) Not like me

or

Like me \( ______\):\( ______\):\( ______\):\( ______\):\( ______\):\( ______\):\( ______\):\( X \) Not like me

If you feel that the concept is closely related to one end of the scale you should place your check-mark as follows:

Like me \( ______\):\( ______\):\( ______\):\( ______\):\( ______\):\( ______\):\( ______\):\( X \) Not like me

or

Like me \( ______\):\( ______\):\( ______\):\( ______\):\( ______\):\( ______\):\( ______\):\( ______\) Not like me

If you feel that the concept is very slightly related to one end of the scale you should place your check-mark as follows:

Like me \( ______\):\( ______\):\( ______\):\( ______\):\( ______\):\( ______\):\( ______\):\( X \) Not like me

or

Like me \( ______\):\( ______\):\( ______\):\( ______\):\( ______\):\( ______\):\( ______\):\( ______\) Not like me

If you feel that the concept to be neutral or both sides of the scale are totally irrelevant, you should place your check-mark as follows:

Like me \( ______\):\( ______\):\( ______\):\( ______\):\( ______\):\( ______\):\( ______\):\( ______\:\( ______\) Not like me

Figure 1. Example of a 7-point Semantic Differential scale with directions. Adapted from “The Measurement of Meaning” by C. E. Osgood, G. J. Suci, and Tannenbaum, P. H., 1957. Copyright 1957 by the University of Illinois Press.

Likert vs. Semantic Differential Scales

In a review of the literature, one study measured the psychological construct of resilience using the Marlowe-Crowne social Desirability Scale (MCSDS) and compared results obtained using a seven-point Likert-based and a Semantic Differential-based scale. Acquiescence bias was a concern, particularly when Likert response items are worded positively, and participants may not put as much thought into their responses,
thus resulting in an acquiescence bias. One way to reduce the problem of positively worded response items would be to transform the items into negations of the concept being measured, but this introduces additional problems or systematic errors as individuals may react differently to positive and negative items. A possible solution to acquiescence bias is to use a Semantic Differential scale. The Semantic Differential scale is more cognitively complex than a traditional Likert scale, but does not use negations (Friborg, Martinussen, & Rosenvinge, 2006).

Acquiescence bias was lower using a Semantic Differential scale than a Likert-based scale when measuring the psychological construct of resilience (Friborg et al., 2006). Data collected with the Semantic Differential format fit the measurement model better than data collected with the Likert format did, except for one factor (i.e., Family Coherence). The Semantic Differential-based scale proved better than the Likert scale in terms of model fit and uni-dimensionality. These results suggest transforming an instrument using a Likert scale to one containing a Semantic Differential scale, which might provide an adequate solution to the problem of acquiescence bias (Friborg et al., 2006).

**Ipsative Scores**

Since quantitative analyses are predicated on analyzing normative samples, ipsative scores become a difficulty. Ipsative scores are a product of forced-choice measurement instruments where a response on one item constrains responses on other items (e.g., ranking an item as first constrains any other items from being ranked first).
Ipsative scores have been treated by some researchers as an ordinal level of measurement due to scores being summed (Grimm & Yarnold, 2000).

Baron (1996) examined the debate in the literature, both pro and con as to whether ipsative scores could be analyzed using standard statistical procedures. Two opinions were described. First, the majority of researchers believed ipsative scores were impossible to analyze or interpret using standard statistical procedures but could be used in limited contexts. Secondly, a minority of researchers believed the properties of ipsative data were just as useful as normative data and could be analyzed using parametric tests, even though ipsative scores do not meet the criteria (i.e., interval data) for parametric analysis.

Further debate has surrounded whether it would be appropriate to convert ipsative scores into normative scores for comparison purposes, and the preponderance of opinion is not in favor of normalizing ipsative data (Closs, 1996). This conclusion presents some difficulties for this study, as comparisons of participant responses to the surveys will produce ipsative and Likert scores. To make comparisons and correlate the data, the scores obtained from the 7-point Likert and Semantic Differential scales will need to be converted to the Kolb LSI 4-point scale or the scores will need to be normalized.

**Purpose of Study**

This study seeks to address these two concerns by taking the Kolb LSI-2005 (v. 3.1) and rewriting the 12 sentence stems and 4 corresponding response statements into a 48-item survey and comparing the consistency of results obtained using the two different measurement scales and the Kolb LSI. The Likert and Semantic Differential
measurement scales have unique properties. The Likert scale produces normative scores, which can be extrapolated to a larger population. The Semantic Differential scale produces ordinal scores but is not a forced-choice format. By restructuring the 12-item Kolb LSI into a 48-item survey, one sentence stem and its four corresponding response statements would now become four questions. The participant would now have the opportunity to rank all four questions on the same data point of the measurement scale.

Consequently, the purpose of this thesis is twofold. First, a review of the research literature will examine the validity and factor structure (i.e., four learning styles) of the Kolb LSI instrument used in a post-secondary classroom setting. An empirical study will investigate and analyze the consistency of Likert and Semantic Differential responses matched with the Kolb LSI sentence stems. The two new 48-item instruments (Likert and Semantic Differential) will have corresponding response statements matching the Kolb LSI content. The study will examine the outcomes in participant responses between the Kolb LSI-2005 (v. 3.1) and a rewritten Likert or Semantic Differential version of the Kolb LSI instrument. Unlike ipsative scores, which are individual in nature, Likert scores are normative and results can be extrapolated to a larger population. Semantic Differential scores, as ordinal scores, produce medians and modes.

Some researchers have suggested the reliability and validity of the Kolb results might be more acceptable if the data were normative. One way of achieving a normative sample would be to rewrite the 12-item Kolb LSI into a 48-item instrument using a Likert scale. Geiger et al. (1993) undertook this procedure and examined the viability of using a modified 48-item version of the Kolb LSI-1985, using a Likert measurement scale and
found similar results except the correlations of the bi-polar dimensions had discrepancies.

Bi-polar dimensions of the Kolb LSI measure a participants’ preference for a specific learning mode (i.e., AC-CE – preference for abstractness over concreteness or AE-RO – preference for action over reflection) and are located on opposite ends of an axis, hence the term, bi-polar (Kolb & Kolb, 2005). This thesis will take the Geiger et al. (1993) study a step further and compare the results of the Kolb LSI-2005 to results obtained on two restructured versions of the Kolb LSI-2005 using Likert and Semantic Differential scaling.

Accordingly, a second purpose of this thesis is to compare the results of the 12-item Kolb LSI with two 48-item rewritten versions of the Kolb LSI. One version uses a Likert scale and the second version uses a Semantic Differential scale. The Semantic Differential scale has not been cited in the Kolb LSI research literature and a comparison between the two scales and the attendant reliability and validity results are areas of research that have not been investigated.

**Research Questions and Hypotheses**

The feasibility of using the Kolb Learning Style Inventory (LSI), version 3.1 (2005) with two types of scales, Likert (Likert, 1932) and Semantic Differential (Osgood et al., 1957), using a within and between subjects research design will be investigated. The research question being examined is whether consistency of response and correlations exist between results obtained on the 12-item Kolb LSI and results obtained on the 48-item Likert or Semantic Differential surveys.
Two hypotheses were examined to support the research question. Hypothesis 1: Kolb LSI scores are a function of the group, whereby the group is in reference to the sample which consists of selected undergraduate education students. Hypothesis 2: Learning style scores obtained from the restructured 48-item Likert and Semantic Differential surveys are the same as those obtained on the Kolb LSI-2005 (v. 3.1) survey.

Assumptions

The research literature has treated the Kolb LSI data as both ordinal and interval scaling, parametric statistical techniques have been used to analyze the data. Kolb LSI scores are ipsative and an ongoing debate continues as to whether ipsative scores should be treated as ordinal or interval data. Although some researchers have treated ipsative scores as ordinal or interval data, due to the measure being forced-choice and summed, ipsative scoring does not meet the criteria to use parametric statistical techniques (Baron, 1996; Cornwell & Dunlap, 1994).

Many studies analyzing the Kolb LSI, which produces ipsative scores, have used both non-parametric and parametric statistical techniques. The current study uses ipsative scores and the Likert and Semantic Differential measurement scales. Data from the ipsative scores will be treated as ordinal data. Likewise, data from Likert scaling will be treated as ordinal data. A question arises about whether results obtained from the Semantic Differential scale measurement scales should be treated as ordinal or interval data and whether parametric rather than non-parametric statistical techniques should be used to analyze the results. Osgood et al. (1957) did not come to a definitive conclusion as to whether results obtained from the Semantic Differential scale should be treated as
ordinal or interval. For the purposes of this study, the Semantic Differential data will be treated as ordinal and non-parametric statistical tests will be used to analyze the data.

Although the authors of the Semantic Differential scale have not specifically stated whether the Semantic Differential scale is ordinal or interval, they used parametric statistical techniques to analyze data. In previous studies, the results from a Semantic Differential scale have been treated as interval and parametric statistical techniques have been used (Friborg et al., 2006; Long, Henderson, & Ziller, 1968). The purists argue that the Likert measurement scale produces ordinal measures, while the pragmatists believe that the scale can be interpreted as interval measures (Doering & Hubbard, 1979). For the purposes of this study, a purist or a conservative position will be taken. The scores produced by the Likert and Semantic Differential instruments will be treated as ordinal data and non-parametric statistical techniques will be used to analyze the data.

**Summary**

The Kolb LSI has been used for over three decades and is one of the more popular forms of measuring learning styles or learning preferences. Two criticisms of the inventory, both inter-related, refer to the instruments’ use of a forced-choice format and producing results in the form of ipsative scores. A question raised in the research literature revolves around whether the Kolb LSI could be designed in a format that is not forced-choice and does not produce ipsative scores.

This study seeks to investigate whether restructuring the 12-item Kolb LSI into a 48-item survey using either a Likert or Semantic Differential measurement scale would produce a consistency of response and correlate across all three surveys. Both the Likert
and Semantic Differential measurement scales are not forced-choice, but the Likert scale produces results that are considered as normative and can be extrapolated to a larger population. The Semantic Differential scale produces ordinal scores and is not a forced-choice scale.

The purpose behind investigating the Kolb LSI and the Likert and Semantic Differential versions of the Kolb LSI is to examine the feasibility of using different measurement scales to obtain similar results. The Likert scale would produce normative results and the Semantic Differential scale would produce ordinal scores but would not constrain the participants’ selection of valid choices.

In summary, Chapter 1 gave an overview of the history of learning style inventories, research questions key terms, theoretical framework, background, purpose of study, research questions, and assumptions. The chapter also contains extensive sections on measurement scales and the Kolb Learning Style Inventory. Chapter 2 examines the Kolb LSI research literature including an examination of the validity and reliability of the instrument. Chapter 3 describes the methodology, subjects and the instruments. Chapter 4 presents the results of the research, and Chapter 5 has a discussion of the research findings and the conclusion of the study.
Chapter 2: Literature Review

The initial focus of this Literature Review was to examine a selection of articles analyzing the validity of the Kolb Learning Style Inventory and its usefulness as a tool in identifying learning styles and predicting students’ success in the learning process. After investigating the validity and reliability of the Kolb instrument, effects of using different measurement scales with the Kolb LSI in an attempt to resolve the issue of ipsative scores will be examined. The Kolb instrument is not easy to score and the use of an alternative form of scaling might alleviate this concern for classroom teachers.

None of the articles examined dealt with the administration of the Kolb LSI in an elementary or secondary classroom setting. The lack of inclusion of articles using the Kolb LSI in an elementary or secondary classroom setting was a function of searching for research articles dealing with the validity and reliability of the Kolb LSI instrument. The studies located took place in a post-secondary setting with the researchers using samples of convenience. A secondary emphasis of the literature review was to examine a selection of articles analyzing learning styles.

Measuring Learning Styles

The term learning styles is difficult to find an all-encompassing definition because researchers provide many different definitions. One such definition of learning styles, known as VAK (visual, auditory, and kinaesthetic), includes individual differences that affect classroom learning and can include preferences for learning via visual materials versus text or auditory materials and kinaesthetic activities.
Over the years, several instruments have been developed to evaluate a person’s learning style, and some have shared in popularity. Four such instruments are the Myers-Briggs Type Indicator (MBTI) is one of the oldest instruments measuring learning styles. The MBTI uses Carl Jung’s theory of psychological types as the theoretical foundation. The instrument identifies individuals’ preferences on eight characteristics: *extraversion, introversion, sensing, intuition, thinking, feeling, judging,* and *perceiving* (Briggs, Myers, McCaulley, Quenck, & Hammer, 2001). The Canfield Learning Style Inventory is a self-reporting questionnaire used to assess student instructional preferences (Canfield, 1976). The Anthony Gregorc Style Delineator is a self-report non-cognitive inventory to identify dominant styles of processing information. The instrument contains two dimensions (i.e., perception and sequence) and has results plotted on an x/y axis, which is similar to results obtained from the Kolb LSI (Gregorc, 1982).

One of the better-known instruments includes the Honey-Mumford Learning Styles Questionnaire (1982, 1992), which measured learning preferences relative to the learning cycle. Honey and Mumford (1995) identified four learning styles: activists, reflectors, theorists, and pragmatists. Their questionnaire had some similarity to the Kolb LSI (Kolb & Kolb, 2005).

Another means of measuring learning styles and the primary focus of this literature review is the Kolb Learning Styles Inventory. This learning style inventory identifies four types of learners and four learning modes (Harris, Dwyer, & Leeming, 2003). The four learning modes include CE – Concrete Experience, RO – Reflective Observation, AC – Abstract Conceptualization, and AE – Active Experimentation. When
the Kolb LSI is completed, a participant receives a score for each of the learning modes. The type of learner can interchangeably be used as learning style. The four types of learners or learning styles are Accommodating, Diverging, Assimilating, and Converging.

**Measurement Issues and the Kolb LSI**

The Kolb LSI is a forced-choice instrument and produces ipsative scores that are individual in nature and are not useful in extrapolating the results to be representative of a larger population. Interpretation of the statistical findings of the Kolb LSI should be tempered with the understanding that the scores are not normative, but rather ipsative, and thus not reflective of group properties.

Ipsative scores is an interesting topic worthy of further examination. The term came up in the literature review, and all statistical resources examined did not discuss the issues related to ipsative scores. Anastasi’s 1968 Psychological Testing was the only resource to mention ipsative scores. Due to the scant mention of the term in the statistical reference literature available, this attempts to examine the behavior of ipsative scores, relative to Likert and Semantic Differential scores.

**Ipsative and Normative Scaling**

Only one study compared ipsative and normative scaling results using the Kolb LSI. Geiger et al. (1993) undertook a study comparing an ipsative and normative version of the Kolb LSI-1985 by rewriting the 12-item instrument into a 48-item instrument using a 7-point Likert scale. The factor structure, validity, and reliability of results were
analyzed by comparing the two instruments using a large sample (N = 455). The normative 48-item instrument coefficient alpha reliabilities were strong for all four scales (.77 to .86) and similar to the results obtained for the ipsative version (.81 to .85).

Scale correlations were undertaken by examining the equivalence of the two instruments by correlating the four scale scores. The adjusted correlations ranged from .466 to .615, with three of the four correlation values greater than .50. The two-factor structure produced different results for the ipsative and normative instrument. Neither instrument supported Kolb’s theorized bi-polar dimensions (i.e., AC-CE and AE-RO). The ipsative version found two strong bi-polar factors running from CE to RO (feeling to watching) and AE to AC (doing to thinking), opposite to the theorized bi-polar dimensions. The normative version produced a number of findings including separate factors for the AC scale, a factor representing the CE and AE scales and RO items loaded significantly on either factor. Unlike the two-factor structure, the four-factor structure was a best fit for the normative data (Geiger et al., 1993). These findings are a good starting point and future research into the use of normative scaling would be a good focus. This research article forms a foundation from which the forthcoming study’s results can be compared to and any similarities and differences in the findings can be discussed in detail.

Reliability and Validity of the Kolb LSI

Researchers in several studies across disciplines have used the Kolb Learning Styles Inventory. A number of researchers have examined the validity and reliability of the Kolb Learning Styles Inventory scale (Geiger et al., 1993; Kayes, 2005; Romero,
Reliability of a measurement scale or instrument is important in determining whether consistency is obtained in the results of future studies. One must remember that an instrument may produce reliable findings, but it does not necessarily hold that the instrument is valid. In reviewing the Kolb LSI, researchers found significant and non-significant results in the areas of reliability and validity. Reliability results were presented in the form of internal consistency reliability and test-retest reliability.

Internal Consistency Reliability is the extent to which tests or procedures assess the same characteristic, skill, or quality and is a measure of the precision of the instrument being used in a study. The resulting internal consistency correlations of the instruments’ items are essentially a measure of homogeneity. Cronbach’s Alpha is the principle statistical technique used to determine internal consistency reliability (Anastasi, 1968). Cronbach’s Alpha was used to measure internal consistency of three versions of the Kolb LSI (i.e., LSI -1985; LSI-1993 and LSI-1999).

Confirmatory factor analysis is an important statistical technique that allows the researcher to make a determination of whether the instrument they are evaluating is truly measuring what it is supposed to be measuring. A by-product of confirmatory factor analysis is a measurement of internal consistency. Confirmatory factor analysis was used in two studies providing measurement results of internal consistency (Loo, 1999; Romero et al., 1992). The most significant findings were high statistically significant internal
consistency reliability for the two bi-polar dimensions and each individual dimension and significant test-retest reliability for the two scales.

The suitability of the two bi-polar dimensions and the four learning dimensions using a large sample (N = 200) were investigated. The Kolb LSI-1985 instrument was found to have high statistically significant internal consistency results for each learning dimension (i.e., CE – α = .82; RO – α = .82; AC – α = .80; and AE – α = .84) (Loo, 1999). The two bi-polar dimensions (i.e., [AC – CE] and [AE – RO]) of the Kolb LSI-1985 using two large samples: N = 509 and N = 153 were investigated. High statistically significant internal consistency results were found. Sample 1 results of the bi-polar dimensions were AC – CE (α = .84) and AE – RO (α = .86) and Sample 2 results were AC – CE (α = .78) and AE – RO (α = .80) (Romero et al., 1992).

Only two studies strictly used Cronbach’s alpha to measure internal consistency reliability (Kayes, 2005 and Yahya, 1998). Kayes (2005) replicated a previous study investigating the two bi-polar dimensions and the four learning modes using a large sample (N = 221). The revised Kolb LSI-1999 found high statistically significant results as Cronbach’s alpha scores ranged from .77 to .82 for each dimensional construct and .77 to .84 for the two bi-polar dimensions (see Patten, 2007). Yahya (1998) investigated the Kolb LSI-1985 and found high statistically significant results as the correlation alpha coefficients all had values greater than .80.

Test-retest reliability is the process by which instruments and their results are measured over time to determine an instruments’ reliability. Ideally, the administration of the instrument is repeated with the same subjects at a future date and these results are
correlated with the initial administration to determine the stability of the instrument with results in the form of a reliability coefficient (Anastasi, 1968). Pearson’s product moment and Spearman’s rank-order correlations are most often used to provide test-retest reliability results.

Questions about the reliability of the Kolb LSI continued with examinations of test-retest reliability (Romero et al., 1992; Kayes, 2005). Romero et al. (1992) only found statistically significant test-retest reliability results for sample two. The results were $r = .75$ for the AC -- CE dimension and $r = .73$ for the AE – RO dimension, while Kayes (2005) found moderate statistically significant test-retest reliability values of .73 for the two scales. The correlations were positive and substantial for the test-retest reliability measures, but not so high as to eliminate questions about the reliability of the Kolb LSI.

Statistics related to validity, internal, external, and construct validity was discussed, as was factor analysis and confirmatory factor analysis, both of which play a supporting role in terms of whether an instrument was reliable and valid. A review of the articles for this literature review found internal and external validity as well as construct and predictive validity discussed.

Internal validity refers to the rigor in which the study was designed and implemented and to the extent to which the researchers have taken into account alternative explanations for any causal relationship (Howell, Miller, Park, Sattler, Schack, Spery, … Palmquist, 2005). The internal validity and reliability of the revised Kolb LSI-1999, which now contained randomized response sets, using a large sample ($N = 221$), was examined by Kayes (2005). The Cronbach’s alphas of an inter-correlation matrix
ranged from .77 to .82 for each dimensional construct and are within the minimal acceptable range (see Huck, Cormier, & Bounds, 1974).

Construct validity seeks agreement between a specific testing instrument, and a theoretical concept, and relies on subjective judgments and empirical data (i.e., data based on observations) (see Patten, 2007). Construct validity can be broken down into two sub-categories: convergent and discriminant validity (Howell et. al., 2005). The construct validity of the Kolb LSI-1999 was investigated and found the between scale item correlations ranging from -.18 to -.48 and within inter scale correlations ranged from .76 to .82. Since the within scale correlations were greater than the between scale correlations, results suggest an empirically distinct construct (Kayes, 2005) (see Anastasi, 1968).

External validity refers to representativeness or generalizability, in essence, to what degree can the results of a study be extrapolated to other populations, settings, treatments or measurement variables (Huck et al., 1974). External validity of the Kolb LSI-1985 evidence was presented only in the form of a geometrical presentation containing the plotted factors supportive of the instrument for identifying similar learning styles of students in the same academic major (Romero et al., 1992). A review of the Kolb LSI literature was undertaken and the overall reliability and validity of the Kolb LSI instrument was found to be weak in the researcher papers that were examined (Garner, 2000).
Kolb Learning Style Inventory Constructs

A secondary but supportive test of reliability and construct validity is factor analysis, which examines the structure of a testing instrument. An analysis of the factor loadings and interrelationships between the data points determines how many factors explain the variance. For example, one might have a 20-item test but only five factors or five items might explain 75% of the variance. Ideally, test developers want to design a test with the fewest number of factors and items to explain the greatest amount of variance (Anastasi, 1968).

In examining the factor structure of the 12-item Kolb LSI-1985, Loo (2004) presented his results in a 4 x 12 matrix. Despite all four components or learning dimensions having an eigenvalue ≥ 1, the four-component factor structure accounted for only 56.6% of the variance, thus leaving more than 40% unexplained variance, which is a relatively low number (Huck et al., 1974). The factor structure results in the Willcoxson and Prosser (1996) study was re-evaluated and the factor loadings of the four learning dimensions were examined. The three-factor structure explained 99.7% of the variance and the two-factor model explained 73% of the variance (Yahya, 1998). Finally, the factor structure of the Kolb LSI-1999 instrument was examined and the two-factor model that explained over 70% of the variance was preferred over the three-factor model, due to the bi-polar dimensions loading on both of the two factors. The eigenvalues for all factor loadings were greater than 1.00, which would indicate an instrument of good functions (Kayes, 2005) (Norusis, 1988).
Confirmatory factor analysis is theoretical or hypothesis driven and allows researchers to measure and test a particular factor structure. Goodness of fit measures are used to evaluate a specific factor structure, but do not calculate factor scores, unlike Factor Analysis (Albright & Park, 2005). One of the principle uses of confirmatory factor analysis is to evaluate whether an instrument is truly measuring what it is supposed to be measuring, and if not, the instrument might need to be rewritten.

The two-factor model of the Kolb LSI-1985 was found to be superior to the zero-factor and one-factor model. Results were supported using the relative fit index measured in the form of differences between chi-square ($\chi^2$) results and ($pd$) values and the factor loadings were greater than .40 and highly statistically significant ($p < .01$) (Romero et al., 1992). The goodness of fit of the two bi-polar dimensions and the four learning dimensions was examined by using confirmatory factor analysis, in order to get around the problem of ipsative scores, but results were not supportive, as the data was found not to be a good fit (Loo, 1999).

Other Findings for the Kolb Learning Style Inventory

An examination was made as to whether a person’s obtained learning style would have any impact on her or his academic performance when completing a text-only or enhanced-text web module with a sample of 159 participants. No statistical significant effects were found in terms of module type. The mean test scores for the four learning styles were not statistically significantly different either (Harris et al., 2003).

An experimental study measured whether learning styles, based on the Kolb LSI-2005 (v. 3.1) would predict learning preferences and academic success. Unfortunately,
the lack of details and the nature of control of the subjects prevented a clear interpretation of the results of the study (Gaur, Kohli, & Khanna, 2009).

Two large but evenly split samples (N = 181) and (N = 185) correlated the results from two assessment instruments (i.e., Kolb LSI-1985 and a neo-Piagetian Development Level Test) and two instructional methods (i.e., Inquiry and Expository). The Development Level Test was significantly more predictive of academic achievement than the Kolb LSI-1985 at the $p < 0.001$ (Lawson & Johnson, 2002).

Differences between the learning styles of first and third year architecture students were examined and assumption was made that once students became acclimated to the demands and the thinking required in the program, their learning style measures would move. The hypothesis was that the movement would be in a Southerly direction within the Assimilator quadrant. The term, southerly direction, refers to the location of the Assimilator quadrant within the Kolb LSI axes. Results supported the identified hypothesis, but one would recommend a longitudinal study to obtain specific results (Tucker, 2009).

The significant effects of both the thinking-feeling group and the doing-watching group were examined using MANOVA, but the results indicated no significant effects for the thinking-feeling group. The doing-watching group had only one significant effect for participating in groups at the $p < 0.01$, with an effect size = 0.43. Gender differences also were explored, but only one statistically significant result was found whereby men preferred doing practical exercises (Loo, 2004).
Learning Styles and Academic Performance

One of the focuses of this literature review was to determine whether the Kolb LSI had any predictive value in academic performance. The Kolb LSI-1985 instrument was used to examine whether there was a difference in learning styles of first and third year architecture students with the expectation that students would adapt their learning styles to meet the assessment demands of the architecture program. First semester assignment marks were correlated with the students obtained Kolb learning styles and Tucker hypothesized that students with higher marks would have a learning style located south of the AC-CE bi-polar dimension with learning styles located in the converging and assimilating quadrants. Results supported the finding. Students with higher marks had learning styles that were located south of the AC-CE bi-polar dimension. The weaker students’ learning styles were located north of the AC-CE bi-polar dimension. This was the only Kolb study that examined the relationship between learning styles and academic performance (Tucker, 2009).

The two remaining studies examined academic performance using learning style inventories other than the Kolb LSI. Learner attitudes were examined and evaluated to determine whether they could be used to predict academic success measured by GPA. The research focus was whether cognitive style would predict student success in terms of GPA and whether online technology self-efficacy would predict a students’ GPA in web-based distance education courses. Results of this study were mixed. Students had higher confidence levels with online technologies, but no significant increase in their GPA. Cognitive style was sometimes a predictor of students’ higher GPAs (DeTure, 2004).
Experiential learning activities were examined to determine whether these activities were effective in promoting learning in a third year undergraduate economics class. Students were given a mix of experiential and traditional learning activities from which their learning experiences could be further evaluated. Information was gathered via a survey containing 20 learning activities and students responded by reflecting upon their entire university learning experience and describing their preferences for specific types of learning experiences. Overall, 60% of students found experiential learning to be important and 13% found experiential learning to be unimportant. Traditional learning activities scored poorly. Differences were found between males and females with 64% of men preferring experiential learning activities to 54% of women (Hawtrey, 2007).

While one of the focuses of the literature review was to investigate whether the Kolb LSI had any predictive value in academic performance, only one article was located which dealt with the Kolb LSI and its ability to predict academic performance. Tucker (2009) examined whether a correlation would exist between learning styles and grades on first term assignments. In this study, one of the hypotheses specified that successful architecture students’ learning styles would be located in a southerly direction or south of the AE-RO bi-polar dimension or in the converging and assimilating quadrants as the skill sets and ways of thinking about implementing architecture reflect these two learning styles. Results supported this hypothesis and weaker students had learning styles north of the AE-RO bi-polar dimension or in the accommodating and diverging quadrants. This use of the Kolb LSI to predict academic success was interesting, but it is debatable whether this is a good example. Due finding only one article dealing with the Kolb LSI and the ability of the instrument to predict academic success, a conclusion as to whether
the literature is weak or mixed regarding the Kolb LSI ability to predict academic success, one study is not sufficient to make a satisfactory conclusion (Tucker, 2009).

**Specific Common Findings**

The purpose was to review the research literature to examine the validity and structure of the Kolb LSI instrument in a post-secondary classroom setting. Over half the articles were devoted to the Kolb LSI. The characteristics describing learning styles varied little among the instruments. The same or very similar adjectives were used to describe a learning style behavior. For most of the research articles, the role of learning styles in the different research scenarios were described in the presentation of statistical results.

**Kolb LSI**

The most central finding was the variability in the results regarding internal consistency, test-retest reliability, and validity of the Kolb LSI. Some of the theoretical papers focused strictly on the design of the Kolb LSI and did not present findings for various forms of reliability and validity backed up by statistical data. Only four studies presented statistically significant results to support the internal-consistency of the Kolb LSI with an emphasis on the bi-polar dimensions (Kayes, 2005; Loo, 1999; Romero et al., 1992; Yahya, 1998). Test-Retest Reliability was examined in only two papers with mixed results. Romero et al. (1992) found statistically significant results, but only in one of two samples, while Kayes (2005) found statistically significant test-retest reliability results in the entire study. Both based their findings on evaluating the bi-polar dimensions.
Internal, construct, and external validity findings were discussed in two papers. Statistically significant internal validity and construct validity results for the revised Kolb LSI-1999 were investigated. The determination was made that statistically significant construct validity was found because the within scale correlations were greater than the between scale correlations, which suggests an empirically distinct construct (Kayes, 2005) (see Anastasi, 1968). External validity was discussed in Romero et al. (1992), but no mention was made as to whether statistically significant results were found. Finally, Garner (2000) undertook a review of the Kolb LSI literature and found the overall reliability and validity of the instrument weak. Garner’s paper is an excellent resource for locating additional studies.

The factor structure of the Kolb LSI was examined in a number of studies and researchers came to different conclusions. Factor analysis and the more advanced confirmatory factor analysis were undertaken in a number of papers. The four-factor model was found to be less than satisfactory, given factor loadings only accounted for 56.6% of the variance despite eigenvalues ≥ 1 (Loo, 2004). In a second study, while the three-factor model explained 99.7% of the variance, the two-factor model, which explained 73% of the variance, was preferred due to the model being more parsimonious (Yahya, 1998). In a third study the two-factor model was preferred to the three-factor model due to the results explaining 70% of the variance and bi-polar dimensions loading on two factors with eigenvalues ≥ 1 (Kayes, 2005).

The factor structure was tested using confirmatory factor analysis to determine the superior factor structure and to get around the problem of ipsative scores (Romero et al.,
Both authors found the two-factor model was superior to the zero-factor or one-factor model using the relative fit index, but Loo (1999) was unsuccessful in resolving the issue of ipsative scores due to the data not being a good fit.

The statistical techniques of ANOVA and MANOVA were used in some of the studies with mixed results (Harris et al., 2003; Lawson & Johnson, 2002; Tucker, 2009; Loo, 1999). Harris et al. (2003) found no statistically significant effects in terms of the module type that students used during instruction or their mean test scores.

Using the Kolb LSI-1985 and the neo-Piagetian Development Level Test, academic achievement results were correlated with learning styles and the form of instruction. The Development Level Test was found to be more predictive of academic achievement than the Kolb LSI-1985 (Lawson & Johnson, 2002). Finally, one study used MANOVA to examine the preference for doing practical exercise and participating in groups across both genders. Results were mixed, but males preferred doing practical exercises and participating in groups across both genders (Loo, 2004).

**Learning Style Studies in an E-learning Environment**

In a study concerning the effects of formative assessment and learning styles on student achievement in a web-based learning environment, students were assigned randomly to one of three formative assessment strategies. The first assessment strategy consisted of the Formative Assessment Module of the Web-Based Assessment and Test Analysis system (FAM-WATA), consisting of six web-based formative assessment strategies. The second strategy was the Normal Module of Web-Based Assessment and Test Analysis system (N-WATA), consisting of partial web-based assessments. The third
strategy was the Paper and Pencil Test (PPT) approach without any form of web-based assessment (Wang, Wang, Wang, & Huang, 2006).

Researchers also have examined the role played by learning styles in an e-learning environment. In one such study, researchers wanted to discover whether an e-learning environment benefited students with different learning styles, as well as what kind of learning style was best suited for each type of e-learning environment. Students were assigned randomly to one of three groups after they took the Kolb Learning Style Inventory to identify their learning style (e.g., Accommodator; Diverger; Assimilator; and Converger). ANCOVA statistical analysis found that learning styles and the form of formative assessment strategy were significant factors affecting student achievement in a web-based learning environment. Student achievement on the FAM-WATA group was significantly higher than the N-WATA and the PPT groups (Wang et al., 2006).

**Literature Review Summary**

The articles in this literature review presented varying reliability and validity results. Most of the Kolb articles examined the Kolb LSI-1985 instrument (Geiger et al., 1993; Lawson & Johnson, 2002; Loo, 2004; Loo, 1999; Romero, Tepper & Tetrault, 1992; Tucker, 2009; Yahya, 1998). The Kolb LSI-1985 version did not randomize the learning modes attendant to each response statement. The column for each set of response statements measured the same learning mode. Beginning with the Kolb LSI-1999 version and continuing with the Kolb LSI-2005 (v. 3.1), the learning modes were randomized across columns.
All of the studies took place in a higher education setting and no studies have been reviewed which took place in a public school setting. Since the Kolb LSI is written at the seventh grade level, future studies could examine the effectiveness of the Kolb LSI within a public school setting. In essence, have studies been completed which have used elementary or secondary age students as the sample population and assessed the effectiveness of the Kolb LSI? Another area of research would be to see examples whereby teachers modified their teaching strategies to match the learning styles of the students. Only one study had the instructors take the Kolb LSI, but little was done with this information in terms of correlating any effects a teachers’ learning style had on the mode of instruction and the students’ academic success. Research could be undertaken examining the vexing problem of ipsative scores and remedy their occurrence by converting the 12-item Kolb LSI into a 48-item questionnaire using a Likert scale and comparing results to the 12-item Kolb LSI (Geiger et al., 1993).

The literature on learning styles, the Kolb LSI, and other learning style instruments is informative and in some instances provides an in depth examination and analyses of the aforementioned topics. The primary focus of this review was spent examining studies describing the use of the Kolb LSI in a higher education setting. A majority of the Kolb LSI research articles had statistically significant validity and reliability results, but the results varied in terms of statistical significance when the authors addressed specific research questions or hypotheses. Learning styles is multifaceted with numerous definitions, but the articles sampled gave a good overview of the topic. The remaining learning style instruments also provided some valuable and similar information to the Kolb LSI, such that varying results were found.
In the limited number of articles examined, few studies presented extensive findings regarding validity and reliability of the Kolb LSI. While journal articles may not be able to address reliability and validity in extensive detail due to article length restrictions, more research should be undertaken in this area. Thus, the question regarding how many studies have found the Kolb LSI to be reliable and valid is difficult to ascertain. However, Romero et al. (1992) and Kayes (2005) found support for test-retest reliability.

One of the vexing questions faced by researchers of the Kolb LSI inventory is how to get around the problem of ipsative scores, which call into question the results due to samples not being normative. Recommendations were made to change the response scale to a rating or Likert scale (Loo, 1999) and (Duff, 2004) and perhaps David A. Kolb will take this advice. Additional learning style instruments and their attendant reliability and validity results could be examined. The current study extends Loo’s recommendation by examining the effects of Likert and a Semantic Differential scales on learning style scores obtained from restructuring the Kolb LSI-2005 (v. 3.1) to a 48-item Likert survey and a 48-item Semantic Differential survey.

The research question being examined is whether a consistency of response and correlation exists between results obtained on the 12-item Kolb LSI and results obtained on the 48-item Likert or Semantic Differential survey. Theoretically, one would expect that when a participant indicates a response statement is “most like me” on the Kolb LSI, he or she should also select either the agree or strongly agree option on the Likert scale or be highly to the left (i.e., like me) on the bi-polar Semantic Differential continuum. But,
unlike the Kolb LSI which necessitates a ranking of all four response statements at the exclusion of the other statements, a participant is allowed to answer all four response statements as “most like me” without ranking.

Independent and dependent variables in this study are based on two hypotheses: (1) the Kolb LSI scores are a function of the group, which for this study include the elementary education, secondary education, and general education students, and (2) learning style scores obtained from the restructured 48-item Likert and Semantic Differential surveys are the same as those obtained on the Kolb LSI-2005 (v. 3.1) survey. Independent variables include the instruments (i.e., Kolb, Likert, and Semantic Differential) and the groups. Dependent variables include the learning style scores obtained from the Kolb LSI and scores obtained from the Likert or Semantic Differential surveys.
Chapter 3: Methodology

The purpose of this study is to compare results obtained from three survey instruments (i.e., Kolb LSI, Likert and Semantic Differential), each using a different measurement scale.

Research Design

A within and between subjects design was utilized. Participants randomly were divided into two groups: the Kolb LSI and the Likert scale (Group 1) or the Kolb LSI and the Semantic Differential scale (Group 2). Within-subject scores were obtained by comparing the results of participants within each group. The between scores were obtained by comparing the results of the Kolb LSI and a comparison of the Kolb results obtained from the Likert or Semantic Differential surveys of the two groups.

Participants

Seventy-two participants from three undergraduate Education courses at a public liberal studies institution completed the surveys. Participants voluntarily enrolled in one of the three courses: a course focusing on grades K-8 (N = 14), a course focusing on grades 6-12 (N = 39), and a general education course (N = 15). All participants in each class gained knowledge of either teaching for learning in the elementary or secondary classrooms or general education in the USA, of which learning styles is a topic in all three courses. Participants voluntarily engaged in this study to learn more about how learning styles are measured and to receive their learning style scores if they wished. Demographic data include age, gender, and college level, which describe the characteristics of the sample. The participants were unfamiliar with the Kolb LSI and its
content, how the inventory was scored, or of the attendant characteristics of the four learning styles. Any threat of external validity was alleviated due to this lack of knowledge.

**Instruments**

Three instruments were used in this study. The first instrument was the 12-item Kolb LSI-2005 (v. 3.1), which contains 12 sentence stems with 4 corresponding response statements and uses a 4-point scale where responses were ranked from Least Like Me to Most Like Me. The Kolb LSI instrument was restructured as a 48-item survey in which each sentence stem and corresponding response statement became one question. All participants completed the Kolb LSI-2005 (v. 3.1) survey. In addition, participants completed one of two 48-item surveys prepared with either a 7-point Likert scale or a 7-point Semantic Differential scale. The Kolb LSI instrument was assigned a unique ID number, which was placed on a corresponding Likert or Semantic Differential scale. The two surveys completed by each participant (i.e., the Kolb LSI-2005 (v. 3.1) and the Likert or Semantic Differential survey) contained the same identification number for within-subject statistical analyses.

The 7-point Likert measurement scale was ordered from Very Strongly Disagree to Very Strongly Agree. When calculations were made, the Very Strongly Disagree response received a score of one and the Very Strongly Agree response received a score of seven. Reverse polarity of the Semantic Differential scale had negative response positions to the left and positive response positions to the right of the continuum, which
allowed the data response point on the far left of Semantic Differential continuum to receive a score of one and the data point on the far right to receive a score of seven.

Sequence bias was avoided by having half of each group of 34 participants respond to the Kolb LSI first and the other half responding to either the Likert or Semantic Differential version of the scale first (Anastasi, 1968). An equal number of participants (N = 17) wrote either the Kolb LSI or the Likert survey first, but 16 participants wrote the Semantic Differential survey first and 18 participants wrote the Kolb LSI survey second. Response set bias was avoided in the Likert and Semantic Differential surveys by randomizing the order of the 48-items using a random numbers table (Dean & Voss, 1999).

Procedures

Participants were assigned randomly to two survey groups of 36 participants. Prior to handing out the surveys, the four survey packages were placed in a sequential order wherein the first and the fifth participant received the same survey package. Participants received a package containing two of the three surveys. When a participant completed one survey, he or she immediately began completing the second survey. Half of the participants completed the Kolb LSI-2005 (v. 3.1) first and then completed either a restructured Likert or Semantic Differential survey. The remaining participants completed the surveys in reverse order. Both groups completed the Kolb LSI-2005 (v. 3.1) survey and the restructured 48-item Likert or Semantic Differential survey.

For participants who did not wish to participate, a handout describing Learning Styles could be read in lieu of completing the surveys. All surveys were submitted and all
participants voluntarily attempted to complete both surveys. The surveys were collected from the participants by the researcher and then placed in a separate envelope, one for each class. Participants were provided with feedback regarding the results of the Kolb LSI one week later and were told their Kolb learning style, but were not provided with Likert or Semantic Differential results.

**Statistical Procedures**

The SPSS Grad Pack (v. 18) statistical program was used to analyze the data. Once the data had been collected and entered into the SPSS program, the learning modes (i.e., CE, RO, AC, AE) and bi-polar dimension (AC-CE and AE-RO) scores were calculated. The bi-polar dimension scores were graphed onto a specially designed Kolb LSI grid. The graphed bi-polar dimensions provided a Kolb learning style (i.e., Accommodating, Diverging, Assimilating, and Converging).

**Limitations of the Methodology**

The primary limitation to this study is the small sample size (N = 68), which limited the type of analysis that could be carried out. A larger sample size would have allowed the use of the McNemar test and chi-square analysis. In the latter case, the 4 x 4 analysis across learning modes requires a minimum of 80 participants, so that the expected cell value meets the required level of five (see Huck et al., 1974).

Osgood’s Semantic Differential scale has not been used to evaluate the reliability and validity of the Kolb LSI, and only one paper has examined the use of a Likert scale to evaluate the Kolb LSI (Friborg et al., 2006). Comparison of results from this new avenue
of research to previous studies would be difficult, given the paucity of existing research. In addition, few studies have examined the validity and reliability of the Kolb LSI-2005 (v. 3.1). The majority of studies have focused on the Kolb LSI-1985 version.

Another limitation to this study, is that the non-parametric Friedman test could not be used due to the use of two scale formats (i.e., Kolb LSI 4-item scale and Likert or Semantic Differential 7-item scale) and participants only completing two surveys. The Friedman test measures whether three or more samples of data come from the same population group and is similar in design to the parametric one-way ANOVA (Huck et al., 1974).

In this study, each participant completed the Kolb LSI and a modified Likert or Semantic Differential version of the Kolb LSI, so the Wilcoxon Signed Ranks test could not be used due to the use of two scale formats (i.e., 4-item and 7-item). The non-parametric Wilcoxon Matched-Pairs Signed Ranks Test is similar to the parametric t-test (Huck et al., 1974).

While non-parametric statistical techniques were used in this thesis, the parametric statistical test of Factor Analysis would have been useful. Many of the research studies examined for this thesis undertook factor analysis to determine the appropriate factor model for the surveys. Since this study is examining and analyzing two new learning style Likert or Semantic Differential surveys based on the Kolb LSI-2005 (v. 3.1), knowledge of the factor loadings for each instrument would be useful for future studies. A factor analysis of the surveys cannot be analyzed due to the small sample size. Tabachnick & Fidell (2007) state a sample size of 50 is very poor, while a sample size of
300 is good and would produce reliable correlation coefficients and valid factor loadings. A review of the literature contains differing opinions regarding sample size. The conservative approach recommends 10 times the number of variables in a study and a sample size of 68 falls far short of this requirement (MacCullum, Widaman, Shang, & Hong, 1999).

Statistics Selected

The characteristics of the data were a determinant in the decision about statistical test for data analysis. The Kolb LSI scores are ipsative and in past studies have been treated as ordinal and interval. The Likert scale produces ordinal measures and the Semantic Differential scale produces interval or ordinal measures. Due to the variety measurement levels of the data, a conservative decision was made to treat the scores obtained from the three survey instruments as ordinal. In so doing, non-parametric statistical techniques, rather than parametric statistics, were used to analyze the data.

Frequencies, Sign test, Kruskall-Wallis test, Mann-Whitney U test, Median tests, and Spearman rank order correlations were the primary statistical techniques used in this study. Frequencies were used to provide descriptive characteristics of the participants and the Sign test was used to extend and clarify the findings of one of the frequency distributions. Due to the use of non-parametric statistical techniques, median tests were used rather than means. The non-parametric Spearman rank order correlation statistic was used to calculate correlations among the three surveys of the learning modes, bi-polar dimensions and learning styles.
The Kruskall-Wallis test was selected to undertake a comparison of learning styles across three groups (i.e., participants from the Secondary, Elementary, and General Education courses) and the three instruments. Course was the grouping variable. The Mann-Whitney U test undertook an examination of the role of sequence bias in the administration of the three surveys. Two survey sets (i.e., Set 1: Kolb LSI–Likert and Likert-Kolb LSI; Set 2: Kolb LSI–Semantic Differential and Semantic Differential–Kolb LSI) were administered and the Mann-Whitney U test allowed the researcher to determine whether a significant difference existed between the two independent samples. Sequence was the grouping variable (i.e., the Kolb LSI presented first or second).

In the next chapter, the results from the aforementioned statistical techniques should provide an initial understanding of how the scores obtained from the two re-structured Likert and Semantic Differential surveys compare to results obtained from the Kolb LSI. Comparison of learning style across three instruments with an intervening variable of course will provide one with an analysis of whether there were significant differences in learning styles among the three classes and the three instruments. Sequence bias will be analyzed by examining whether the sequence-order of survey administration had any effect on the learning styles obtained by participants. Finally, a correlation analysis of the learning styles, learning modes, and bi-polar dimensions obtained from both surveys sets will be examined.
Chapter 4: Results

The presentation of the analysis of the results of data collected during the study are presented in the following order: (1) descriptive analysis of the demographic characteristics of the participants independent of learning style, (2) descriptive analysis of the demographic characteristics of participants according to learning style and/or the three learning style instruments used in the study, (3) comparison of the Kolb LSI scores of the participants to the Kolb LSI norms, and (4) statistical analysis of the data based on the hypotheses under investigation. The discussion of the results is presented in Chapter 5.

Participants and Missing Data

 Missing data were encountered on four (or 5.6%) of the original 72 surveys. Surveys with missing data were removed from the initial sample, leaving a final sample of 68 participants. The 68 participants consisted of 30 male and 38 female undergraduate education students who were either pursuing an elementary or secondary teaching career or who had enrolled in a general education course. The majority of participants were at the junior (45.6%) and senior (26.5%) college levels. Secondary teaching majors accounted for 57.4% of participants and the remainder were split between elementary teaching majors (20.6%) and general education (22.1%) majors. The mean age of the participants was 21.2 years. The age breakdown by course was similar (i.e., Elementary = 20.6, Secondary = 21.2, and General education = 20). A more detailed breakdown of the sample is located in Table 2.
Table 2

*College Level, Gender, and Age of Participants by Course*

<table>
<thead>
<tr>
<th>College Level</th>
<th>Gender</th>
<th>Secondary ED 231 (n = 39) Age M</th>
<th>Elementary ED 230 (n = 14) Age M</th>
<th>General Education ED 101 (n = 15) Age M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshman Males</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Freshman Females</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Sophomore Males</td>
<td>2</td>
<td>19.5</td>
<td>1</td>
<td>19.0</td>
</tr>
<tr>
<td>Sophomore Females</td>
<td>8</td>
<td>19.9</td>
<td>8</td>
<td>20.4</td>
</tr>
<tr>
<td>Junior Males</td>
<td>13</td>
<td>20.9</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Junior Females</td>
<td>8</td>
<td>19.9</td>
<td>8</td>
<td>20.4</td>
</tr>
<tr>
<td>Senior Males</td>
<td>6</td>
<td>23.3</td>
<td>1</td>
<td>22.0</td>
</tr>
<tr>
<td>Senior Females</td>
<td>6</td>
<td>22.3</td>
<td>4</td>
<td>21.3</td>
</tr>
<tr>
<td>Graduate Males</td>
<td>4</td>
<td>24.5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Graduate Females</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

*Note.* M = means

**Learning Style by Instrument**

All participants completed the Kolb LSI survey, but only half of this sample (N = 34) completed either the modified Likert or Semantic Differential version of the Kolb LSI. Seven frequency statistical runs were undertaken to provide an overview of the learning style characteristics of the data.

To calculate a participant’s learning style (i.e., accommodating, converging, assimilating, or diverging), the values of the two bi-polar dimensions (i.e., AC-CE and AE-RO) were calculated and then graphed. When the two bi-polar dimensions were graphed, the product was a shape, similar to a kite design. The learning style quadrant
(i.e., accommodating, diverging, assimilating, or converging) specified the learning style by the quadrant in which the kite design was most prominently located. The intersection of the two bi-polar dimensions identified the dominant learning style for each participant. Once a graphical representation of a participant’s learning style was obtained, the learning style was assigned a number. One problem encountered was that a few learning style results had intersection points fall on the axes. These learning styles were designated as balanced. Consequently, for this study, balanced refers to a learning style that falls very close to or on the Kolb axes rather than in a quadrant, which makes a specific learning style difficult to determine. The learning style “Balanced” occurred on eight surveys from the Likert and Semantic Differential graphs.

Table 3 presents the frequency distribution of learning styles obtained by participants for each survey instrument. The dominant learning style across survey instruments varied by survey with Diverging and Accommodating learning styles being the most prevalent.
Table 3

*Learning Styles by Survey Instruments*

<table>
<thead>
<tr>
<th>Learning style</th>
<th>Survey instruments</th>
<th>Kolb (n = 68)</th>
<th>Likert (n = 34)</th>
<th>Semantic Differential (n = 34)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Accommodating</td>
<td>23</td>
<td>33.8%</td>
<td>12</td>
<td>35.3%</td>
</tr>
<tr>
<td>Diverging</td>
<td>21</td>
<td>30.9%</td>
<td>15</td>
<td>44.1%</td>
</tr>
<tr>
<td>Assimilating</td>
<td>15</td>
<td>22.1%</td>
<td>3</td>
<td>8.9%</td>
</tr>
<tr>
<td>Converging</td>
<td>9</td>
<td>13.2%</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Balanced</td>
<td>0</td>
<td>-</td>
<td>4</td>
<td>11.8%</td>
</tr>
</tbody>
</table>

*Note.* All participants completed the Kolb. From the Kolb group, randomly assigned participants completed either the Likert or Semantic Differential Survey.

The frequency distribution of learning styles obtained by participants for each survey instrument are presented in Tables 4 and 5 and present the number and percentages of hits and misses between Kolb inventory and Likert and Semantic Differential surveys. The overall hit rate of the Likert and Semantic Differential surveys compared to the Kolb LSI was 47%.
Table 4

Comparison of Hits and Misses of the Likert Learning Style with Kolb Learning Style

<table>
<thead>
<tr>
<th>Learning style</th>
<th>Likert survey instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Likert (n = 34)</td>
</tr>
<tr>
<td></td>
<td>n</td>
</tr>
<tr>
<td>Accommodating</td>
<td>12</td>
</tr>
<tr>
<td>Diverging</td>
<td>15</td>
</tr>
<tr>
<td>Assimilating</td>
<td>3</td>
</tr>
<tr>
<td>Converging</td>
<td>0</td>
</tr>
<tr>
<td>Balanced</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 5

Comparison of Hits and Misses of the Semantic Differential Learning Style with Kolb Learning Style

<table>
<thead>
<tr>
<th>Learning style</th>
<th>Semantic Differential survey instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Semantic Differential (n = 34)</td>
</tr>
<tr>
<td></td>
<td>N</td>
</tr>
<tr>
<td>Accommodating</td>
<td>8</td>
</tr>
<tr>
<td>Diverging</td>
<td>16</td>
</tr>
<tr>
<td>Assimilating</td>
<td>4</td>
</tr>
<tr>
<td>Converging</td>
<td>2</td>
</tr>
<tr>
<td>Balanced</td>
<td>4</td>
</tr>
</tbody>
</table>
Table 6 presents the frequency distribution of learning styles by gender and instrument. The sample was consisted of Males (n = 30, 44.1%) and Females (n = 38, 55.9%). The dominant learning style across gender varied by survey with the Accommodating and Diverging learning styles being the most prevalent.

Table 6

Learning Style by Gender and Instrument

<table>
<thead>
<tr>
<th>Gender</th>
<th>Learning style</th>
<th>Instrument</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Kolb (n = 68)</td>
<td>Likert (n = 34)</td>
<td>Semantic Differential (n = 34)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td>Male</td>
<td>Accommodating</td>
<td>11</td>
<td>16.2%</td>
<td>7</td>
<td>20.6%</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Diverging</td>
<td>9</td>
<td>13.2%</td>
<td>5</td>
<td>14.7%</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Assimilating</td>
<td>7</td>
<td>10.3%</td>
<td>1</td>
<td>2.9%</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Converging</td>
<td>3</td>
<td>4.4%</td>
<td>0</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Balanced</td>
<td>0</td>
<td>-</td>
<td>2</td>
<td>5.9%</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td><strong>N</strong></td>
<td>30</td>
<td>44.1%</td>
<td>15</td>
<td>44.1%</td>
<td>15</td>
</tr>
<tr>
<td>Female</td>
<td>Accommodating</td>
<td>12</td>
<td>17.6%</td>
<td>5</td>
<td>14.7%</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Diverging</td>
<td>12</td>
<td>17.6%</td>
<td>10</td>
<td>29.4%</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Assimilating</td>
<td>8</td>
<td>11.8%</td>
<td>2</td>
<td>5.9%</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Converging</td>
<td>6</td>
<td>8.9%</td>
<td>0</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Balanced</td>
<td>0</td>
<td>-</td>
<td>2</td>
<td>5.9%</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td><strong>N</strong></td>
<td>38</td>
<td>55.9%</td>
<td>19</td>
<td>55.9%</td>
<td>19</td>
</tr>
</tbody>
</table>

*Note.* All participants completed the Kolb. From the Kolb group, randomly assigned participants completed either the Likert or Semantic Differential Survey.
Table 7 presents the frequency distribution of educational level by instrument.

The majority of participants were at the junior level (45.6%).

Table 7

*Education Level by Survey Instruments*

<table>
<thead>
<tr>
<th>Educational level</th>
<th>Kolb (n = 68)</th>
<th>Likert (n = 34)</th>
<th>Semantic Differential (n = 34)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n %</td>
<td>N %</td>
<td>n %</td>
</tr>
<tr>
<td>Freshman</td>
<td>7 10.3%</td>
<td>3 8.8%</td>
<td>4 11.8%</td>
</tr>
<tr>
<td>Sophomore</td>
<td>8 11.8%</td>
<td>6 17.6%</td>
<td>2 5.9%</td>
</tr>
<tr>
<td>Junior</td>
<td>31 45.6%</td>
<td>17 50.0%</td>
<td>14 41.2%</td>
</tr>
<tr>
<td>Senior</td>
<td>18 26.5%</td>
<td>8 23.5%</td>
<td>10 29.4%</td>
</tr>
<tr>
<td>Graduate</td>
<td>2 2.9%</td>
<td>-</td>
<td>2 5.9%</td>
</tr>
<tr>
<td>Other</td>
<td>2 2.9%</td>
<td>-</td>
<td>2 5.9%</td>
</tr>
</tbody>
</table>

*Note.* All participants completed the Kolb. From the Kolb group, randomly assigned participants completed either the Likert or Semantic Differential Survey.

Table 8 presents the frequency distribution of learning style by educational level and instrument. The learning styles of Diverging and Accommodating were the dominant learning styles for all educational levels across all three surveys.
Table 8

Learning Style by Educational Level and Instrument

<table>
<thead>
<tr>
<th>Educational level</th>
<th>Learning style</th>
<th>Instruments</th>
<th>Kolb (n = 68)</th>
<th>Likert (n = 34)</th>
<th>Semantic Differential (n = 34)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>Freshman</td>
<td>Accommodating</td>
<td>2</td>
<td>2.9%</td>
<td>2</td>
<td>5.9%</td>
</tr>
<tr>
<td></td>
<td>Diverging</td>
<td>3</td>
<td>4.4%</td>
<td>1</td>
<td>2.9%</td>
</tr>
<tr>
<td></td>
<td>Assimilating</td>
<td>2</td>
<td>2.9%</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Converging</td>
<td>0</td>
<td>-</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Balanced</td>
<td>0</td>
<td>-</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Sophomore</td>
<td>Accommodating</td>
<td>2</td>
<td>2.9%</td>
<td>2</td>
<td>5.9%</td>
</tr>
<tr>
<td></td>
<td>Diverging</td>
<td>2</td>
<td>2.9%</td>
<td>3</td>
<td>8.8%</td>
</tr>
<tr>
<td></td>
<td>Assimilating</td>
<td>3</td>
<td>4.4%</td>
<td>1</td>
<td>2.9%</td>
</tr>
<tr>
<td></td>
<td>Converging</td>
<td>1</td>
<td>1.5%</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Balanced</td>
<td>0</td>
<td>-</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Junior</td>
<td>Accommodating</td>
<td>9</td>
<td>13.2%</td>
<td>5</td>
<td>14.7%</td>
</tr>
<tr>
<td></td>
<td>Diverging</td>
<td>12</td>
<td>17.6%</td>
<td>7</td>
<td>20.6%</td>
</tr>
<tr>
<td></td>
<td>Assimilating</td>
<td>6</td>
<td>8.8%</td>
<td>2</td>
<td>5.9%</td>
</tr>
<tr>
<td></td>
<td>Converging</td>
<td>4</td>
<td>5.9%</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Balanced</td>
<td>0</td>
<td>-</td>
<td>3</td>
<td>8.8%</td>
</tr>
<tr>
<td>Senior</td>
<td>Accommodating</td>
<td>10</td>
<td>14.7%</td>
<td>3</td>
<td>8.8%</td>
</tr>
<tr>
<td></td>
<td>Diverging</td>
<td>2</td>
<td>2.9%</td>
<td>4</td>
<td>11.9%</td>
</tr>
<tr>
<td></td>
<td>Assimilating</td>
<td>3</td>
<td>4.4%</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Converging</td>
<td>3</td>
<td>4.4%</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Balanced</td>
<td>0</td>
<td>-</td>
<td>1</td>
<td>2.9%</td>
</tr>
<tr>
<td>Graduate</td>
<td>Accommodating</td>
<td>0</td>
<td>-</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Diverging</td>
<td>1</td>
<td>2.9%</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Assimilating</td>
<td>1</td>
<td>2.9%</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Converging</td>
<td>0</td>
<td>-</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Balanced</td>
<td>0</td>
<td>-</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Other</td>
<td>Accommodating</td>
<td>0</td>
<td>-</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Diverging</td>
<td>1</td>
<td>2.9%</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Assimilating</td>
<td>0</td>
<td>-</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Converging</td>
<td>1</td>
<td>2.9%</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Balanced</td>
<td>0</td>
<td>-</td>
<td>0</td>
<td>-</td>
</tr>
</tbody>
</table>
Table 9 presents the frequency distribution of learning style by course and survey instrument. Over half of the participants were enrolled in secondary education (57.4%) and the remaining were split between the general and elementary education courses.

Table 9

*Learning Style by Course and Instrument*

<table>
<thead>
<tr>
<th>Course</th>
<th>Learning style</th>
<th>Kolb (n = 68)</th>
<th>Likert (n = 34)</th>
<th>Semantic Differential (n = 34)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>ED 101</td>
<td>Accommodating</td>
<td>3</td>
<td>4.4%</td>
<td>4</td>
</tr>
<tr>
<td>General</td>
<td>Diverging</td>
<td>5</td>
<td>7.4%</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Assimilating</td>
<td>6</td>
<td>8.8%</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Converging</td>
<td>1</td>
<td>1.5%</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Balanced</td>
<td>0</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>N</td>
<td></td>
<td>15</td>
<td>22.1%</td>
<td>7</td>
</tr>
<tr>
<td>ED 230</td>
<td>Accommodating</td>
<td>7</td>
<td>10.3%</td>
<td>2</td>
</tr>
<tr>
<td>Elementary</td>
<td>Diverging</td>
<td>4</td>
<td>5.9%</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Assimilating</td>
<td>1</td>
<td>1.5%</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Converging</td>
<td>2</td>
<td>2.9%</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Balanced</td>
<td>0</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>N</td>
<td></td>
<td>14</td>
<td>20.6%</td>
<td>7</td>
</tr>
<tr>
<td>ED 231</td>
<td>Accommodating</td>
<td>13</td>
<td>19.1%</td>
<td>6</td>
</tr>
<tr>
<td>Secondary</td>
<td>Diverging</td>
<td>12</td>
<td>17.6%</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Assimilating</td>
<td>8</td>
<td>11.8%</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Converging</td>
<td>6</td>
<td>8.8%</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Balanced</td>
<td>0</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>N</td>
<td></td>
<td>39</td>
<td>57.4%</td>
<td>20</td>
</tr>
</tbody>
</table>

*Note.* All participants completed the Kolb. From the Kolb group, randomly assigned participants completed either the Likert or Semantic Differential Survey.

Tables 10 and 11 present frequency distributions outlining a comparison of learning styles by survey sequence order for the two survey sets (i.e., Kolb LSI and the
Likert scale [Group 1] or the Kolb LSI and the Semantic Differential scale [Group 2]).

Table 10 presents the descriptive data of the Kolb LSI – Likert survey set.

Accommodating and Diverging were the most prevalent learning styles in the Kolb LSI – Likert survey sequence, while no specific learning style was dominant in the Likert – Kolb LSI survey sequence.

Table 10

*Comparison of Learning Styles by Kolb and Likert Survey Sequence Order*

<table>
<thead>
<tr>
<th>Learning style</th>
<th>Survey sequence order</th>
<th>Kolb LSI and Likert surveys n = 34</th>
<th>Likert and Kolb LSI surveys n = 34</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Kolb (n = 17)</td>
<td>Likert (n = 17)</td>
<td>Likert (n = 17)</td>
</tr>
<tr>
<td></td>
<td>n %</td>
<td>n %</td>
<td>N %</td>
</tr>
<tr>
<td>Accommodating</td>
<td>9 52.9%</td>
<td>6 35.3%</td>
<td>6 35.3%</td>
</tr>
<tr>
<td>Diverging</td>
<td>4 23.5%</td>
<td>9 52.9%</td>
<td>6 35.3%</td>
</tr>
<tr>
<td>Assimilating</td>
<td>2 11.8%</td>
<td>0 -</td>
<td>3 17.6%</td>
</tr>
<tr>
<td>Converging</td>
<td>2 11.8%</td>
<td>0 -</td>
<td>0 -</td>
</tr>
<tr>
<td>Balanced</td>
<td>0 -</td>
<td>2 11.8%</td>
<td>2 11.8%</td>
</tr>
</tbody>
</table>
Table 11 presents the descriptive data of the Kolb LSI – Semantic Differential survey set. Diverging was the most prevalent learning style in the Kolb LSI – Semantic Differential survey sequence across both surveys, and Diverging was the dominant learning style only on the Kolb inventory in the Semantic Differential – Kolb LSI survey sequence.

Table 11

**Learning Styles by Kolb and Semantic Differential Survey Sequence Order**

<table>
<thead>
<tr>
<th>Learning style</th>
<th>Kolb LSI and Semantic Differential surveys (n = 34)</th>
<th>Semantic Differential and Kolb LSI surveys (n = 34)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Kolb (n = 18)</td>
<td>Semantic Differential (n = 18)</td>
</tr>
<tr>
<td>N</td>
<td>%</td>
<td>n %</td>
</tr>
<tr>
<td>Accommodating</td>
<td>1 5.6%</td>
<td>3 16.7%</td>
</tr>
<tr>
<td>Diverging</td>
<td>9 50.0%</td>
<td>8 44.4%</td>
</tr>
<tr>
<td>Assimilating</td>
<td>5 27.8%</td>
<td>3 16.7%</td>
</tr>
<tr>
<td>Converging</td>
<td>3 16.7%</td>
<td>1 5.6%</td>
</tr>
<tr>
<td>Balanced</td>
<td>0 -</td>
<td>3 16.7%</td>
</tr>
</tbody>
</table>

**Comparison of Kolb LSI Norms to Sample Scores**

The mean and standard deviation of the four learning modes and two bi-polar dimension scores obtained from the Kolb LSI-2005 were calculated. The results were compared to the Kolb LSI-2005 norms published by the Hay Group (Kolb & Kolb,
As shown in Table 12, the sample scores did not appreciably deviate from the Kolb LSI-2005 norms despite the smaller sample (n = 68).

Table 12

Comparison of Kolb LSI Norms and Current Kolb LSI Scores

<table>
<thead>
<tr>
<th>Learning modes and Bi-polar dimensions</th>
<th>Kolb LSI norms (n = 6977)</th>
<th>Sample Kolb LSI scores (n = 68)</th>
<th>Standard deviations</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE</td>
<td>25.39</td>
<td>26.34</td>
<td>6.43  6.70</td>
</tr>
<tr>
<td>RO</td>
<td>28.19</td>
<td>30.43</td>
<td>7.07  7.00</td>
</tr>
<tr>
<td>AC</td>
<td>32.22</td>
<td>28.70</td>
<td>7.29  8.01</td>
</tr>
<tr>
<td>AE</td>
<td>34.14</td>
<td>34.54</td>
<td>6.68  7.42</td>
</tr>
<tr>
<td>AC-CE</td>
<td>6.83</td>
<td>2.35</td>
<td>11.69 12.27</td>
</tr>
<tr>
<td>AE-RO</td>
<td>5.95</td>
<td>4.12</td>
<td>11.63 11.87</td>
</tr>
</tbody>
</table>

Note: CE = Concrete Experience; RO = Reflective Observation; AC = Abstract Conceptualization; AE = Active Experimentation; AC-CE = Abstract Conceptualization – Concrete Experience; AE-RO = Active Experimentation – Reflective Observation.


Analysis of Learning Styles by Course and Instrument

The Kruskall-Wallis test was used to determine whether significant differences were observed in obtained learning styles across the three courses. Table 13 has three p-values from the comparison of Kruskall-Wallis ranks of each course and instrument. The differences in learning styles by course across learning style instrument were not significant, so the participants’ data by course could be combined.
Table 13

*Kruskall-Wallis Analysis of Participant Learning Style by Course across Learning Style Instruments*

<table>
<thead>
<tr>
<th>Learning style</th>
<th>Course</th>
<th>Sample size</th>
<th>Mean ranks</th>
<th>Chi-square</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kolb LSI</td>
<td>ED 231 Secondary</td>
<td>39</td>
<td>34.97</td>
<td>2.166</td>
<td>.339</td>
</tr>
<tr>
<td></td>
<td>ED 230 Elementary</td>
<td>14</td>
<td>28.57</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ED 101 General Education</td>
<td>15</td>
<td>38.80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Likert</td>
<td>ED 231 Secondary</td>
<td>20</td>
<td>19.80</td>
<td>3.588</td>
<td>.166</td>
</tr>
<tr>
<td></td>
<td>ED 230 Elementary</td>
<td>7</td>
<td>16.14</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ED 101 General Education</td>
<td>7</td>
<td>12.29</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Semantic</td>
<td>ED 231 Secondary</td>
<td>19</td>
<td>18.08</td>
<td>1.633</td>
<td>.442</td>
</tr>
<tr>
<td>Differential</td>
<td>ED 230 Elementary</td>
<td>7</td>
<td>13.64</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ED 101 General Education</td>
<td>8</td>
<td>19.50</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Investigation of Sequence Order by Instrument**

The Mann-Whitney U test was conducted to determine whether the sequence in which the surveys were answered was of significance. Four z-scores were obtained, two for the Kolb LSI – Likert combination and two for the Kolb LSI – Semantic Differential combination. The three test variables were the Kolb LSI, Likert and Semantic Differential learning style scores and the grouping variable was sequence order. Table 14 presented the sequence order results for the Kolb LSI – Likert and Likert – Kolb LSI survey set. As shown in Tables 14 and 15, sequence bias was not found to be significant and did not affect the obtained learning style scores (see Sheskin, 2007).
Table 14

*Mann-Whitney U Analysis of Learning Style by Instrument Sequence Order of the Kolb LSI and Likert Surveys*

<table>
<thead>
<tr>
<th>Learning style</th>
<th>Group</th>
<th>Survey sequence-order</th>
<th>Sample size (n = 34)</th>
<th>Mean rank</th>
<th>z-score</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kolb LSI</td>
<td>1</td>
<td>Kolb LSI – Likert</td>
<td>n = 17</td>
<td>16.38</td>
<td>-.699</td>
<td>0.24</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Likert – Kolb LSI</td>
<td>n = 17</td>
<td>18.62</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Likert</td>
<td>1</td>
<td>Kolb LSI – Likert</td>
<td>n = 17</td>
<td>16.71</td>
<td>-.499</td>
<td>0.31</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Likert – Kolb LSI</td>
<td>n = 17</td>
<td>18.29</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 15 presents results for the Kolb LSI – Semantic Differential and Semantic Differential and Semantic Differential – Kolb LSI survey set.

Table 15

*Mann-Whitney U Analysis of Learning Style by Instrument Sequence Order of the Kolb LSI and Semantic Differential Surveys*

<table>
<thead>
<tr>
<th>Learning style</th>
<th>Group</th>
<th>Survey sequence-order</th>
<th>Sample size (n = 34)</th>
<th>Mean rank</th>
<th>z-score</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kolb LSI</td>
<td>4</td>
<td>Kolb LSI – Semantic Differential</td>
<td>n = 18</td>
<td>19.5</td>
<td>-1.299</td>
<td>0.097</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Semantic Differential - Kolb LSI</td>
<td>n = 16</td>
<td>15.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Semantic Differential</td>
<td>4</td>
<td>Kolb LSI – Semantic Differential</td>
<td>n = 18</td>
<td>19.56</td>
<td>-1.361</td>
<td>Range between 0.097 to 0.081</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Semantic Differential – Kolb LSI</td>
<td>n = 16</td>
<td>15.19</td>
<td>0.097</td>
<td>0.081</td>
</tr>
</tbody>
</table>
Investigation of Sequence Order and Learning Modes

The non-parametric Median test was undertaken to determine whether any of the individual learning mode scores, or bi-polar dimensions obtained from both survey sets (i.e., Kolb LSI – Likert and Kolb LSI – Semantic Differential) could be pooled into one sample (see Huck et al., 1974). The scores obtained for each individual learning mode and the bi-polar dimensions, for the three surveys were examined and sequence order was used as the grouping variable. The Median test evaluated the scores obtained from the Kolb LSI - Semantic Differential and the Kolb LSI - Likert survey order differences of administration.

Tables 16, 17, and 18 examined the Median Tests for Survey Sequence-Order of the Kolb LSI, Likert, and Semantic Differential Learning Modes. Two survey sets were administered in two sequence orders (i.e., Kolb LSI – Likert and Likert – Kolb LSI; Kolb LSI – Semantic Differential and Semantic Differential – Kolb LSI). As shown in Table 16, no significant difference for the Kolb LSI learning modes (i.e., CE, RO, AC, AE) were found in either the Likert or Semantic Differential survey sets.
Table 16

Survey Sequence Order and Kolb Learning Modes

<table>
<thead>
<tr>
<th>Group</th>
<th>Survey sequence order</th>
<th>Kolb learning modes</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>CE</td>
<td>RO</td>
<td>AC</td>
<td>AE</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Kolb LSI – Likert</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; Median</td>
<td>8</td>
<td>9</td>
<td>7</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>≤ Median</td>
<td>9</td>
<td>8</td>
<td>10</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Likert – Kolb LSI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; Median</td>
<td>6</td>
<td>8</td>
<td>10</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>≤ Median</td>
<td>11</td>
<td>9</td>
<td>7</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>34</td>
<td>34</td>
<td>34</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Grand Median</td>
<td>26.0</td>
<td>28.5</td>
<td>27.5</td>
<td>37.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yates’ Continuity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Correction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Asymp. Sig.</td>
<td>.727</td>
<td>1.00</td>
<td>.493</td>
<td>.296</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Kolb LSI – SemDiff</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; Median</td>
<td>9</td>
<td>11</td>
<td>8</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>≤ Median</td>
<td>9</td>
<td>7</td>
<td>10</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>SemDiff – Kolb LSI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; Median</td>
<td>8</td>
<td>6</td>
<td>8</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>≤ Median</td>
<td>8</td>
<td>10</td>
<td>8</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>34</td>
<td>34</td>
<td>34</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Grand Median</td>
<td>25.5</td>
<td>31.5</td>
<td>28.0</td>
<td>35.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yates’ Continuity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Correction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Asymp. Sig.</td>
<td>.731</td>
<td>.303</td>
<td>.984</td>
<td>.760</td>
<td></td>
</tr>
</tbody>
</table>

Note. CE = Concrete Experience; RO = Reflective Observation; AC = Abstract Conceptualization; AE = Active Experimentation
In Table 17 has an evaluation of the Kolb LSI and Likert survey set. The Likert Abstract Conceptualization (LAC) learning mode score was significant. Due to this significant result, the samples for these two variables could not be pooled into one sample.

Table 17

*Survey Sequence Order and Likert Learning Modes*

<table>
<thead>
<tr>
<th>Group</th>
<th>Survey sequence order</th>
<th>LCE (n = 34)</th>
<th>LRO (n = 34)</th>
<th>LAC (n = 34)</th>
<th>LAE (n = 34)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Kolb LSI – Likert</td>
<td>7</td>
<td>8</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>&gt; Median</td>
<td>10</td>
<td>9</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>Likert – Kolb LSI</td>
<td>10</td>
<td>7</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>&gt; Median</td>
<td>7</td>
<td>10</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>≤ Median</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Grand Median</td>
<td>55.5</td>
<td>56.0</td>
<td>57.0</td>
<td>67.0</td>
</tr>
</tbody>
</table>

Yates’ Continuity Correction
Asymp. Sig.  .493  1.00  0.040*  1.00

*Note. LCE = Likert Concrete Experience; LRO = Likert Reflective Observation; LAC = Likert Abstract Conceptualization; LAE = Likert Active Experimentation
* Correlation is significant at the 0.05 level (2-tailed)
Table 18 has an analysis of the Kolb LSI and Semantic Differential survey set. The Semantic Differential Concrete Experience (SCE) learning mode score was significant. Due to this significant result, the samples for these two variables could not be pooled into one sample.

Table 18

**Survey Sequence Order and Semantic Differential Learning Modes**

<table>
<thead>
<tr>
<th>Group</th>
<th>Survey sequence order</th>
<th>SCE (n = 34)</th>
<th>SRO (n = 34)</th>
<th>SAC (n = 34)</th>
<th>SAE (n = 34)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 Kolb LSI – SemDiff</td>
<td>&gt; Median</td>
<td>5</td>
<td>10</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>≤ Median</td>
<td>13</td>
<td>8</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>3 SemDiff – Kolb LSI</td>
<td>&gt; Median</td>
<td>12</td>
<td>6</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>≤ Median</td>
<td>4</td>
<td>10</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Grand Median</td>
<td></td>
<td>56.5</td>
<td>63.0</td>
<td>61.0</td>
<td>69.5</td>
</tr>
</tbody>
</table>

Yates’ Continuity Correction

Asymp. Sig. .016* .479 .175 .731

* Denotes significance at the 0.05 level (2-tailed)

**Note.** SCE = Semantic Differential Concrete Experience; SRO = Semantic Differential Reflective Observation; SAC = Semantic Differential Abstract Conceptualization; SAE = Semantic Differential Active Experimentation

Investigation of Sequence Order and Bi-polar Dimensions

Tables 19 and 20 present the Median Tests of Survey Sequence-Order and a comparison of bi-polar dimension scores obtained from the two survey sets. Table 19 presents the bi-polar dimensions of the Kolb – Likert survey set, and Table 20 contains the bi-polar dimensions of the Kolb – Semantic Differential survey set. Table 19 found no significant differences of survey sequence-order and its effects on the bi-polar
dimensions of the Kollb LSI – Likert survey set. Therefore, the bi-polar dimension scores from this survey set could be pooled and survey sequence order is no longer an issue.

Table 19

Survey Sequence Order and Comparison of Kolb LSI and Likert Bi-polar Dimensions

<table>
<thead>
<tr>
<th>Group</th>
<th>Survey sequence order</th>
<th>Bi-polar dimensions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>AC-CE (n = 34)</td>
<td>AE-RO (n = 34)</td>
</tr>
<tr>
<td>1</td>
<td>Kolb LSI – Likert</td>
<td>≥ Median</td>
<td>≤ Median</td>
</tr>
<tr>
<td></td>
<td>&gt; Median</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>2</td>
<td>Likert – Kolb LSI</td>
<td>&gt; Median</td>
<td>≤ Median</td>
</tr>
<tr>
<td></td>
<td>Grand Median</td>
<td>-1.00</td>
<td>10.5</td>
</tr>
</tbody>
</table>

Yates’ Continuity Correction
Asymp. Sig. .731 1.00 1.00 1.00

Table 20 found no significant differences of survey sequence-order and its effects on the bi-polar dimensions of the Kollb LSI – Semantic Differential survey set. Therefore, the bi-polar dimension scores from this survey set could be pooled and survey sequence order is no longer an issue.
Table 20

*Survey Sequence Order and Comparison of Kolb LSI and Semantic Differential Bi-polar Dimensions*

<table>
<thead>
<tr>
<th>Group</th>
<th>Survey sequence order</th>
<th>Bi-polar dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>AC-CE</td>
</tr>
<tr>
<td>4</td>
<td>Kolb LSI – SemDiff</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; Median</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>≤ Median</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>SemDiff – Kolb LSI</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; Median</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>≤ Median</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Grand Median</td>
<td>2.00</td>
</tr>
<tr>
<td></td>
<td>Yates’ Continuity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Correction</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Asymp. Sig.</td>
<td>.760</td>
</tr>
</tbody>
</table>

*Note. AC-CE = Abstract Conceptualization – Concrete Experience; AE-RO = Active Experimentation – Reflective Observation; SAC-SCE = Semantic Differential Abstract Conceptualization – Semantic Differential Concrete Experience; SAE-SRO = Semantic Differential Active Experimentation – Semantic Differential Reflective Observation*

**Correlation Analysis**

Correlations were calculated between the learning modes and bi-polar dimensions of the two survey sets. Table 21 has the Spearman rank-order correlations (Spearman’s Rho) between the four learning style scores (i.e., Accommodating, Diverging, Converging, and Assimilating) and the three surveys (i.e., Kolb, Likert, Semantic Differential). All correlation coefficients obtained on two survey sets were significant at the $p < 0.05$ level.
### Table 21

*Spearman Rank-order Correlations of the Kolb, Likert and Semantic Differential Learning Styles*

<table>
<thead>
<tr>
<th>Learning styles</th>
<th>Kolb (n = 68)</th>
<th>Likert (n = 34)</th>
<th>Semantic Differential (n = 34)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kolb Correlation Coefficient</td>
<td>1.00</td>
<td>.402*</td>
<td>.360*</td>
</tr>
<tr>
<td>Likert Correlation Coefficient</td>
<td>.402*</td>
<td>1.00</td>
<td>–</td>
</tr>
<tr>
<td>Semantic Differential Correlation Coefficient</td>
<td>.360*</td>
<td>–</td>
<td>1.00</td>
</tr>
</tbody>
</table>

*Note.*

* Spearman’s rho Correlation is significant at the 0.05 level (2-tailed)

In Table 22, the Kolb Learning Modes were correlated with the Likert and Semantic Differential Learning Modes. All correlations, except for the learning mode of (AE – LAE), had statistical significance at the $p < 0.05$ level.

Overall, twelve positive moderate correlations were calculated for the learning modes and bi-polar dimensions to determine whether statistically significant differences existed in learning modes or bi-polar dimensions on either survey.
Table 22

*Spearman Rank-order Correlation Analysis of Kolb, Likert and Semantic Differential Learning Modes*

<table>
<thead>
<tr>
<th>Learning modes</th>
<th>Kolb learning modes</th>
<th>LCE (n = 34)</th>
<th>LRO (n = 34)</th>
<th>SCE (n = 34)</th>
<th>SRO (n = 34)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE</td>
<td>Correlation Coefficient</td>
<td>.512**</td>
<td>.550**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RO</td>
<td>Correlation Coefficient</td>
<td>.493**</td>
<td>.558**</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Learning Modes</th>
<th>Kolb Learning Modes</th>
<th>LAC (n = 34)</th>
<th>LAE (n = 34)</th>
<th>SAC (n = 34)</th>
<th>SAE (n = 34)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC</td>
<td>Correlation Coefficient</td>
<td>.404*</td>
<td>.434*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AE</td>
<td>Correlation Coefficient</td>
<td>.284</td>
<td>.491**</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note. CE = Concrete Experience; RO = Reflective Observation; LCE = Likert Concrete Experience; LRO = Likert Reflective Observation; SCE = Semantic Differential Concrete Experience; SRO = Semantic Differential Reflective Observation; AC = Abstract Conceptualization; AE = Active Experimentation; LAC = Likert Abstract Conceptualization; LAE = Likert Active Experimentation; SAC = Semantic Differential Abstract Conceptualization; SAE = Semantic Differential Active Experimentation*

*Correlation is significant at the 0.05 level (2-tailed)*

**Correlation is significant at the 0.01 level (2-tailed)
As shown in Table 23, the correlation coefficients for all bi-polar dimensions correlated significantly with one another at the $p < 0.01$ level.

Table 23

*Spearman Rank-order Correlation Analysis of Kolb, Likert and Semantic Differential Bi-polar Dimensions*

<table>
<thead>
<tr>
<th>Bi-polar dimensions</th>
<th>Kolb bi-polar dimensions</th>
<th>LAC-LCE (n = 34)</th>
<th>SAC-SCE (n = 34)</th>
<th>LAE-LRO (n = 34)</th>
<th>SAE-SRO (n = 34)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC-CE</td>
<td>Correlation Coefficient</td>
<td>.584**</td>
<td>.644**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AE-RO</td>
<td>Correlation Coefficient</td>
<td>.491**</td>
<td></td>
<td>.623**</td>
<td></td>
</tr>
</tbody>
</table>

*Note. AC-CE = Abstract Conceptualization – Concrete Experience; AE-RO = Active Experimentation – Reflective Observation; LAC-LCE = Likert Abstract Conceptualization – Likert Concrete Experience; SAC-SCE = Semantic Differential Abstract Conceptualization – Semantic Differential Concrete Experience; LAE-LRO = Likert Active Experimentation – Likert Reflective Observation; SAE-SRO = Semantic Differential Active Experimentation – Semantic Differential Concrete Experience*

* Spearman’s rho Correlation is significant at the 0.05 level (2-tailed)

** Spearman’s rho Correlation is significant at the 0.01 level (2-tailed)

In Chapter 4, a series of descriptive and non-parametric statistics described the analyses of data from 68 sets of learning styles inventories. Chapter 5 presents a discussion of these analyses within the theoretical framework of experiential learning and the educational research literature review.
Chapter 5: Discussion and Conclusion

Some students might not be able to verbalize how they learn best or what methods of learning might increase their interest in the subject matter. Teachers might want a quick way to determine their students’ learning styles to help increase student interest, facilitate differentiated instruction, or conduct whole classroom instruction to address the majority of students’ learning styles. The purpose of this study was to see whether a quick, normative method of identifying prevalent learning styles within a class might be possible as the Kolb LSI can be difficult to score.

David A. Kolb, as a practitioner of Experiential Learning Theory (ELT), designed an instrument to measure based on the ELT to identify learning styles. Kolb and Kolb (2005) defined experiential learning as a process whereby knowledge is created through the combination of grasping and transforming experience. Kolb viewed experiential learning as a holistic process involving the interaction of thinking, feeling, perceiving, and behaving characteristics.

This study made no attempt to have the participants engage in experiential learning activities or to investigate the validity or reliability of the Kolb LSI. An assumption was made that the Kolb LSI produced valid scores, even though previous researchers found both support and lack of support for the validity or reliability of the Kolb LSI (Geiger et al., 1993; Kayes, 2005; Loo, 1999; Romero et. al, 1992; Tucker, 2009; Yahya, 1998). The sole purpose of the research was to compare participants’ responses to the Kolb LSI and either a modified Likert or Semantic Differential survey.
The consistency of responses and correlations of the three surveys were compared to test whether a normative method of calculating learning styles would be valid.

**Research Hypotheses Outcomes**

The research question examined whether a consistency of responses and significant correlations exist between results obtained on the 12-item Kolb LSI and results obtained on the 48-item Likert or Semantic Differential survey. Two hypotheses were examined: Hypothesis 1: Kolb LSI scores are a function of the group, which for this study included elementary education, secondary education, and general education students. Hypothesis 2: Learning style scores obtained from the restructured 48-item Likert and Semantic Differential surveys were the same as those obtained on the Kolb LSI-2005 (v. 3.1) survey.

The first hypothesis found limited support using the Kruskall-Wallis test and comparing the hits and misses of the Kolb LSI learning styles to the learning styles obtained on the Likert and Semantic Differential surveys. The Likert survey results contained three learning styles with a 66.7% hit rate with the remaining learning styles well below 50%. The Semantic Differential learning style of Assimilating had a 75% hit rate, but the remaining learning styles had a hit rate of less than 50%. A hit rate of 47% is not very high. A larger sample might yield better results and a chi-square test of significance with a larger sample would have provided a clearer picture of results.

The results of the Kruskall-Wallis test, found no significant differences in the learning styles scores by course across the three survey instruments. Upon further examination of the results, due to the small sample size of 68 participants, it was
impossible to run a chi-square test due to the requirement of having at a minimum, an expected count of 5 participants per cell. The minimum sample size needed to run a chi-square test assuming a perfect alignment of scores in each cell, would have been a sample size of 80 participants, due to working with a 4 x 4 matrix involving 16 cells. Another difficulty with finding support for the first hypothesis was the reliance on a convenience sample solely made up of education students. A more diverse and larger sample would have provided a more realistic sample to the population at large, and if the sample size was increased the chi-square statistical test could be used to determine the significance of the findings.

The second hypothesis found limited support from the results obtained from the Mann-Whitney U test, median tests, and Spearman rank order correlations. The Mann-Whitney U test found no evidence of sequence bias based on the survey administration sequence order. The Median tests found significant findings on the Semantic Differential concrete experience [SCE] learning mode. One would be unsure to what degree one significant learning mode would affect combining the two study samples in a calculation of the bi-polar dimension score.

Spearman rank-order correlation tests found limited support for the second hypothesis. While the learning styles and bi-polar dimension correlations were significant, the learning style correlations only explained 13% to 16% of the variance and the bi-polar dimensions explained 24% to 41% of the variance. The learning mode correlations found limited support for the second hypothesis. All learning modes correlations were found to be significant except for the Active Experimentation (AE)
learning mode of the Kolb and Likert survey set. The three remaining learning mode
correlations were significant but the correlation results only explained 16% to 31% of the
variance. All of the aforementioned explained variances are weak (see Huck et al., 1974).

Significance of the Findings

Results obtained from the three instruments (i.e., 12-item Kolb LSI and 48-item
Likert or 48-item Semantic Differential) were compared for learning styles, learning
modes, and bi-polar dimensions. The learning style correlations from the three
instruments were significant at the $p < .05$ level, except the Kolb and Likert active
experimentation (AE) learning mode. The four bi-polar dimensions were significant at
the $p < .01$ level. Spearman rank order correlations significance determined the three
instruments to be of statistically significant construct validity. However, due to the low
levels of explained variance, the practicality of these findings can be called into question.
Construct validity was the only form of validity that could be measured because the
measurement scales of the three instruments contained a different number of data points
(i.e., 4-point and 7-point) in the measurement scales. Reliability of the measurement
scales was not a focus of this study.

A secondary analysis examined whether differences existed in learning styles
across courses and instrument and whether the sequence order of the administration of
the surveys played a role in influencing the scores obtained from the three surveys. No
significant differences in learning styles were obtained across courses and instruments.
Learning styles did not differ significantly across courses or instruments. The order of the
administration of the two survey sets was found not to be significant. Therefore, survey sequence order did not affect the learning style results.

No significant difference in learning styles scores was obtained from the sequence order of the two survey sets, so the learning style results could be pooled. The Median Tests found no statistical significance for the two bi-polar dimensions in either survey set. One could argue for combining the two sample sets, but one would be unsure to what degree the two significant results would affect the calculation of the bi-polar dimension score, given one significant difference was found for the Likert abstract conceptualization (LAC) learning mode. Consequently, these results were not pooled.

Relationship of the Research Literature to Study Results

Aside from the Geiger et al. (1993) article, this research is likely to be one of the first studies to investigate the feasibility of using alternative scale formats (i.e., Likert and Semantic Differential) to measure learning styles obtained from the Kolb LSI (see Geiger et al., 1993; Kayes, 2005; Romero et al., 1992; Tucker, 2009; Yahya, 1998). Two separate randomly assigned participant groups were formed. One group completed the Kolb and Likert survey, and the other group completed the same Kolb survey along with a Semantic Differential survey. A within-group analysis was carried out for the Kolb-Likert group and a separate within-group analysis was carried out with the Kolb-Semantic Differential group.

The factor structure of the Kolb LSI instrument was investigated in six studies (Gaur, 2009; Kayes, 2005; Loo, 1999; Loo, 2004; Romero et al., 1992; Yahya, 1998), but this analysis was not an area of focus for this study. Validity, reliability, and factor
analysis findings of the Kolb LSI results could not be compared for similarities with previous literature due to the small sample size, ordinal data, and selection of non-parametric statistical techniques for analysis of the data. Variables used in factor analysis should be quantitative at the interval or ratio level (see Norusis, 1988).

One emphasis noted in the literature review was a focus on efficacy of additional learning style instruments beyond the Kolb LSI. This study examined the possibility of using Likert and Semantic Differential scales as alternative formats based on the Kolb LSI for measuring learning styles. A 7-point Likert scale was used to make comparisons easier between the Likert and Semantic Differential scales. Stevens (1946) developed a hierarchy of levels of measurement and the ipsative results from the Kolb LSI. He treated normative data from a Likert survey as ordinal.

**Practical Importance of the Study**

As it is currently designed, the Kolb LSI is a forced-choice instrument containing 12 sentence stems and four corresponding response statements. When completing the Kolb LSI, a participant is not given the opportunity to make two or more selections ranked as “Most Like Me or Least Like Me.” However, by restructuring the Kolb LSI and creating a 48-item survey using a different measurement scale, the participant would be able to make two similar selections and would no longer have to rank the selection choices. This research builds upon the study undertaken by Geiger et al. (1993), which modified the Kolb inventory into a 48-item survey using a Likert scale. Similarly, in this thesis, the Kolb LSI was restructured into a 48-item Likert survey and a 48-item
Semantic Differential survey was introduced to examine whether different measurement scales that do not produce ipsative scores could be used to measure learning styles.

**Strengths and Limitations of the Study**

The three primary strengths of this investigation include the following:

1. Developing new instruments to deal with the problem of ipsative scores,

2. Extending prior research (Geiger et al., 1993) by including comparisons of the Kolb and Likert scaling to the Semantic Differential scale, and

3. Analyzing the data using non-parametric statistics and correctly treating the data as ordinal, consistent with Stevens (1946).

This study sought to develop survey instruments using measurement scales that did not produce ipsative scores because ipsative scores are individual in nature and results cannot be pooled correctly to describe the characteristics of an entire survey group. The Likert and Semantic Differential measurement scales do not produce ipsative scores, and results from these surveys have the potential to describe the characteristics of an entire group and to extrapolate results.

While many studies have treated the Kolb LSI, Likert, and Semantic Differential scores as interval data, this study took a conservative approach and used non-parametric statistics to analyze the ordinal data collected in this study. All of the Kolb LSI research articles described in the literature review used parametric statistical tests to analyze the data. If parametric statistics had been used in this study, any concern with Type II error
could have been addressed by lowering the level of significance from .05 to .10, even though it increases the likelihood of a Type I error (see Huck et al., 1974).

Four primary limitations of this investigation into learning style instruments and scaling include the following:

(1) Different scale ranges,

(2) Sample size too small,

(3) Sample of convenience limited to education students, and

(4) Statistical techniques limited to the use of non-parametric statistical tests.

Two different scale ranges (i.e., 4-point and a 7-point) were used in the design of the surveys. The Kolb LSI used a 4-point and the Likert and Semantic Differential used a 7-point scale. To make effective comparisons of the data, the three instruments needed the same scale range. Linear transformation of the Likert and Semantic Differential scores is a weak approach to comparing the learning style scores obtained from the three instruments. In general, results from the Likert and Semantic Differential scale could be compared, but the participants did not have an opportunity to complete both of these two instruments.

The sample size (n = 68) had an impact on the thoroughness of the data analysis. Due to the small sample size, the Friedman, Wilcoxon Signed Rank and the McNemar statistical tests could not be undertaken, and crosstab results were meaningless due to the cells having fewer than five participants. A larger sample size would allow the researcher
to investigate the Likert and Semantic Differential versions of the Kolb LSI using factor analysis, although variables used in factor analysis should be quantitative at the interval or ratio level.

The sample was limited to post-secondary education students who had some familiarity with learning styles. If a more diverse sample (e.g., unfamiliar with learning styles and unskilled in academic achievement) had completed the Kolb LSI and the Likert or Semantic Differential surveys, the possibility for conflicting results and generalizability might exist.

**Future Research**

One area of future research would be to treat the data as interval and re-evaluate the results using parametric rather than non-parametric statistical techniques. Using parametric statistical techniques would be consistent with the approaches used by researchers who have investigated the Kolb LSI (Gaur, 2009; Geiger et al., 1993; Harris et al., 2003; Kayes, 2005; Lawson & Johnson, 2002; Loo, 1999; Loo, 2004; Romero et al., 1992; Tucker, 2009; Yahya, 1998). Although the researchers who authored the Semantic Differential scale (Osgood et al., 1957) have recommended treating the data as ordinal, they have also found it acceptable to analyze Semantic Differential data as interval data. Geiger et al. (1993) analyzed the modified Likert survey of the Kolb LSI using parametric statistical tests.

Modifying the Kolb LSI using different measurement scales is an avenue of research that has not been fully explored. The majority of papers analyzed in the literature review examined the factor structure of the Kolb LSI. Since the Likert and the
Semantic Differential surveys are new learning styles instruments, the factor structure has not been analyzed. A possible future research question is “How do factor loading of the modified surveys compare to factor loadings of the Kolb LSI found in previous research studies?”

Another area of focus would be to compare the item-by-item responses of the participants to each individual question of the three surveys. A suggestion by Geiger et al. (1993) was that after participants are presented with the 48-item Likert or Semantic Differential survey, participants could rank order the four corresponding response statement to one question. A final area of future research would be to replicate the research design using middle and high school students to test whether the Kolb LSI or Likert and Semantic Differential survey results could assist teachers to tailor their teaching and the attendant learning activities to the learning styles of the students.

Summary

The focus of this thesis was to examine the feasibility of using different measurement scales with the Kolb LSI that would not produce ipsative scores. A review of the Kolb LSI research literature found only one article that addressed the issue of ipsative scores by designing a 48-item normative version using a Likert measurement scale (Geiger et al., 1993). This research article did not find significant differences in obtained results between the two survey instruments. The current study broadened this area of research and included an examination of the Likert and Semantic Differential measurement scales. The Spearman rank-order statistical test determined statistically significant construct validity was present between the three scales on the dimensions of
learning styles, learning modes, and bi-polar dimensions, but the explained variances were very low. All learning styles, bi-polar dimensions and learning modes were found to be significant, except for the Kolb and Likert active experimentation (AE) learning mode. Despite the significant correlation findings, once again the variances were low.

When the Kolb, Likert and Semantic Differential bi-polar dimensions were graphed to obtain and identify the learning style of each participant, this researcher discovered evidence for the learning style categorized as “balanced” on the Likert and Semantic Differential scales. Kolb (2007) mentions the “balanced” learning style, but obtained this learning style infrequently. The “balanced” learning style falls very close to or on the Kolb axes, rather than in a quadrant, which makes a learning style difficult to determine and occurred on eight surveys from the Likert and Semantic Differential graphs.

The results in this thesis found limited support for the findings of the Geiger et al. (1993) study. Specifically, Geiger et al. (1993) found support to use the normative version of the Kolb survey with high Cronbach’s alpha correlations ranging from .77 to .86 for the four learning modes. A further analysis of the survey instruments found that the normative version’s bi-polar dimensions were opposite to Kolb’s theorized bi-polar dimensions. Despite the factor loadings of the 2-factor model loading on different bi-polar dimensions, high Cronbach’s alpha correlations were significant and justified further study into the use of the normative 48-item version of the Kolb LSI.

Since this study could not run a factor analysis, or use the Cronbach’s alpha correlation statistical technique, recommending the use of Likert or Semantic Differential
measurement scale in lieu of the Kolb measurement scale is not possible. The current sample size of 68 compared to the Geiger et al. (1993) sample size of 455 participants was a limiting factor. The inability to use the chi-square statistic and run a test of significance and obtaining low explained variance results from the Spearman rank-order correlations, also limited the study’s findings. Despite these limitations, further exploration of the possibilities of using the Likert and Semantic Differential measurement scales with the Kolb LSI should be conducted with a larger and more diverse sample. No evidence was found to support that learning style scores are a function of the group, which in this case involved education students in different classes and levels of instruction, but a larger and more diverse sample is needed to test this claim definitively. Future research could provide evidence to support using different measurement scales that do not produce ipsative scores to measure learning styles.
References


study on high school students. *Educational Psychology*, 28, 73-81.

doi:10.1080/01443410701417945
Appendix A: IRB Approval Letter

June 2, 2010

Ms. Grace E. Jamieson
2507-2 Forest Laneway
Toronto, Ontario
Canada M2N 5X7

Dear Ms. Jamieson:

A review of your file for the August, 2010 graduation has been completed. Current, unfulfilled requirements include:

**Satisfactory Completion of Your Thesis**

All degree requirements, (with the exception of grades for your current courses and papers written in conjunction with these courses), must be completed prior to the graduation deadline of July 9, 2010. The certification that papers (written in conjunction with prior, incomplete courses), or research projects have been accepted, along with the Graduate Plan of Study, test scores, all transcripts and transfer credit forms, and final copies of Masters Theses must be submitted to the Graduate Office by the above date. If you do not meet these deadlines, your name will be removed from the graduation list. In addition, all outstanding, incomplete grades must also be removed from your record by the time final grades are due. Please verify that your name (as listed above) reflects how your name should be printed on your diploma, and that the address used on this letter is where your diploma should be mailed.

Your official transcript verifying your conferred degree will be mailed after final grades are posted, and your diploma will follow under separate cover. Your degree will be listed on your transcript as a Master of Arts in Education degree in the Secondary Education program. In order to receive a diploma, all fees owed to Northern must be paid, satisfactory grades must be received in all courses in which you are currently enrolled or in courses that are still incomplete, and your overall graduate grade point average must be at least a 3.0.

Please email Nancy Ohman in the Office of Graduate Studies if your records disagree with any of the above information. Her email address is: nohman@nmu.edu.

Sincerely,

Dr. Terrance E. Seethoff, Associate Provost and Dean of Graduate Studies, Continuing Education, and Research
cc: Dr. Mitch Klett, Advisor
    Education Department
Appendix B: Informed Consent Participant Form

February 17, 2010

Kolb Learning Style Inventory (Kolb LSI) – Participant Copy

I invite you to participate in a voluntary research study because you are an undergraduate education student and have recently studied the topic of learning styles. The purpose of this study is to examine whether differences exist in participant responses to the Kolb LSI using different measurement scales. Participation will provide one with knowledge of one way learning styles are assessed and will provide a concrete example of a learning instrument. Approximately 60 students will take part in this study.

If you agree to participate, I would like you to complete two attached survey items, which should take between 15 – 30 minutes. Completion of the surveys is voluntary and serves as permission to use your responses for completion of a Master’s Thesis and possible future research. You may stop the survey at anytime. You are free to respond or not respond to any item. If you decide not to participate, please return the blank surveys to the box provided.

All information from the study will remain confidential and in a secure location. Surveys will be issued ID code numbers and no contact information will be collected. Survey responses will not be disclosed outside of the investigators. Results of this study may be published for scientific purposes; however, your identity will not be revealed. Federal regulatory agencies and the Northern Michigan University Institutional Review Board (a committee that reviews and approves research studies) may inspect and copy records pertaining to this research.

There are minimal risks from being in this study. You will not benefit personally. However, we hope others may benefit in the future from what we learn from this study. You will not have any costs for being in this research study. You won’t be paid for being in this research study. Taking part in this research study is voluntary. If you decide not to be part of this study, or if you stop participating at any time, you will not be penalized or lose any benefits for which you otherwise qualify.

If you have any questions regarding the nature of this research project, contact the principal investigator, Ms. Grace Jamieson at gjamieso@nmu.edu or faculty advisor, Dr. Judy Puncochar at jpuncoch@nmu.edu or 906-227-1366. If you have any questions regarding your rights as a participant in a research project, you may contact Dr. Cynthia Prosen of the Human Subjects Research Review Committee of Northern Michigan University at cprosen@nmu.edu or 906-227-2300.

I have read the above “Informed Consent Statement.” The nature, risks, demands, and benefits of the project have been explained to me. I understand that I may ask questions and that I am free to withdraw from the project at any time without incurring ill will or negative consequences. I also understand this informed consent document will be kept separate from data collected in this project to maintain anonymity (confidentiality). I understand a copy of the consent form is for my records. I understand access to the signed consent form is restricted to principal researchers.

________________________________________
Participant’s Signature

________________________
Date

Thank you very much for your consideration.

Grace Jamieson, B.A. (Hons.); M.A.; B. Ed.; M.L.I.S., Principal Investigator
Master’s Student in Education, Northern Michigan University

HS10-340
Appendix C: Letter from HayGroup Granting Permission

Congratulations! LSI Research Approval

From: Jessica Menendez (jessica.menendez@haygroup.com)
Sent: February 17, 2010 1:42:38 PM
To: Grace Jamieson (gejamieson@hotmail.com)
Attachments: Scan001.PDF (923 KB)

Hi Grace,

Congratulations! Your research request regarding use of the Learning Style Inventory (LSI) has been approved. Attached you will find one document containing three pages (PDF file—Adobe Acrobat 4.05):

* MCB200C - This is a copy of the LSI test. You may print or copy this document as needed for your research.

* MCB200D - The profile sheet contains the answer key for the test as well as the profiling graphs for plotting scores. This document may also be reproduced as necessary for your research. The AC-CE score on the Learning Style Type Grid is obtained by subtracting the CE score from the AC score. Similarly, the AE-BE score = AE minus BE.

These files are for data collection only. This permission does not extend to including a copy of these files in your research paper. It should be sufficient to source it.

The committee has requested that I ask you to please send a copy of your results/findings as they have an interest in these. We wish you luck with your project and look forward to hearing about your results. Please email a copy of your completed research paper to Jessica_Menendez@haygroup.com or mail it to the following address:

LSI Research Contracts
c/o Jessica Menendez
HayGroup
116 Huntington Avenue, 4th floor
Boston, MA 02116

If you have any further questions, please let me know.

Regards,

Jessica L. Menendez
Hay Group Transforming Learning
116 Huntington Avenue
Boston, MA 02116
(617) 927-5026 (OD)
(617) 927-5008 (F)
www.haygroup.com/TL

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This email has been scanned by the MessageLabs Email Security System. For more information please visit http://www.mesagelabs.com/email
Appendix D: Likert Survey - Example

ID Number: ________

Learning Style Inventory Survey

Instructions

When answering this questionnaire, please make your judgments regarding response statements using the set of scales.

Important:

(1) Carefully, read each statement. Please rate how strongly you agree or disagree or are undecided with each of the following statements. Circle the appropriate letter(s).

(2) Do not circle more than one response.

Questionnaire starts on the following page.
Sample Likert Questionnaire

<table>
<thead>
<tr>
<th></th>
<th>Very Strongly Disagree</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Undecided</th>
<th>Agree</th>
<th>Strongly Agree</th>
<th>Very Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>When I prepare for a test, I like to work in a group.</td>
<td>VSD</td>
<td>SD</td>
<td>D</td>
<td>U</td>
<td>A</td>
<td>SA</td>
</tr>
<tr>
<td>2.</td>
<td>I learn best by taking copious notes during lectures.</td>
<td>VSD</td>
<td>SD</td>
<td>D</td>
<td>U</td>
<td>A</td>
<td>SA</td>
</tr>
</tbody>
</table>

Demographic Data

Age: __________

Gender: ________

College Level (Circle one):

- Freshman
- Sophomore
- Junior
- Senior
- Graduate
Appendix E: Example of Semantic Differential Survey with Instructions

ID Number: ________

Instructions

When answering this questionnaire, please make your judgments regarding response statements using the set of scales.

Important:

(1) Place your check marks in the middle of the spaces
(2) Make sure to check every scale for every concept – do not omit any
(3) Never put more than one check mark on a single scale

If you feel that the concept is very closely related to one end of the scale you should place your check-mark as follows:

Like me ___:____:____:____:____:____:____ Not like me

or

Like me ___:____:____:____:____:____:__ Not like me

If you feel that the concept is closely related to one end of the scale you should place your check-mark as follows:

Like me ____:___:____:____:____:____:____ Not like me

or

Like me ____:____:____:____:____:____:__ Not like me

If you feel that the concept is very slightly related to one end of the scale you should place your check-mark as follows:

Like me ____:____:____:____:____:____:__ Not like me

or

Like me ____:____:____:____:____:____:__ Not like me

If you feel that the concept to be neutral or both sides of the scale are totally irrelevant, you should place your check-mark as follows:

Like me ____:____:____:____:____:____:____ Not like me
Sample Semantic Differential Survey

1. When I prepare for a test, I like to work in a group.
   Like me _____:_____:_____:_____:_____:_____:_____ Not like me

2. I learn best by taking copious notes during lectures.
   Like me _____:_____:_____:_____:_____:_____:_____ Not like me

Demographic Data

Age: ____________
Gender: _________
College Level (Circle one):
   Freshman
   Sophomore
   Junior
   Senior
   Graduate
Appendix F: Learning Styles Handout

The term learning styles is difficult to find an all encompassing definition as researchers provide many different definitions. One such definition of learning styles, known as VAK (visual, auditory and kinesthetic), includes individual differences that affect classroom learning and can include preferences for learning via visual materials versus text or auditory materials and kinesthetic activities. From a strictly theoretical perspective with practical applications, is the prominent theory of learning styles known as Bloom’s Taxonomy. This theory focuses on the cognitive domain and consists of six educational objectives including: knowledge, comprehension, application, analysis, synthesis and evaluation, with knowledge being the lowest level and evaluation the highest level of thinking (Woolfolk, 2007).

Howard Gardner’s theory of Multiple Intelligences (1983) expands the concept of learning styles beyond the cognitive domain and contains learning styles which are not usually tested in IQ tests or classroom assessments. The eight types of intelligences include: linguistic, logical-mathematical, musical, bodily-kinesthetic, spatial, interpersonal, intrapersonal and naturalist intelligence (Gardner & Moran, 2006).

Over the years a variety of instruments have been developed to evaluate a person’s learning style and have had some success. One of the better known instruments include the Honey-Mumford Learning Styles Questionnaire (1982, 1992) which measured learning preferences relative to the learning cycle and this questionnaire had some similarity to the Kolb LSI (Kolb & Kolb, 2005).

The Myers-Briggs Type Indicator (MBTI) is one of the oldest instruments measuring learning styles using Carl Jung’s theory of psychological types as the theoretical foundation. The instrument identifies individuals’ preferences on eight characteristics including: extraversion, introversion, sensing, intuition, thinking, feeling, judging and perceiving. (Briggs et al., 2001). The Canfield Learning Style Inventory is a self-reporting questionnaire and has been used to assess student instructional preferences (Canfield, 1976). The Anthony Gregorc Style Delineator is a self-report non-cognitive inventory used to recognize and identify dominant styles of processing information. The instrument contains two dimensions (i.e., perception and sequence) and results are plotted on an x/y axis similar to results obtained from the Kolb LSI (Gregorc, 1982).

Another means of measuring learning styles is the Kolb Learning Styles Inventory, the focus of this study. This learning style inventory identifies four types of learners and four learning modes (Harris et al., 2003). Ideally, educators need to strive to develop resources incorporating materials at the higher cognitive domain levels.
A number of research papers and peer reviewed articles have examined the topic of learning styles and have come to varying conclusions. One such study examined and evaluated learner attitudes that could be used to predict success in terms of GPA with a focus on whether cognitive style would predict student success in terms of GPA and whether online technology self-efficacy would predict student success in terms of GPA in web-based distance education courses. Results of this study were mixed. It was found that students had higher confidence levels with online technologies, but no significant increase in their GPA and that cognitive style was sometimes a predictor of student success in terms of higher GPA results (DeTure, 2004).

Another study examined whether experiential learning activities were effective in promoting learning in a third year undergraduate economics class. Students were given a mix of experiential and traditional learning activities from which their learning experiences could be further evaluated. Information was gathered via a survey containing 20 learning activities and students were to respond by reflecting upon their entire university learning experience and describing their preferences for specific types of learning experiences. Overall, 60 percent of students found experiential learning to be important and 13 percent found it to be unimportant. Traditional learning activities scored poorly. There were differences between males and females with 64% of men preferring experiential learning activities to 54% of women. Due to the differences in these results, further research needs to be undertaken (Hawtrey, 2007).

The form of instruction should be taken into consideration when evaluating what works best with different learning styles. One study examined the educational experiences of self-selected university students (i.e., volunteers) who were enrolled in either an online course or in a traditional class with face-to-face instruction. Results were somewhat discouraging for advocates of online learning, as it was found that students participating in the online courses did just as well as students participating in the courses with face-to-face instruction. Finally, the study found that online students’ preferred learning styles tended to change from the beginning to the end of the semester (Liu, 2007).

Another study investigated the effects of formative assessment and learning styles on student achievement in a web-based learning environment. Students were randomly assigned to one of three formative assessment strategies. The first assessment strategy consisted of the Formative Assessment Module of the Web-Based Assessment and Test Analysis system (FAM-WATA), which consisted of six web-based formative assessment strategies. The second strategy was the Normal Module of Web-Based Assessment and Test Analysis system (N-WATA) and consisted of partial web-based assessments. The third strategy was the Paper and Pencil Test (PPT) approach without any form of web-based assessment (Wang, Wang, Wang, & Huang, 2006).
Research studies have also examined the role played by learning styles in an e-learning environment. In one such study, researchers wanted to discover whether an e-learning environment benefited students with different learning styles as well as what kind of learning style was best suited for each type of e-learning environment. Students were randomly assigned to one of three groups after they took the Kolb Learning Style Inventory to identify their learning style (e.g., Accommodator; Diverger; Assimilator and Converger). ANCOVA statistical analysis found that learning styles and the form of formative assessment strategy were significant factors affecting student achievement in a web-based learning environment. Student achievement on the FAM-WATA group was significantly higher than the N-WATA and the PPT groups (Wang et al., 2006).

KOLB LEARNING STYLES INVENTORY

The Kolb Learning Styles Inventory (LSI) identifies four different types of learners (i.e., Accommodators, Divergers, Assimilators and Convergers) and each learner has a preferred learning mode (i.e., Concrete experience; Reflective observation; Abstract conceptualization and Active experimentation) (Harris et al., 2003). While this learning style inventory describes four different types of learners, unlike Bloom’s Taxonomy, this learning style inventory contains two learning modes for each type of learner (e.g., Divergers are those who prefer being reflective and are also observers, hence, Reflective observation). Over the years, the Kolb Learning Styles Inventory (LSI) had been used when assessing the effectiveness of academic achievement in online and web-based courses. Results have been mixed in terms of measuring the effectiveness of the Kolb Learning Styles Inventory (LSI) to predict success in either online or traditional classroom assessments.

One such study was undertaken to see whether a text only online module vs. an enhanced text online module with multimedia and interactivity elements, made any difference on test scores and reactions based on the Kolb’s learning style inventory (LSIaa). A volunteer sample of 159 participants was randomly assigned with 81 students completing the text only online module and 78 students completing the enhanced text online module. This study provided a variety of results. Specifically, there was no difference in terms of gender, no significant effect in terms of module taken, mean test scores were not significantly different between the two groups and the correlation between the online test score and the likeability score was found to be significant. No significant effect was found on the in-class score due to learning style, all groups performed equally well in the lecture format and there was no significant difference in terms of long term learning between the two groups (Harris et al., 2003).

Another study examined the relationship between Kolb’s four learning styles (i.e., Accommodators, Divergers, Assimilators and Convergers) and four learning modes (i.e.,
Concrete experience, Reflective observation, Abstract conceptualization and Active experimentation), as well as their learning preferences (i.e., feeling, watching, thinking and doing), using undergraduate business students as the subjects. Students were assigned to one of four groups depending on the results of the LSI. Weak linkages between learning styles and learning preferences were found, with only two learning preferences being significant including participating in groups and doing practical exercises. Additional research needs to be undertaken to support the claim that there is a relationship between Kolb’s learning styles inventory and educational success (Loo, 2004).

References


