The Kolb Learning Style Inventory—Version 3.1
2005 Technical Specifications

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May 15, 2005

Abstract

The Kolb Learning Style Inventory Version 3.1 (KLSI 3.1), revised in 2005, is the latest revision of the original Learning Style Inventory developed by David A. Kolb. Like its predecessors, KLSI 3.1 is based on experiential learning theory (Kolb 1984) and is designed to help individuals identify the way they learn from experience. This revision includes new norms that are based on a larger, more diverse, and more representative sample of 6977 LSI users. The format, items, scoring and interpretative booklet remain identical with KLSI 3. The technical specifications are designed to adhere to the standards for educational and psychological testing developed by the American Educational Research Association, the American Psychological Association, and the National Council on Measurement in Education (1999). Section 1 of the technical specifications describes the conceptual foundations of the LSI 3.1 in the theory of experiential learning (ELT). Section 2 provides a description of the inventory that includes its purpose, history, and format. Section 3 describes the characteristics of the KLSI 3.1 normative sample. Section 4 includes internal reliability and test-retest reliability studies of the inventory. Section 5 provides information about research on the internal and external validity for the instrument. Internal validity studies of the structure of the KLSI 3.1 using correlation and factor analysis are reported. External validity includes research on demographics, educational specialization, concurrent validity with other experiential learning assessment instruments, aptitude test performance, academic performance, experiential learning in teams, and educational applications.

1. CONCEPTUAL FOUNDATION—EXPERIENTIAL LEARNING THEORY AND INDIVIDUAL LEARNING STYLES

The Kolb Learning Style Inventory differs from other tests of learning style and personality used in education by being based on a comprehensive theory of learning and development. Experiential learning theory (ELT) draws on the work of prominent twentieth century scholars who gave experience a central role in their theories of human learning and development-notably John Dewey, Kurt Lewin, Jean Piaget, William James, Carl Jung, Paulo Freire, Carl Rogers, and others-to develop a holistic model of the experiential learning process and a multi-linear model of adult development. The theory, described in detail in *Experiential Learning: Experience as the Source of Learning and Development* (Kolb 1984), is built on six propositions that are shared by these scholars.

1. Learning is best conceived as a process, not in terms of outcomes. To improve learning in higher education, the primary focus should be on engaging students in a process that best enhances their learning —a process that includes feedback on the effectiveness of their learning efforts. "...education must be conceived as a continuing reconstruction of experience: ... the process and goal of education are one and the same thing." (Dewey 1897: 79)
2. All learning is relearning. Learning is best facilitated by a process that draws out the students' beliefs and ideas about a topic so that they can be examined, tested, and integrated with new, more refined ideas.
3. Learning requires the resolution of conflicts between dialectically opposed modes of adaptation to the world. Conflict, differences, and disagreement are what drive the learning process. In the process of learning, one is called upon to move back and forth between opposing modes of reflection and action and feeling and thinking.
4. Learning is a holistic process of adaptation to the world. It is not just the result of cognition but involves the integrated functioning of the total person—thinking, feeling, perceiving, and behaving.
5. Learning results from synergetic transactions between the person and the environment. In Piaget's terms, learning occurs through equilibration of the dialectic processes of assimilating new experiences into existing concepts and accommodating existing concepts to new experience.
6. Learning is the process of creating knowledge. ELT proposes a constructivist theory of learning whereby social knowledge is created and recreated in the personal knowledge of the learner. This stands in contrast to the "transmission" model on which much current educational practice is based, where pre-existing fixed ideas are transmitted to the learner.

ELT defines learning as "the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience" (Kolb 1984: 41). The ELT model portrays two dialectically related modes of grasping experience-Concrete Experience (CE) and Abstract Conceptualization (AC)-and two dialectically related modes of transforming experience-Reflective Observation (RO) and Active Experimentation (AE). Experiential learning is a process of constructing knowledge that involves a creative tension among the four learning modes that is responsive to contextual demands. This process is portrayed as an idealized learning cycle or spiral where the learner "touches all the bases"—experiencing, reflecting, thinking, and acting-in a recursive process that is responsive to the learning situation and what is being learned. Immediate or concrete experiences are the basis for observations and reflections. These reflections are assimilated and distilled into abstract concepts from which new implications for action can be drawn. These implications can be actively tested and serve as guides in creating new experiences (Figure 1). ELT proposes that this idealized learning cycle will vary by individuals' learning style and learning context.

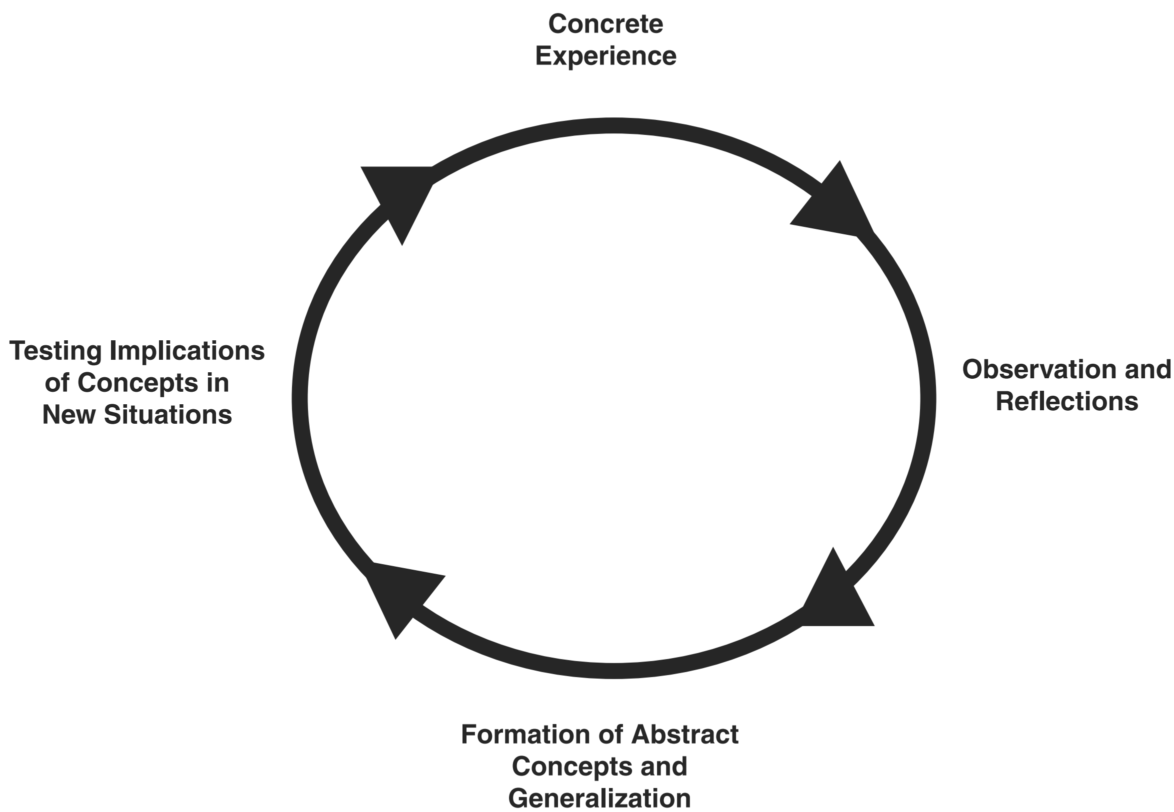


Figure 1. The experiential learning cycle

In *The art of changing the brain: Enriching teaching by exploring the biology of learning,* James Zull, a biologist and founding director of CWRU's University Center for Innovation in Teaching and Education (UCITE), sees a link between ELT and neuroscience research, suggesting that this process of experiential learning is related to the process of brain functioning as shown in Figure 2. "Put into words, the figure illustrates that concrete experiences come through the sensory cortex, reflective observation involves the integrative cortex at the back, creating new abstract concepts occurs in the frontal integrative cortex, and active testing involves the motor brain. In other words, the learning cycle arises from the structure of the brain." (Zull 2002: 18-19)

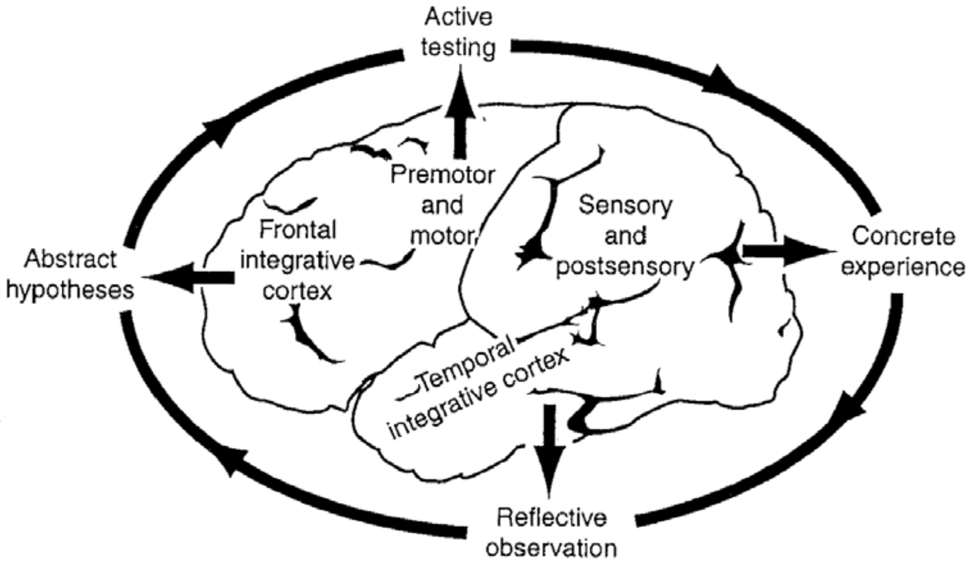


Figure 2. The experiential learning cycle and regions of the cerebral cortex.
Reprinted with permission of the author (Zull 2002)

ELT posits that learning is the major determinant of human development and that how individuals learn shapes the course of their personal development. Previous research (Kolb 1984) has shown that learning styles are influenced by personality type, educational specialization, career choice, and current job role and tasks. Yamazaki (2002, 2004a) has recently identified cultural influences as well. The ELT developmental model (Kolb 1984) defines three stages: (1) acquisition, from birth to adolescence, where basic abilities and cognitive structures develop; (2) specialization, from formal schooling through the early work and personal experiences of adulthood, where social, educational, and organizational socialization forces shape the development of a particular, specialized learning style; and (3) integration in midcareer and later life, where nondominant modes of learning are expressed in work and personal life. Development through these stages is characterized by increasing complexity and relativism in adapting to the world and by increased integration of the dialectic conflicts between AC and CE and AE and RO. Development is conceived as multi-linear based on an individual's particular learning style and life path—development of CE increases affective complexity, of RO increases perceptual complexity, of AC increases symbolic complexity, and of AE increases behavioral complexity.

The concept of learning style describes individual differences in learning based on the learner's preference for employing different phases of the learning cycle. Because of our hereditary equipment, our particular life experiences, and the demands of our present environment, we develop a preferred way of choosing among the four learning modes. We resolve the conflict between being concrete or abstract and between being active or reflective in patterned, characteristic ways.

Much of the research on ELT has focused on the concept of learning style, using the Learning Style Inventory (LSI) to assess individual learning styles (Kolb 1971, 1985, 1999). While individuals tested on the LSI show many different patterns of scores, previous research with the instrument has identified four learning styles that are associated with different approaches to learning—Diverging, Assimilating, Converging, and Accommodating. The following summary of the four basic learning styles is based on both research and clinical observation of these patterns of LSI scores (Kolb1984, 1999a).

An individual with diverging style has CE and RO as dominant learning abilities. People with this learning style are best at viewing concrete situations from many different points of view. It is labeled Diverging because a person with it performs better in situations that call for generation of ideas, such as a brainstorming session. People with a Diverging learning style have broad cultural interests and like to gather information. They are interested in people, tend to be imaginative and emotional, have broad cultural interests, and tend to specialize in the arts. In formal learning situations, people with the Diverging style prefer to work in groups, listening with an open mind to different points of view and receiving personalized feedback.

An individual with an assimilating style has AC and RO as dominant learning abilities. People with this learning style are best at understanding a wide range of information and putting it into concise, logical form. Individuals with an Assimilating style are less focused on people and more interested in ideas and abstract concepts. Generally, people with this style find it more important that a theory have logical soundness than practical value. The Assimilating learning style is important for effectiveness in information and science careers. In formal learning situations, people with this style prefer readings, lectures, exploring analytical models, and having time to think things through.

An individual with a converging style has AC and AE as dominant learning abilities.   People with this learning style are best at finding practical uses for ideas and theories. They have the ability to solve problems and make decisions based on finding solutions to questions or problems. Individuals with a Converging learning style prefer to deal with technical tasks and problems rather than with social issues and interpersonal issues. These learning skills are important for effectiveness in specialist and technology careers. In formal learning situations, people with this style prefer to experiment with new ideas, simulations, laboratory assignments, and practical applications.

An individual with an accommodating style has CE and AE as dominant learning abilities. People with this learning style have the ability to learn from primarily "hands-on" experience. They enjoy carrying out plans and involving themselves in new and challenging experiences. Their tendency may be to act on "gut" feelings rather than on logical analysis. In solving problems, individuals with an Accommodating learning style rely more heavily on people for information than on their own technical analysis. This learning style is important for effectiveness in action-oriented careers such as marketing or sales. In formal learning situations, people with the Accommodating learning style prefer to work with others to get assignments done, to set goals, to do field work, and to test out different approaches to completing a project.

FACTORS THAT SHAPE AND INFLUENCE LEARNING STYLES

The above patterns of behavior associated with the four basic learning styles are shaped by transactions between people and their environment at five different levels—personality, educational specialization, professional career, current job role, and adaptive competencies. While some have interpreted learning style as a personality variable (Garner 2000; Furnam, Jackson, and Miller 1999), ELT defines learning style as a social psychological concept that is only partially determined by personality. Personality exerts a small but pervasive influence in nearly all situations; but at the other levels, learning style is influenced by increasingly specific environmental demands of educational specialization, career, job, and tasks skills. Table 1 summarizes previous research that has identified how learning styles are determined at these various levels.

Table 1. Relationship Between Learning Styles and Five Levels of Behavior

Behavior Level	Diverging	Assimilating	Converging	Accommodating
Personality types	Introverted Feeling	Introverted Intuition	Extraverted Thinking	Extraverted Sensation
Educational Specialization	Arts, English History Psychology	Mathematics Physical Science	Engineering Medicine	Education Communication Nursing
Professional Career	Social Service Arts	Sciences Research Information	Engineering Medicine Technology	Sales Social Service Education
Current Jobs	Personal jobs	Information jobs	Technical jobs	Executive jobs
Adaptive Competencies	Valuing skills	Thinking skills	Decision skills	Action skills

Personality Types

Although the learning styles of and learning modes proposed by ELT are derived from the works of Dewey, Lewin, and Piaget, many have noted the similarity of these concepts to Carl Jung's descriptions of individuals' preferred ways for adapting in the world. Several research studies relating the LSI with the Myers-Briggs Type Indicator (MBTI) indicate that Jung's Extraversion/Introversion dialectical dimension correlates with the Active/Reflective dialectic of ELT, and the MBTI Feeling/Thinking dimension correlates with the LSI Concrete Experience/ Abstract Conceptualization dimension. The MBTI Sensing type is associated with the LSI Accommodating learning style, and the MBTI Intuitive type with the LSI Assimilating style. MBTI Feeling types correspond to LSI Diverging learning styles, and Thinking types to Converging styles. The above discussion implies that the Accommodating learning style is the Extraverted Sensing type, and the Converging style the Extraverted Thinking type. The Assimilating learning style corresponds to the Introverted Intuitive personality type, and the Diverging style to the Introverted Feeling type. Myers (1962) descriptions of these MBTI types are very similar to the corresponding LSI learning styles as described by ELT (Kolb 1984, 83-85).

Educational Specialization

Early educational experiences shape people's individual learning styles by instilling positive attitudes toward specific sets of learning skills and by teaching students how to learn. Although elementary education is generalized, an increasing process of specialization begins in high school and becomes sharper during the college years. This specialization in the realms of social knowledge influences individuals' orientations toward learning, resulting in particular relations between learning styles and early training in an educational specialty or discipline. For example, people specializing in the arts, history, political science, English, and psychology tend to have Diverging learning styles, while those majoring in more abstract and applied areas such as medicine and engineering have Converging learning styles. Individuals with Accommodating styles often have educational backgrounds in education, communications, and nursing, and those with Assimilating styles in mathematics and physical sciences.

Professional Career

A third set of factors that shape learning styles stems from professional careers. One's professional career choice not only exposes one to a specialized learning environment, but it also involves a commitment to a generic professional problem, such as social service, that requires a specialized adaptive orientation. In addition, one becomes a member of a reference group of peers who share a professional mentality and a common set of values and beliefs about how one should behave professionally. This professional orientation shapes learning style through habits acquired in professional training and through the more immediate normative pressures involved in being a competent professional. Research over the years has shown that social service and arts careers attract people with a Diverging learning style. Professions in the sciences and information or research have people with an Assimilating learning style. The Converging learning styles tends to be dominant among professionals in technology-intensive fields such as medicine and engineering. Finally, the Accommodating learning style characterizes people with careers in fields such as sales, social service, and education.

Current Job Role

The fourth level of factors influencing learning style is the person's current job role. The task demands and pressures of a job shape a person's adaptive orientation. Executive jobs, such as general management, that require a strong orientation to task accomplishment and decision making in uncertain emergent circumstances require an Accommodating learning style. Personal jobs, such as counseling and personnel administration, which require the establishment of personal relationships and effective communication with other people, demand a Diverging learning style. Information jobs, such as planning and research, which require data gathering and analysis, as well as conceptual modeling, require an Assimilating learning style. Technical jobs, such as bench engineering and production, require technical and problem-solving skills, which require a convergent learning orientation.

Adaptive Competencies

The fifth and most immediate level of forces that shapes learning style is the specific task or problem the person is currently working on. Each task we face requires a corresponding set of skills for effective performance. The effective matching of task demands and personal skills results in an adaptive competence. The Accommodative learning style encompasses a set of competencies that can best be termed Acting skills: Leadership, Initiative, and Action. The Diverging learning style is associated with Valuing skills: Relationship, Helping Others, and Sense Making. The Assimilating learning style is related to Thinking skills: Information Gathering, Information Analysis, and Theory Building. Finally, the Converging learning style is associated with Decision skills like Quantitative Analysis, Use of Technology, and Goal Setting (Kolb1984).

2. THE LEARNING STYLE INVENTORY

PURPOSE

The Learning Style Inventory (LSI) was created to fulfill two purposes:

1. To serve as an educational tool to increase individuals' understanding of the process of learning from experience and their unique individual approach to learning. By increasing awareness of how they learn, the aim is to increase learners' capacity for meta-cognitive control of their learning process, enabling them to monitor and select learning approaches that work best for them in different learning situations. By providing a language for talking about learning styles and the learning process, the inventory can foster conversation among learners and educators about how to create the most effective learning environment for those involved. For this purpose, the inventory is best presented not as a test, but as an experience in understanding how one learns. Scores on the inventory should not be interpreted as definitive, but as a starting point for exploration of how one learns best. To facilitate this purpose, a self-scoring and interpretation book that explains the experiential learning cycle and the characteristics of the different learning styles, along with scoring and profiling instructions, is included with the inventory.
2. To provide a research tool for investigating experiential learning theory (ELT) and the characteristics of individual learning styles. This research can contribute to the broad advancement of experiential learning and, specifically, to the validity of interpretations of individual learning style scores. A research version of the instrument, including only the inventory to be scored by the researcher, is available for this purpose.

The LSI is not a criterion-referenced test and is not intended for use to predict behavior for purposes of selection, placement, job assignment, or selective treatment. This includes not using the instrument to assign learners to different educational treatments, a process sometimes referred to as tracking. Such categorizations based on a single test score amount to stereotyping that runs counter to the philosophy of experiential learning, which emphasizes individual uniqueness. "When it is used in the simple, straightforward, and open way intended, the LSI usually provides a valuable self-examination and discussion that recognizes the uniqueness, complexity, and variability in individual approaches to learning. The danger lies in the reification of learning styles into fixed traits, such that learning styles become stereotypes used to pigeonhole individuals and their behavior." (Kolb 1981a: 290-291)

The LSI is constructed as a self-assessment exercise and tool for construct validation of ELT. Tests designed for predictive validity typically begin with a criterion, such as academic achievement, and work backward to identify items or tests with high criterion correlations. Even so, even the most sophisticated of these tests rarely rises above a .5 correlation with the criterion. For example, while Graduate Record Examination Subject Test scores are better predictors of first-year graduate school grades than either the General Test score or undergraduate GPA, the combination of these three measures only produces multiple correlations with grades ranging from .4 to .6 in various fields (Anastasi and Urbina 1997).

Construct validation is not focused on an outcome criterion, but on the theory or construct the test measures. Here the emphasis is on the pattern of convergent and discriminant theoretical predictions made by the theory. Failure to confirm predictions calls into question the test and the theory. "However, even if each of the correlations proved to be quite low, their cumulative effect would be to support the validity of the test and the underlying theory." (Selltiz, Jahoda, Deutsch, and Cook 1960: 160) Judged by the standards of construct validity, ELT has been widely accepted as a useful framework for learning-centered educational innovation, including instructional design, curriculum development, and life-long learning. Field and job classification studies viewed as a whole also show a pattern of results consistent with the ELT structure of knowledge theory.

HISTORY

Five versions of the Learning Style Inventory have been published over the last 35 years. During this time, attempts have been made to openly share information about the inventory, its scoring, and its technical characteristics with other interested researchers. The results of their research have been instrumental in the continuous improvement of the inventory.

Learning Style Inventory-Version 1 (Kolb 1971, Kolb 1976)

The original Learning Style Inventory (LSI 1) was created in 1969 as part of an MIT curriculum development project that resulted in the first management textbook based on experiential learning (Kolb, Rubin, and McIntyre 1971). It was originally developed as an experiential educational exercise designed to help learners understand the process of experiential learning and their unique individual style of learning from experience. The term "learning style" was coined to describe these individual differences in how people learn.

Items for the inventory were selected from a longer list of words and phrases developed for each learning mode by a panel of four behavioral scientists familiar with experiential learning theory. This list was given to a group of 20 graduate students who were asked to rate each word or phrase for social desirability. Attempting to select words that were of equal social desirability, a final set of 12 items including a word or phrase for each learning mode was selected for pre-testing. Analysis showed that three of these sets produced nearly random responses and were thus eliminated, resulting in a final version of the LSI with 9 items. These items were further refined through item-whole correlation analysis to include six scored items for each learning mode.

Research with the inventory was stimulated by classroom discussions with students, who found the LSI to be helpful to them in understanding the process of experiential learning and how they learned. From 1971 until it was revised in 1985, there were more than 350 published research studies using the LSI. Validity for the LSI 1 was established in a number of fields, including education, management, psychology, computer science, medicine, and nursing (Hickcox 1990, Iliff 1994). The results of this research with LSI 1 provided provided empirical support for the most complete and systematic statement of ELT, *Experiential Learning: Experience as the Source of Learning and Development* (Kolb 1984). Several studies of the LSI 1 identified psychometric weaknesses of the instrument, particularly low internal consistency reliability and test-retest reliability.

Learning Style Inventory-Version 2 (Kolb 1985)

Low reliability coefficients and other concerns about the LSI 1 led to a revision of the inventory in 1985 (LSI 2). Six new items chosen to increase internal reliability (alpha) were added to each scale, making 12 scored items on each scale. These changes increased scale alphas to an average of .81 ranging from .73 to .88. Wording of all items was simplified to a seventh grade reading level, and the format was changed to include sentence stems (e.g., "When I learn"). Correlations between the LSI 1 and LSI 2 scales averaged .91 and ranged from .87 to .93. A new more diverse normative reference group of 1446 men and women was created.

Research with the LSI 2 continued to establish validity for the instrument. From 1985 until the publication of the LSI 3 1999, more than 630 studies were published, most using the LSI 2. While internal reliability estimates for the LSI 2 remained high in independent studies, test-retest reliability remained low.

Learning Style Inventory-Version 2a (Kolb 1993)

In 1991 Veres, Sims, and Locklear published a reliability study of a randomized version of the LSI 2 that showed a small decrease in internal reliability but a dramatic increase in test-retest reliability with the random scoring format. To study this format, a research version of the random format inventory (LSI 2a) was published in 1993.

Kolb Learning Style Inventory-Version 3 (Kolb 1999)

In 1999 the randomized format was adopted in a revised self-scoring and interpretation booklet (LSI 3) that included a color-coded scoring sheet to simplify scoring. The new booklet was organized to follow the learning cycle, emphasizing the LSI as an "experience in learning how you learn." New application information on teamwork, managing conflict, personal and professional communication, and career choice and development were added. The LSI 3 continued to use the LSI 2 normative reference group until norms for the randomized version could be created.

Kolb Learning Style Inventory-Version 3.1 (Kolb 2005)

The new LSI 3.1 described here modified the LSI 3 to include new normative data described below. This revision includes new norms that are based on a larger, more diverse and representative sample of 6977 LSI users. The format, items, scoring, and interpretative booklet remain identical to KLSI 3. The only change in KLSI 3.1 is in the norm charts used to convert raw LSI scores.

FORMAT

The Learning Style Inventory is designed to measure the degree to which individuals display the different learning styles derived from experiential learning theory. The form of the inventory is determined by three design parameters. First, the test is brief and straightforward, making it useful both for research and for discussing the learning process with individuals and providing feedback. Second, the test is constructed in such a way that individuals respond to it as they would respond to a learning situation: it requires them to resolve the tensions between the abstract-concrete and active-reflective orientations. For this reason, the LSI format requires them to rank order their preferences for the abstract, concrete, active, and reflective orientations. Third, and most obviously, it was hoped that the measures of learning styles would predict behavior in a way consistent with the theory of experiential learning.

All versions of the LSI have had the same format—a short questionnaire (9 items for LSI 1 and 12 items for subsequent versions) that asks respondents to rank four sentence endings that correspond to the four learning modes—Concrete Experience (e.g., experiencing), Reflective Observation (reflecting), Abstract Conceptualization (thinking), and Active Experimentation (doing). Items in the LSI are geared to a seventh grade reading level. The inventory is intended for use by teens and adults. It is not intended for use by younger children. The LSI has been translated into many languages, including, Arabic, Chinese, French, Japanese, Italian, Portuguese, Spanish, Swedish, and Thai, and there have been many cross-cultural studies using it (Yamazaki 2002).

The Forced-Choice Format of the LSI

The format of the LSI is a forced-choice format that ranks an individual's relative choice preferences among the four modes of the learning cycle. This is in contrast to the more common normative, or free-choice, format, such as the widely used Likert scale, which rates absolute preferences on independent dimensions. The forced-choice format of the LSI was dictated by the theory of experiential learning and by the primary purpose of the instrument.

ELT is a holistic, dynamic, and dialectic theory of learning. Because it is holistic, the four modes that make up the experiential learning cycle-CE, RO, AC, and AE- are conceived as interdependent. Learning involves resolving the creative tension among these learning modes in response to the specific learning situation. Since the two learning dimensions, AC-CE and AE-RO, are related dialectically, the choice of one pole involves not choosing the opposite pole. Therefore, because ELT postulates that learning in life situations requires the resolution of conflicts among interdependent learning modes, to be ecologically valid, the learning style assessment process should require a similar process of conflict resolution in the choice of one's preferred learning approach.

ELT defines learning style not as a fixed trait, but as a dynamic state arising from an individual's preferential resolution of the dual dialectics of experiencing/conceptualizing and acting/reflecting. "The stability and endurance of these states in individuals comes not solely from fixed genetic qualities or characteristics of human beings: nor, for that matter, does it come from the stable fixed demands of environmental circumstances. Rather, stable and enduring patterns of human individuality arise from consistent patterns of transaction between the individual and his or her environment. The way we process the possibilities of each new emerging event determines the range of choices and decisions we see. The choices and decisions we make to some extent determine the events we live through, and these events influence our future choices. Thus, people create themselves through the choice of actual occasions they live through." (Kolb 1984: 63-64)

The primary purpose of the LSI is to provide learners with information about their preferred approach to learning. The most relevant information for the learner is about intra-individual differences, his or her relative preference for the four learning modes, not inter-individual comparisons. Ranking relative preferences among the four modes in a forced-choice format is the most direct way to provide this information. While individuals who take the inventory sometimes report difficulty in making these ranking choices, they report that the feedback they get from the LSI gives them more insight than had been the case when we used a normative Likert rating scale version. This is because the social desirability response bias in the rating scales fails to define a clear learning style, that is, they say they prefer all learning modes. This is supported by Harland's (2002) finding that feedback from a forced-choice test format was perceived as more accurate, valuable, and useful than feedback from a normative version.

The adoption of the forced-choice method for the LSI has at times placed it in the center of an ongoing debate in the research literature about the merits of forced-choice instruments between what might be called "rigorous statisticians" and "pragmatic empiricists." Statisticians have questioned the use of the forced-choice format because of statistical limitations, called ipsativity, that are the result of the ranking procedure. Since ipsative scores represent the relative strength of a variable compared to others in the ranked set, the resulting dependence among scores produces method-induced negative correlations among variables and violates a fundamental assumption of classical test theory required for use of techniques such as analysis of variance and factor analysis-independence of error variance. Cornwell and Dunlap (1994) stated that ipsative scores cannot be factored and that correlation-based analysis of ipsative data produced uninterpretable and invalid results (cf. Hicks 1970, Johnson et al. 1988). Other criticisms include the point that ipsative scores are technically ordinal, not the interval scales required for parametric statistical analysis; that they produce lower internal reliability estimates and lower validity coefficients (Barron 1996). While critics of forced-choice instruments acknowledge that these criticisms do not detract from the validity of intra-individual comparisons (LSI purpose one), they argue that ipsative scores are not appropriate for inter-individual comparisons, since inter-individual comparisons on a ranked variable are not independent absolute preferences, but preferences that are relative to the other ranked variables in the set (Barron 1996, Karpatschof and Elkjaer 2000). However, since ELT argues that a given learning mode preference is relative to the other three modes, it is the comparison of relative not absolute preferences that the theory seeks to assess.

The "pragmatic empiricists" argue that in spite of theoretical statistical arguments, normative and forced-choice variations of the same instrument can produce empirically comparable results. Karpatschof and Elkjaer (2000) advanced this case in their metaphorically titled paper "Yet the Bumblebee Flies." With theory, simulation, and empirical data, they presented evidence for the comparability of ipsative and normative data. Saville and Wilson (1991) found a high correspondence between ipsative and normative scores when forced choice involved a large number of alternative dimensions.

Normative tests also have serious limitations, which the forced-choice format was originally created to deal with (Sisson 1948). Normative scales are subject to numerous response biases—central tendency bias, in which respondents avoid extreme responses, acquiescence response, and social desirability responding-and are easy to fake. Forced- choice instruments are designed to avoid these biases by forcing choice among alternatives in a way that reflects real live choice making (Hicks 1970, Barron 1996). Matthews and Oddy found large bias in the extremeness of positive and negative responses in normative tests and concluded that when sources of artifact are controlled, "individual differences in ipsative scores can be used to rank individuals meaningfully" (1997: 179). Pickworth and Shoeman (2000) found significant response bias in two normative LSI formats developed by Marshall and Merritt (1986) and Geiger et al. (1993). Conversely, Beutell and Kressel (1984) found that social desirability contributed less than 4% of the variance in LSI scores, in spite of the fact that individual LSI items all had very high social desirability.

In addition, ipsative tests can provide external validity evidence comparable to normative data (Barron 1996) or in some cases even better (Hicks 1970). For example, attempts to use normative rating versions of the LSI report reliability and internal validity data but little or no external validity (Pickworth and Shoeman 2000, Geiger et al. 1993, Romero et al. 1992, Marshall and Merritt 1986, Merritt and Marshall 1984).

Characteristics of the LSI Scales

The LSI assesses six variables: four primary scores that measure an individual's relative emphasis on the four learning orientations—Concrete Experience (CE), Reflective Observation (RO), Abstract Conceptualization (AC), and Active Experimentation (AE)—and two combination scores that measure an individual's preference for abstractness over concreteness (AC-CE) and action over reflection (AE-RO). The four primary scales of the LSI are ipsative because of the forced-choice format of the instrument. This results in negative correlations among the four scales, the mean magnitude of which can be estimated (assuming no underlying correlations among them) by the formula -1/(m - 1) where m is the number of variables (Johnson et al. 1988). This results in a predicted average method- induced correlation of -.33 among the four primary LSI scales.

The combination scores AC-CE and AE-RO, however, are not ipsative. Forced- choice instruments can produce scales that are not ipsative (Hicks 1970; Pathi, Manning, and Kolb 1989). To demonstrate the independence of the combination scores and interdependence of the primary scores, Pathi, Manning, and Kolb (1989) had SPSS-X randomly fill out and analyze 1000 LSI's according to the ranking instructions. While the mean intercorrelation among the primary scales was -.33 as predicted, the correlation between AC-CE and AE-RO was +.038.

In addition, if AC-CE and AE-RO were ipsative scales, the correlation between the two scales would be -1.0 according to the above formula. Observed empirical relationships are always much smaller, e.g. +.13 for a sample of 1591 graduate students (Freedman and Stumpf 1978), -.09 for the LSI 2 normative sample of 1446 respondents (Kolb 1999b), -.19 for a sample of 1296 MBA students (Boyatzis and Mainemelis 2000) and -.21 for the normative sample of 6977 LSI's for the KLSI 3.1 described below.

The independence of the two combination scores can be seen by examining some example scoring results. For example, when AC-CE or AE-RO on a given item takes a value of +2 (from, say, AC = 4 and CE = 2, or AC = 3 and CE = 1), the other score can take a value of +2 or -2. Similarly when either score takes a value of +1 (from 4 -3, 3-2, or 2-1), the other can take the values of +3, +1, -1, or -3. In other words, when AC-CE takes a particular value, AE-RO can take two to four different values, and the score on one dimension does not determine the score on the other.

3. NORMS FOR THE LSI VERSION 3.1

New norms for the LSI 3.1 were created from responses by several groups of users who completed the randomized LSI 3. These norms are used to convert LSI raw scale scores to percentile scores (see Appendix 1). The purpose of percentile conversions is to achieve scale comparability among an individual's LSI scores (Barron 1996) and to define cut-points for defining the learning style types. Table 2 shows the means and standard deviations for KLSI 3.1 scale scores for the normative groups.

Table 2. KLSI 3.1 Scores for Normative Groups

SAMPLE	N	CE	RO	AC	AE	AC-CE	AE-RO
TOTAL NORM GROUP	6977 Mn. S.D.	25.39 *6.43*	28.19 *7.07*	32.22 *7.29*	34.14 *6.68*	6.83 *11.69*	5.96 *11.63*
On-line Users	5023	25.22 *6.34*	27.98 *7.03*	32.43 *7.32*	34.36 *6.65*	7.21 *11.64*	6.38 *11.61*
Research Univ. Freshmen	288	23.81 *6.06*	29.82 *6.71*	33.49 *6.91*	32.89 *6.36*	9.68 *10.91*	3.07 *10.99*
Lib. Arts College Students	221	24.51 *6.39*	28.25 *7.32*	32.07 *6.22*	35.05 *7.08*	7.56 *10.34*	6.80 *12.37*
Art College UG	813	28.02 *6.61*	29.51 *7.18*	29.06 *6.94*	33.17 *6.52*	1.00 *11.13*	3.73 *11.49*
Research Univ. MBA	328	25.54 *6.44*	26.98 *6.94*	33.92 *7.37*	33.48 *7.06*	8.38 *11.77*	6.49 *11.92*
Distance E-learning Adult UG	304	23.26 *5.73*	27.64 *7.04*	34.36 *6.87*	34.18 *6.28*	11.10 *10.45*	6.54 *11.00*

TOTAL NORMATIVE GROUP

Normative percentile scores for the LSI 3.1 are based on a total sample of 6977 valid LSI scores from users of the instrument. This user norm group is composed of 50.4% women and 49.4% men. Their age range is 17-75, broken down into the following age-range groups: < 19 = 9.8%, 19-24 = 17.1%, 25-34 = 27%, 35-44 = 23%, 45-54 = 17.2%, and >54 = 5.8 %. Their educational level is as follows: primary school graduate = 1.2%, secondary school degree = 32.1%, university degree = 41.4%, and post-graduate degree = 25.3%. The sample includes college students and working adults in a wide variety of fields. It is made up primarily of U.S. residents (80%) with the remaining 20% of users residing in 64 different countries. The norm group is made up of six subgroups, the specific demographic characteristics of which are described below.

On-line Users

This sample of 5023 is composed of individuals and groups who have signed up to take the LSI on-line. Group users include undergraduate and graduate student groups, adult learners, business management groups, military management groups, and other organizational groups. Half of the sample are men and half are women. Their ages range as follows: <19 = .2%, 19-24 = 10.1%, 25-34 = 29.6%, 35-44 = 28.8%, 45-54 = 23/1%, >55 = 8.1 %. Their educational level is as follows: primary school graduate = 1.7%, secondary school degree = 18.2%, university degree = 45.5%, and postgraduate degree = 34.6%. Most of the on-line users (66%) reside in the U.S. with the remaining 34% living in 64 different countries, with the largest representations from Canada (317), U. K. (212), India (154), Germany (100), Brazil (75), Singapore (59), France (49), and Japan (42).

Research University Freshmen

This sample is composed of 288 entering freshmen at a top research university. 53% are men and 47% are women. All are between the ages of 17 and 22. More than 87% of these students intend to major in science or engineering.

Liberal Arts College Students

Data for this sample were provided by Kayes (2005). This sample includes 221 students (182 undergraduates and 39 part-time graduate students) enrolled in business courses at a private liberal arts college. Their average age is 22, ranging from 18 to 51. 52% are male and 48% are female.

Art College Undergraduates

This sample is composed of 813 freshmen and graduating students from three undergraduate art colleges. Half of the sample are men and half are women. Their average age is 20, distributed as follows: <19 =42.7%, 19-24 = 54.3%, 25-34 = 2%, >35 = 1%.

Research University MBA Students

This sample is composed of 328 full-time (71%) and part-time (29%) MBA students in a research university management school. 63% are men and 37% women. Their average age is 27, distributed as follows: 19-24 = 4.1%, 25-34 = 81.3%, 35-44 = 13.8%, 45-54 = 1%.

Distance E-learning Adult Undergraduate Students

This sample is composed of 304 adult learners enrolled in an e-learning distance education undergraduate degree program at a large state university. 56% are women and 44% men. Their average age is 36, distributed as follows: 19-24 = 6.3%, 25-34 = 37.5%, 35-44 = 40.1%, 45-54 = 14.5%, and > 55 = 1.6%.

CUT-POINTS FOR LEARNING STYLE TYPES

The four basic learning style types—Accommodating, Diverging, Assimilating, and Converging-are created by dividing the AC-CE and AE-RO scores at the fiftieth percentile of the total norm group and plotting them on the Learning Style Type Grid (Kolb 1999a: 6). The cut point for the AC-CE scale is +7, and the cut point for the AE-RO scale is +6. The Accommodating type would be defined by an AC-CE raw score <=7 and an AE-RO score >=7, the Diverging type by AC-CE <=7 and AE-RO <=6, the Converging type by AC-CE >=8 and AE-RO >=7, and the Assimilating type by AC-CE >=8 and AE-RO <=6.

Recent theoretical and empirical work is showing that the original four learning styles can be refined to show nine distinct styles (Eickmann, Kolb, and Kolb 2004; Kolb and Kolb 2005a; Boyatzis and Mainemelis 2000). David Hunt and his associates (Abby, Hunt, and Weiser 1985; Hunt 1987) identified four additional learning styles, which they identified as Northerner, Easterner, Southerner, and Westerner. In addition a Balancing learning style has been identified by Mainemelis, Boyatzis, and Kolb (2002) that integrates AC and CE and AE and RO. These nine learning styles can be defined by placing them on the Learning Style Type Grid. Instead of dividing the grid at the fiftieth percentiles of the LSI normative distributions for AC-CE and AE-RO, the nine styles are defined by dividing the two normative distributions into thirds. On the AE-RO dimension, the active regions are defined by percentiles greater than 66.67% (raw scores => +12) while the reflective regions are defined by percentiles less than 33.33% (<= +1). On the AC-CE dimension, the concrete regions are defined by <= +2 and the abstract regions by => 13. For example the NW accommodating region would be defined by AC-CE raw scores <=2 and AE-RO scores =>12. (See Kolb and Kolb 2005a for examples and details.)

4. RELIABILITY OF THE KLSI 3.1

This section reports internal consistency reliability studies using Cronbach's alpha and test-retest reliability studies for the randomized KLSI 3.1.

INTERNAL CONSISTENCY RELIABILITY

Table 3 reports Cronbach's alpha coefficients for seven different studies of the randomized KLSI 3.1: the norm subsample of on-line LSI users, Kayes (2005) study of liberal arts college students, Wierstra and DeJong's (2002) study of psychology undergraduates, Veres et al. (1991) initial and replication studies of business employees and students, and two studies by Ruble and Stout (1990, 1991) of business students. Wierstra and DeJong and Ruble and Stout used an LSI randomized in a different order than the KLSI 3.1. These results suggest that the KLSI 3.1 scales show good internal consistency reliability across a number of different populations.

Table 3. Internal Consistency Alphas for the Scale Scores of the KLSI 3.1

Source	N	CE	RO	AC	AE	AC-CE	AE-RO
On-line Sample	5023	.77	.81	.84	.80	.82	.82
Kayes (2005)	221	.81	.78	.83	.84	.77	.84
Wierstra & DeJong (2002)	101	.81	.78	.83	.84	.83	.82
Veres et al. (1991)*	711 Initial 1042 Rep.	.56 .67	.67 .67	.71 .74	.52 .58	— —	— —
Ruble & Stout	323 (1990) 403 (1991)	.72 .67	.75 .78	.72 .78	.73 .78	— —	— —

*Alpha coefficients are the average of three repeated administrations. Alphas for the initial administration were higher (average = .70).

TEST-RETEST RELIABILITY

Two test-retest reliability studies of the randomized format KLSI 3.1 have been published. Veres et al. (1991) administered the LSI three times at 8-week intervals to initial (N = 711) and replication (N =1042) groups of business employees and students and found test-retest correlations well above .9 in all cases. Kappa coefficients indicated that very few students changed their learning style type from administration to administration (See Table 4). Ruble and Stout (1991) administered the LSI twice to 253 undergraduate and graduate business students and found test-retest reliabilities that averaged .54 for the six LSI scales. A Kappa coefficient of .36 indicated that 47% of students changed their learning style classification on retest. In these studies, test-retest correlation coefficients range from moderate to excellent. The discrepancy between the studies is difficult to explain, although ELT hypothesizes that learning style is situational, varying in response to environmental demands. Changes in style may be the result of discontinuous intervening experiences between test and retest (Kolb 1981a) or individuals' ability to adapt their style to changing environmental demands (Mainemelis, Boyatzis, and Kolb 2002; Jones, Reichard, and Mokhtari 2003).

Table 4. Test-Retest Reliability for the KLSI 3.1 (Veres et al. 1991)

	LSI Scales											
	Concrete			Reflective			Abstract			Active		
Time	1	2	3	1	2	3	1	2	3	1	2	3
					Initial Samples (N = 711)							
1	–	.95	.92	–	.96	.93	–	.97	.94	–	.95	.91
2		–	.96		–	.97		–	.97		–	.97
3												
					Replication Sample (N = 1042)							
1	–	.98	.97	–	.98	.97	–	.99	.97	–	.98	.96
2		–	.99		–	.98		–	.99		–	.99
3												

Data source: Veres et al. (1991). Reproduced with permission. Time between tests was 8 weeks.
Note: Kappa coefficients for the initial sample were .81 for Time 1-Time 2, .71 for Time 1-Time 3 and .86 for Time 2-Time 3. These results indicate that very few subjects changed their learning style classification from one administration to another.

Table 5. Test-Retest Reliability for KLSI 3.1 (Ruble and Stout 1991)

Sample	N	CE	RO	AC	AE	AC-CE	AE-RO
UG/Grad Business Majors	253	.37	.59	.61	.58	.48	.60

LSI was randomized, but in different order than KLSI 3.1. Time between tests was 5 weeks. Kappa coefficient was .36, placing 53% of respondents in the same category on retest.

5. VALIDITY

This section begins with an overview of validity research on the LSI 1 and LSI 2 from 1971 to the introduction of the KLSI 3 in 1999. It is followed by internal validity evidence for the KLSI 3.1 normative group including correlation and factor analysis studies of the LSI scales. The final part is focused on external validity evidence for the KLSI 3.1 and other LSI versions. It begins with demographic relationships of learning style with age, gender, and education level. This is followed by evidence for the relationship between learning style and educational specialization. Concurrent validity studies of relationships between learning style and other experiential learning assessment inventories are then presented followed by studies relating learning style to performance on aptitude tests and academic performance. Next, research on ELT and learning style in teams is presented. The final part presents evidence for the practical utility of ELT and the LSI in the design and conduct of education in different disciplines in higher education.

AN OVERVIEW OF RESEARCH ON ELT AND THE LSI: 1971-1999

Since ELT is a holistic theory of learning that identifies learning style differences among different academic specialties, it is not surprising to see that ELT/LSI research is highly interdisciplinary, addressing learning and educational issues in several fields. Since the first publications in 1971 (Kolb 1971; Kolb, Rubin, and McIntyre 1971) there have been many studies on ELT using the LSI 1 and LSI 2. The Bibliography of Research on Experiential Learning Theory and The Learning Style Inventory (Kolb and Kolb 1999) included 1004 entries.

Table 6 shows the distribution of these studies by field and publication period. The field classification categories are: Education (including K-12, higher education, and adult learning), Management, Computer/Information Science, Psychology, Medicine, Nursing, Accounting, and Law. Studies were also classified as early (1971-1984) or recent (1985-1999). The division makes sense in that the most comprehensive statement of ELT, *Experiential Learning*, was published in 1984, and the original LSI was first revised in 1985.

Table 6. Early and Recent ELT/LSI Research by Academic Field and Publication

ELT/LSI Research	Early Period (1971-1984)	Recent Period (1985-1999)	Total (1971-1999)
By Academic Field			
Education	165	265	430
Management	74	133	207
Computer Science	44	60	104
Psychology	23	78	101
Medicine	28	44	72
Nursing	12	51	63
Accounting	7	15	22
Law	1	4	5
Total	*354*	*650*	*1004*
By Publication Type			
Journal Articles	157	385	542
Doctoral Dissertations	76	133	209
Books and Chapters	43	58	101
Other	78	74	152
Total	*354*	*650*	*1004*

Data Source: Kolb and Kolb 1999

Table 6 also shows the distribution of the 1004 studies according to the publication type. More than 50% of the studies were published in journals, and another approximately 20% were doctoral dissertations. 10% of the studies were either books or book chapters, and the remaining 150 studies were conference presentations, technical manuals, working papers, and master theses. Numbers should be considered approximate, since a few recent citations have yet to be verified by abstract or full text. Also, classification by field is not easy because many studies are interdisciplinary. However, the 1999 Bibliography probably does give a fair representation of the scope, topics, and trends in ELT/LSI research. The following is a brief overview of research activity in the various fields.

Education

The education category includes the largest number of ELT/LSI studies. The bulk of studies in education are in higher education (excluding professional education in the specific fields identified below). K-12 education accounts for a relatively small number, as does adult learning alone. However, in many cases adult learning is integrated with higher education. A number of studies in the education category have been done with sample populations in U.K., Canada, Australia, Finland, Israel, Thailand, China, Melanesia, Spain, and Malta.

Many of the studies in higher education use ELT and the LSI as a framework for educational innovation. These include research on the matching of learning style with instructional method and teaching style and curriculum and program design using ELT (e.g., Claxton and Murrell 1987). A number of publications assess the learning style of various student, faculty, and other groups. Other work includes theoretical contributions to ELT, ELT construct validation, LSI psychometrics, and comparison of different learning style assessment tools. In adult learning there are a number of publications on ELT and adult development, moral development, and career development. The work of Sheckley and colleagues on adult learning at the University of Connecticut is noteworthy here (e.g., Allen, Sheckley, and Keeton 1993; Travers, 1998). K-12 education research has been primarily focused on the use of ELT as a framework for curriculum design, particularly in language and science. (e.g., McCarthy 1996, Hainer 1992)

Management

ELT/LSI research was first published in the management field, and there has continued to be substantial interest in the topic in the management literature. Studies can be roughly grouped into four categories: management and organizational processes, innovation in management education, theoretical contributions to ELT including critique, and psychometric studies of the LSI. Cross-cultural ELT/LSI research has been done in Poland, New Zealand, Australia, Canada, U.K., and Singapore. In the management/organization area, organizational learning is a hot topic. Dixon's book *The Organizational Learning Cycle* (1999) is an excellent example.

Another group of studies has examined the relationship between learning style and management style, decision making, and problem solving. Other work has measured work- related learning environments and investigated the effect of a match between learning style and learning environment on job satisfaction and performance. ELT has been used as a framework for innovation in management education, including research on matching learning styles and learning environments, program design, and experiential learning in computerized business games (e.g., Boyatzis, Cowen, and Kolb 1995; Lengnick-Hall and Sanders 1997).

Other education work has been on training design, management development, and career development. Another area of research has been on the development and critique of ELT. Most psychometric studies of the LSI in the early period were published in management, while recent psychometric studies have been published in psychology journals. Hunsaker reviewed the early studies of the LSI 1 in management and concluded, "The LSI does not demonstrate sufficient reliability to grant it the predictive reliability that such a measurement instrument requires. The underlying model, however, appears to receive enough support to merit further use and development." (1981: 151)

Computer and Information Science

The LSI has been used widely in computer and information science, particularly to study end user software use and end user training (e.g., Bostrom, Olfman, and Sein, 1990; Davis and Bostrom, 1993). Of particular interest for this book on individual differences in cognitive and learning styles is the debate about whether these differences are sufficiently robust to be taken into account in the design of end user software and end user computer training. Other studies have examined the relationship between learning style and problem solving and decision making, on-line search behavior, and performance in computer training and computer-assisted instruction.

Psychology

Studies in psychology have shown a large increase over time, with 77% of the studies in the recent period. Many of these recent studies were on LSI psychometrics. The first version of the LSI was released in 1976 and received wide support for its strong face validity and independence of the two ELT dimensions of the learning process (Marshall and Meritt, 1985; Katz 1986). Although early critiques of the instrument focused on the internal consistency of scales and test-retest reliability, a study by Ferrell (1983) showed that the LSI version 1 was the most psychometrically sound among four learning instruments of that time. In 1985 version 2 of the LSI was released and improved the internal consistency of the scales (Veres, Sims, and Shake 1987; Sims, Veres, Watson, and Buckner 1986). Critiques of this version focused their attention on the test-retest reliability of the instrument, but a study by Veres, Sims, and Locklear (1991) showed that randomizing the order of the LSI version 2 items resulted in dramatic improvement of test-retest reliability. This finding led to experimental research and finally to the latest LSI revision, LSI Version 3 (Kolb 1999a). The LSI version 3 has significantly improved psychometric properties, especially test-retest reliability (see Kolb 1999b).

Other research includes factor analytic studies of the LSI, construct validation studies of ELT using the LSI, and comparison of the LSI with other learning style and cognitive style measures. Another line of work uses ELT as a model for personal growth and development, including examination of counselor-client learning style match and its impact on counseling outcomes. Notable here is the work of Hunt and his colleagues at the Ontario Institute for Studies in Education (Hunt 1992,1987).

Medicine

The majority of studies in medicine focus on learning style analysis in many medical education specialties-residency training, anesthesia education, family medicine, surgical training, and continuing medical education. Of significance here is the program of research by Baker and associates (e.g., Baker, Cooke, Conroy, Bromley, Hollon, and Alpert 1988; Baker, Reines, and Wallace 1985). Also Curry (1999) has done a number of studies comparing different measures of learning styles. Other research has examined clinical supervision and patient-physician relationships, learning style and student performance on examinations, and the relationship between learning style and medical specialty career choice.

Nursing

ELT/LSI research has also increased dramatically with, 81% of the nursing studies in the recent period. In 1990 Laschinger reviewed the experiential learning research in nursing and concluded, "Kolb's theory of experiential learning has been tested extensively in the nursing population. Researchers have investigated relationships between learning style and learning preferences, decision-making skills, educational preparation, nursing roles, nursing specialty, factors influencing career choices, and diagnostic abilities. As would be expected in a human service profession, nursing learning environments have been found to have a predominantly concrete learning press, matching the predominating concrete styles of nurses. Kolb's cycle of learning which requires the use of a variety of learning modalities appears to be a valid and useful model for instructional design in nursing education." (Laschinger 1990: 991)

Accounting

There has been considerable interest in ELT/LSI research in accounting education, where there have been two streams of research activity. One is the comparative assessment of learning style preferences of accounting majors and practitioners, including changes in learning style over the stages of career in accounting and the changing learning style demands of the accounting profession primarily due to the introduction of computers. Other research has been focused on using ELT to design instruction in accounting and studying relationships between learning style and performance in accounting courses.

In 1991 Ruble and Stout reviewed ELT/LSI research in accounting education. Reviewing the literature on predicting the learning styles of accounting students, they found mixed results and concluded that low predictive and classification validity for the LSI was a result of weak psychometric qualities of the original LSI and response set problems in the LSI 1985. They tentatively recommended the use of the randomized version proposed by Veres, Sims, and Locklear (1991). They wrote, "researchers who wish to use the LSI for predictive and classification purposes should consider using a scrambled version of the instrument," and note, "...it is important to keep in mind that assessing the validity of the underlying theoretical model (ELT) is separate from assessing the validity of the measuring instrument (LSI). Thus, for example, the theory may be valid even though the instrument has psychometric limitations. In such a case, sensitivity to differences in learning styles in instructional design may be warranted, even though assessment of an individual's learning style is problematic" (p. 50).

Law

We are now seeing the beginning of significant research programs in legal education, for example the program developed by Reese (1998) using learning style interventions to improve student learning at the University of Denver Law School.

Evaluation of ELT and the LSI

There have been two recent comprehensive reviews of the ELT/LSI literature, one qualitative and one quantitative. In 1990 Hickcox extensively reviewed the theoretical origins of ELT and qualitatively analyzed 81 studies in accounting and business education, helping professions, medical professions, post-secondary education, and teacher education. She concluded that overall 61.7% of the studies supported ELT, 16.1% showed mixed support, and 22.2% did not support ELT.

In 1994 Iliff conducted a meta-analysis of 101 quantitative studies culled from 275 dissertations and 624 articles that were qualitative, theoretical, and quantitative studies of ELT and the LSI. Using Hickox's evaluation format, he found that 49 studies showed strong support for the LSI, 40 showed mixed support, and 12 showed no support. About half of the 101 studies reported sufficient data on the LSI scales to compute effect sizes via meta-analysis. Most studies reported correlations he classified as low (<.5), and effect sizes fell in the weak (.2) to medium (.5) range for the LSI scales. In conclusion Iliff suggests that the magnitude of these statistics is not sufficient to meet standards of predictive validity.

Most of the debate and critique in the ELT/LSI literature has centered on the psychometric properties of the LSI. Results from this research have been of great value in revising the LSI in 1985 and again in 1999. Other critiques, particularly in professional education, have questioned the predictive validity of the LSI. Iliff correctly notes that the LSI was not intended to be a predictive psychological test like IQ, GRE, or GMAT. The LSI was originally developed as a self-assessment exercise and later used as a means of construct validation for ELT. Judged by the standards of construct validity, ELT has been widely accepted as a useful framework for learning-centered educational innovation, including instructional design, curriculum development, and life-long learning. Field and job classification studies viewed as a whole also show a pattern of results consistent with the ELT structure of knowledge theory described in Table 1.

Recent critiques have been more focused on the theory than the instrument, examining the intellectual origins and underlying assumptions of ELT from what might be called a post-modern perspective, where the theory is seen as individualistic, cognitivist, and technological (e.g., Kayes 2002, Vince1998, Holman et al.1997, Hopkins 1993).

INTERNAL VALIDITY EVIDENCE

Several predictions can be made from ELT about the relationship among the scales of the Learning Style Inventory. These relationships have been empirically examined in two ways—through a first-order correlation matrix of the six LSI scales and through factor analysis of the four primary LSI scales and/or inventory items.

Correlation Studies of the LSI Scales

ELT proposes that the four primary modes of the learning cycle—CE, RO, AC, and AE-are composed of two independent dialectic (bipolar) dimensions: a "grasping" dimension measured by the combination score AC-CE and a "transformation" dimension measured by the AE-RO combination score. Thus, the prediction is that AC-CE and AE-RO should be uncorrelated. Also, the CE and AC scales should not correlate with AE-RO and the AE and RO scales should not correlate with AC-CE. In addition, the dialectic poles of both combination dimensions should be negatively correlated, though not perfectly, since the dialectic relationship predicts the possibility of developmental integration of the opposite poles. Finally, the cross-dimensional scales—CE/RO, AC/AE, CE/AE, and AC/RO—should not be correlated as highly as the within-dimension scales.

Table 7 shows these critical scale intercorrelations for the total normative sample and the subsamples. Correlations of AC and CE with the AC-CE dimension and AE and RO with the AE-RO dimensions are not included because they are artificially inflated (all are above .8), because the combination score includes the scale score. The correlations between AC-CE and AE-RO are significant but low. The correlation of .21 for the total norm group indicates that the two scales share only 4.4% common variance. This correlation is somewhat higher than for the LSI 2 norm group (-.09). RO has very low correlations with AC-CE, but correlations of AE with AC-CE are somewhat higher. Correlations of AC with AE-RO are quite low, but with CE are somewhat higher. As predicted, both AC and CE and AE and RO are highly negatively correlated. The cross-dimensional scales, CE/AE and AC/RO, have low correlations as predicted, but the CE/RO and AC/AE have higher correlations than predicted.

Significance levels for correlations involving ipsative scales CE, RO, AC, and AE are not reported, since they are not meaningful because of method-induced negative correlations.

Table 7. KLSI 3.1 Scale Intercorrelations

Sample	N	ACCE /AERO	ACCE /RO	ACCE /AE	AERO /CE	AERO /AC	CE /AC	RO /AE	CE /RO	AC /AE	CE /AE	AC /RO
Total Norm Group	6977	-.21 p<.001	.10	-.26	.24	-.14	-.44	-.43	-.42	-.45	-.03	-.20
On-line Users	5023	-.25 p<.001	.13	-.30	.26	-.17	-.45	-.44	-.44	-.48	.00	-.18
Research University Freshmen	288	-.02 ns	-.06	-.10	.06	.01	-.41	-.41	-.28	-.34	-.20	-.34
Lib. Arts College Students	221	-.14 p<.05	.14	-.10	.15	-.08	-.34	-.48	-.42	-.35	-.18	-.20
Art College UG	813	-.25 p<.01	.18	-.23	.30	-.14	-.35	-.38	-.52	-.44	-.06	-.18
Research University MBA	328	-.20 p<.01	.10	-.25	.17	-.18	-.45	-.45	-.36	-.46	-.07	-.16
Distance E-learning Adult UG	304	-.12 p<.05	-.01	-.22	.18	-.03	.37	-.36	-.36	-.41	-.08	-.31

Significance levels for correlations involving ipsative scales CE, RO, AC, and AE are not reported, since they are not meaningful because of method-induced negative correlations.

Factor Analysis Studies.

We have identified 17 published studies that used factor analysis to study the internal structure of the LSI. Most of these studies have focused on the LSI 2, have studied different kinds of samples and have used a number of different factor extraction and rotation methods and criteria for the interpretation of results. Seven of these studies supported the predicted internal structure of the LSI (Merritt and Marshall 1984, Marshall and Merritt 1985, Marshall and Merritt 1986, Katz 1986, Brew 1996, Yaha 1998, and Kayes 2005); four studies found mixed support (Loo 1996, 1999; Willcoxson and Prosser 1996; and Brew 2002); and six studies found no support (Manfredo 1989; Newstead 1992, Cornwell, Manfredo and Dunlop 1991, Geiger, Boyle, and Pinto 1992; Ruble and Stout 1990; and Wierstra and de Jong 2002).

Factor analysis of the total normative sample and subgroups follows recommendations by Yaha (1998). Principal components analysis with varimax rotation was used to extract 2 factors using the 4 primary LSI scales. Analysis at the item level was not done, since it is not the item scores but the scale scores that are proposed as operational measures of the ELT learning mode constructs. Also, the -.33 correlation among the four items in a set (resulting from the ipsative forced-choice format) makes the interpretation of item factor loadings difficult. Loo argues that the analysis by scale scores alleviates this problem. "It should be noted that factoring scale scores (i.e. Yaha 1998) rather than item scores bypasses the issue of ipsative measures when testing for the two bipolar dimensions" (1999: 216).

ELT would predict that this factor analysis procedure would produce two bipolar factors, one with AC and CE as poles and the other with AE and RO as poles. This is the result for the research university freshmen sample, the liberal arts college sample, and the research university MBA students. However, the total normative sample, the on-line users, and the distance e-learning students show a more mixed result, with the AC scale as one pole and a combination of CE and AE as the other in factor one. In factor two, RO is the dominant pole and CE and AE are the other pole. The art sample shows two different bipolar factors, with RO and CE as poles in factor one and AC and AE as poles in factor two. The percent of variance explained by the two factors is about the same in all seven analyses, with the total being between 70 and 75%—factor one 36-41% and factor two 29-35%.

Table 8. Norm Group Factor Analysis of KLSI 3.1 Scales

Sample	Factor	CE	RO	AC	AE
Total Norm	1 2	.525 .438	.053 -.998	-.988 .148	.520 .475
On-line Users	1 2	.471 .511	.056 -.996	-.991 .120	.582 .433
Research University Freshmen	1 2	.686 .116	.152 -.906	-.945 .077	.216 .760
Lib. Arts College Students	1 2	.167 -.775	-.918 .044	.041 .856	.781 -.079
Art College Undergrad	1 2	.780 .180	-.937 .021	.048 -.918	.209 .752
Research University MBA	1 2	.665 -.215	.064 .952	-.965 -.030	.339 -.694
Distance E-learning Adult UG	1 2	.512 .397	-.019 -.992	-.931 .342	.613 .333

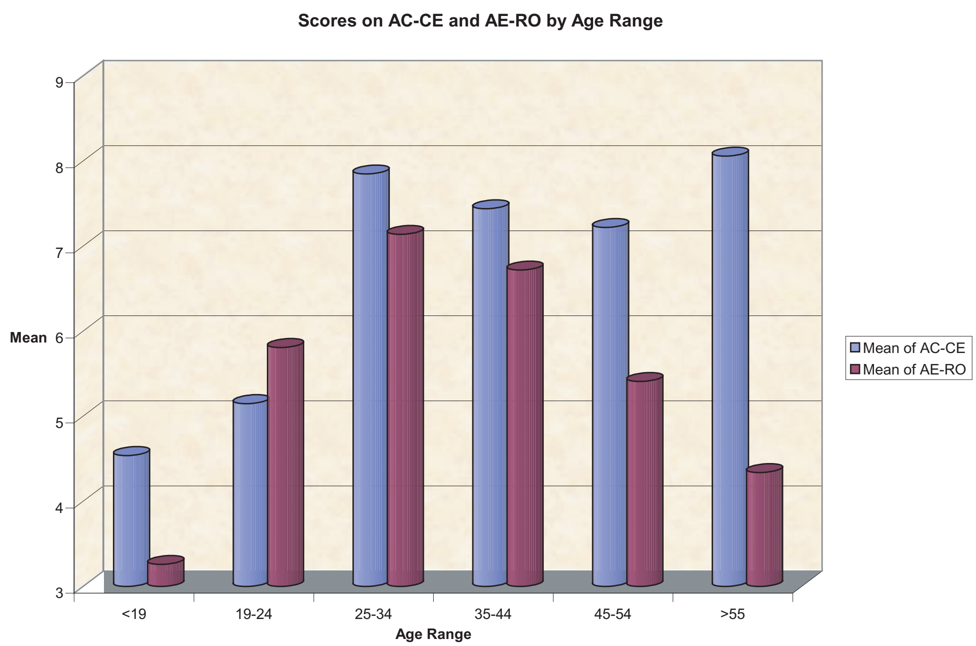
Overall the results of correlation and factor analysis studies show similar results. As Loo notes, "...with only four scale scores, factoring may be unnecessary because the factor pattern structure can be accurately estimated from an inspection of the correlation pattern among the four scales" (1999: 216). These data are consistent with previous versions of the LSI (Kolb 1976b, 1985b) and give qualified support for the ELT basis for the inventories. The support must be qualified because the higher-than-predicted negative correlations between AC and AE, and CE and RO in the KLSI 3.1 normative groups is not predicted and results in the slightly increased negative correlation between AC-CE and AE-RO and the mixed-factor analysis results for all but the research university freshmen, the liberal arts college students, and the distance e-learning sample.

EXTERNAL VALIDITY EVIDENCE

Age

Previous research with the LSI 1 showed that preference for learning by abstraction increased with age, as measured by the AC-CE scale (Kolb 1976b). Preference for learning by action showed an initial increase (up to middle age) and a subsequent decrease in later life, as measured by the AE-RO scale (Kolb 1976b). Results from the KLSI 3.1 normative sample show similar significant relationships between the combination scores and six age ranges- <19, 19-24, 25-34, 35-44, 45-54, >55 -with much larger age cohort sample sizes than the LSI 1 norm group. See Figure 3 and Appendix 2 for complete descriptive statistics and ANOVA results.

Figure 3. KLSI 3.1

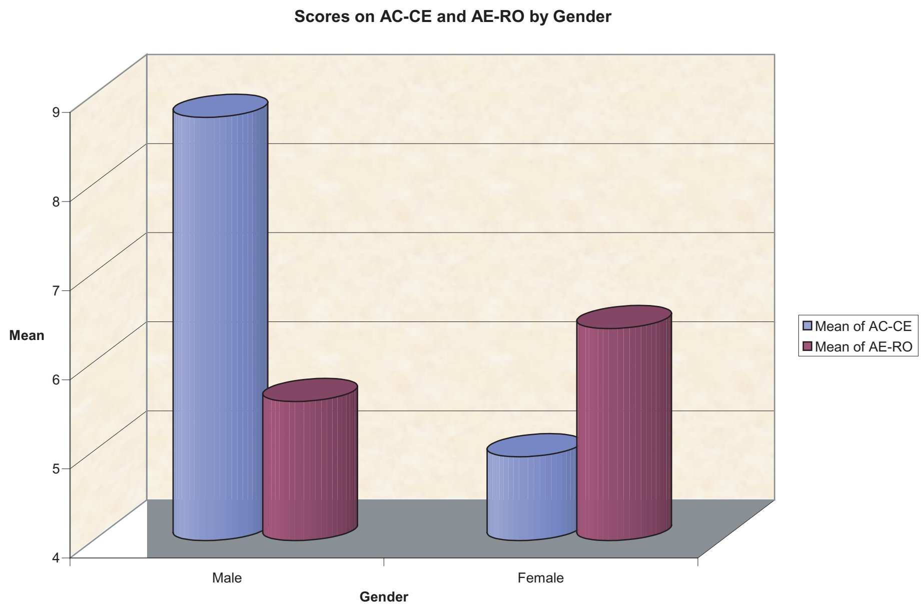


Gender

Previous research with the LSI 1 and LSI 2 normative groups showed that males were more abstract than females on the AC-CE scale and that there were no significant gender differences on the AE-RO dimension (Kolb 1976b, 1985b). Results from the KLSI 3.1 normative sample show similar significant gender differences on AC-CE and smaller but significant differences on AE-RO. See Figure 4 and Appendix 3 for complete descriptive statistics and ANOVA results. These results need to be interpreted carefully, since educational specialization and career choices often interact with gender differences, making it difficult to sort out how much variance in LSI scores can be attributed to gender alone and how much is a function of one's educational background and career (Willcoxson and Prosser 1996). Also, statements like "Women are concrete and men are abstract" are unwarranted stereotypical generalizations, since mean differences are statistically significant but there is considerable overlap between male and female distributions on AC-CE and AE-RO.

These consistent differences by gender on the LSI AC-CE scale provide a theoretical link between ELT and the classic work by Belenky et al., Women's Ways of Knowing (1986). They used gender as a marker to identify two different epistemological orientations, connected knowing and separate knowing, which their research suggested characterized women and men respectively. Connected knowing is empathetic and interpersonal and theoretically related to CE, and separate knowing emphasizes distance from others and relies on challenge and doubt, related to AC. Knight et al. (1997) tested this hypothesized relationship by developing a Knowing Styles Inventory and correlating separate and connected learning with the AC and CE scales of the LSI. They found no relationship between AC and their measure of separate knowing for men or women, and no relationship between CE and connected knowing for women. However, they did find a significant correlation between CE and connected knowing for men.

Figure 4. KLSI 3.1

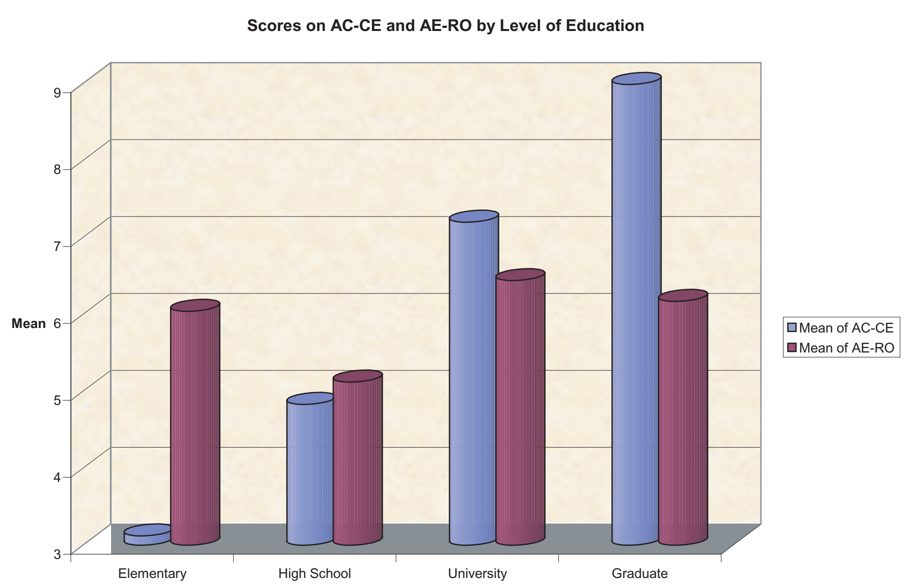


Educational Level

ELT defines two forms of knowledge. Social knowledge is based on abstract knowledge that is culturally codified in language, symbols, and artifacts. An individual's personal knowledge is based on direct uncodified concrete experience plus the level of acquired social knowledge that he or she has acquired. Hence, the theory predicts that abstractness in learning style is related to an individual's level of participation in formal education. Research relating educational level to learning style in the LSI 1 normative sample (Kolb 1976b) showed the predicted linear relationship between amount of education and abstractness. Data from the KLSI 3.1 normative sample show the same linear relationship between abstractness and level of education-from elementary to high school to university to graduate degree.

Differences among degree groups on the AE-RO dimension are smaller, with the largest difference being an increase in active orientation from high school graduates to college graduates. This is similar to results with the LSI 1 normative sample and is supported by longitudinal research that shows increasing movement in learning style from a reflective to an active orientation through the college years (Kolb & Kolb 2005a, Mentkowski and Strait 1983, Mentkowski and Associates 2000). See Figure 5 and Appendix 4 for complete descriptive statistics and ANOVA results.

Figure 5. KLSI 3.1



Educational Specialization

A corollary of the ELT definition of learning as the creation of knowledge through the transformation of experience is that different learning styles are related to different forms of knowledge. Academic disciplines differ in their knowledge structure, technologies and products, criteria for academic excellence and productivity, teaching methods, research methods, and methods for recording and portraying knowledge. Disciplines even show socio-cultural variation differences in faculty and student demographics, personality, and aptitudes, as well as differences in values and group norms. For students, education in an academic field is a continuing process of selection and socialization to the pivotal norms of the field governing criteria for truth and how it is to be achieved, communicated, and used. The resulting educational system emphasizes specialized learning and development through the accentuation of the student's skills and interests. The student's developmental process is a product of the interaction between his or her choices and socialization experiences in academic disciplines. That is, the student's dispositions lead to the choice of educational experiences that match those dispositions. And the resulting experiences further reinforce the same choice dispositions for later experiences. Over time, the socialization and specialization pressures combine to produce increasingly impermeable and homogeneous disciplinary culture, and correspondingly specialized student orientations to learning.

ELT (Kolb 1981b, 1984) provides a typology of specialized fields of study, learning styles, and forms of knowledge based on Pepper's (1942) "world hypotheses" framework. Social professions such as education and social work are typified by the accommodating learning style, a way of knowing that is based on contextualism. The science-based professions such as medicine and engineering are characterized by the converging learning style, which is based on formism. The humanities and social sciences are typified by the diverging learning style and are based on the world hypothesis of organicism. Mathematics and the natural sciences are characterized by the assimilating learning style and the world hypothesis of mechanism.

Overall, previous research with the LSI shows that student learning style distributions differ significantly by academic fields, as predicted by ELT. For example, Willcoxson and Prossor, in their review of research on learning style and educational specialization using the LSI 1, conclude that there is "some measure of agreement amongst researchers regarding the learning style preferences typically found in specified disciplines and more agreement if disciplines are subsumed under descriptions such as social sciences or humanities. It also appears as specified by experiential learning theory that learning styles may be influenced by environmental demands and thus results obtained for professionals and students in a specified discipline may be dissimilar...in all studies the reporting of a numerical majority as the predominant learning style obscures the range of styles found." (1996: 249)

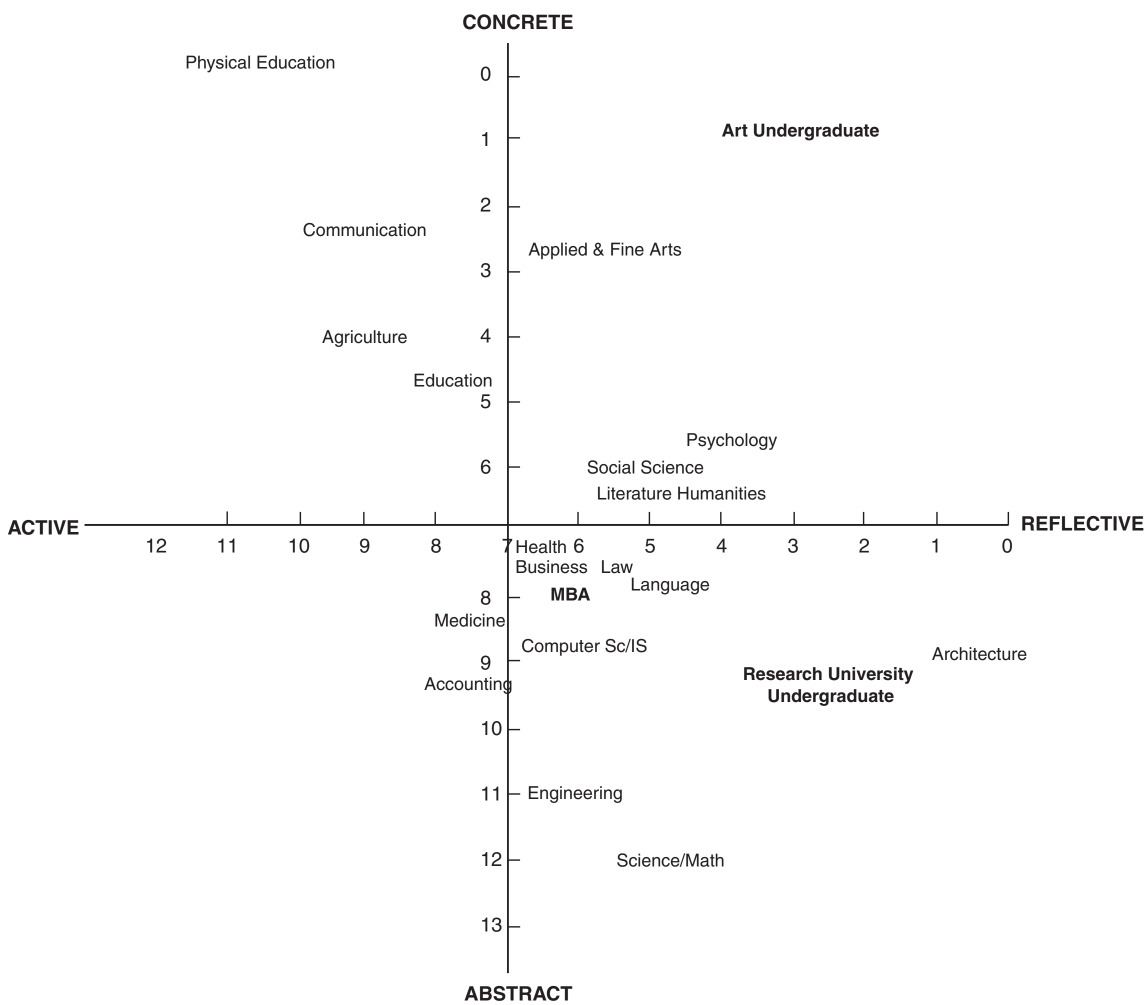
Their last point is important, since ELT does not predict that a match between an individual's learning style and the general knowledge structure of his/her chosen field is necessary for effectiveness, since learning is essential in all fields and, therefore, all learning perspectives are valuable. For example, a person in marketing with an assimilating style of learning doesn't match the typical accommodating style of marketing but, because of his or her assimilating style, may be more effective in communicating with research and development scientists (Kolb 1976).

There is considerable variation in inquiry norms and knowledge structures within some fields. Professions such as management (Loo 2002a, 2002b; Brown and Burke 1987) and medicine (Sadler et al. 1978, Plovnick 1975) are multi-disciplinary including specialties that emphasize different learning styles. Social sciences can vary greatly in their basic inquiry paradigms. In addition, fields can show variation within a given academic department, from undergraduate to graduate levels, and so on. For example, Nulty and Barrett (1996) caution that the learning style grouping should not be taken as absolute representation of a particular student population, because different teaching strategies and discourse modes may be adopted which are not traditional to that discipline. Their study also suggests that learning styles are related to the stage the students have reached in their studies. While students in the first third of their studies adopted learning styles that were similar to each other regardless of the discipline, learning styles of students in the final third of their studies tended to be related to the learning requirement of their academic major.

The distinct value systems and educational goals of each educational institution also exert significant influence on differences in students' learning styles. To investigate the relationship between the way a major is structured and student outcomes, Ishiyama and Hartlaub (2003) conducted a comparative study of student learning styles in two different political science curricular models at two universities. The results indicated that while there was no statistically significant relationship between student learning styles in underclass students, there was a significant difference in mean AC-CE scores among upperclass students between the two universities. Students taking the highly structured, concept-centered political science curriculum at Truman State University demonstrated higher abstract reasoning skills than did students enrolled in the flexible, more content-oriented major at Frostburg State University. The authors suggest that the Truman State program better facilitates the academic requirements recommended by the Association of American Colleges and Universities (AACU) to promote abstract reasoning skills and critical thinking skills necessary for the rigors of professional and graduate education than the flexible curriculum structure at Frostburg State. Other researchers and educators also contend that understanding of the distribution of learning styles in one's discipline and subspecialty is crucial for the improvement of the quality of instructional strategies that respond to the individual need of the learner, as well as the optimal level of competency and performance requirement of each profession (Baker, Simon, and Bazeli 1986; Bostrom, Olfman, and Sein 1990; Drew and Ottewill 1998; Fox and Ronkowski 1997; Kreber 2001; Laschinger 1986; McMurray 1998; Rosenthal 1999; Sandmire, Vroman, and Sanders 2000; Sims 1983).

Results from the KLSI 3.1 on-line user normative subsample show similar results to earlier research on the relationship between learning style and educational specialization. Figure 6 plots the mean scores on AC-CE and AE-RO for respondents who reported different educational specializations and for the three specialized normative subgroups (in bold). Appendix 5 shows the distribution of learning style types for each educational specialty.

Figure 6. KLSI 3.1 Scores on AC-CE and AE-RO



Other Experiential Learning Assessment Instruments

The Learning Skills Profile

The Learning Skills Profile (LSP, Boyatzis and Kolb 1991a, 1991b, 1995) was developed to assess systematically the adaptive competencies associated with learning style (Kolb 1984). The LSP uses a modified Q-sort method to assess level of skill development in four skill areas that are related to the four learning modes—Interpersonal Skills (CE), Perceptual/Information Skills (RO), Analytical Skills (AC), and Behavioral Skills (AE). Several studies have used the LSP in program evaluation (Ballou, Bowers, Boyatzis, & Kolb, 1999; Boyatzis, Cowen, and Kolb 1995) and learning needs assessment (Rainey, Hekelman, Galaska, & Kolb, 1993; Smith 1990). Yamazaki et al. (2002) studied the relationship between LSP and LSI 3.1 scores in a sample of 288 research university freshmen. AC-CE was negatively related to the interpersonal skills of leadership, relationship, and help and positively related to the analytic skills of theory building, quantitative analysis, and technology, as predicted. The AE-RO dimension did not relate to the perceptual/information skills of sense making, information gathering, and information analysis but did relate to the behavioral skills of goal setting and initiative, as predicted (see Table 9). In another study of 198 MBA students, Mainemelis et al. (2002) found similar relationships between LSI 2 scores and the LSI clusters of Interpersonal, Information, Analytic, and Behavioral learning skills (see Table 10).

Table 9. Relationship between Learning Skills Profile Scores and KLSI 3.1

	Interpersonal learning skills (CE)						Perceptual learning skills (RO)						Analytical learning skills (AC)						Behavioral learning skills (AE)					
Variables	Leadership		Relationship		Help & understanding		Sense making		Information gathering		Information analysis		Theory building		Quantitative analysis		Technology & computer		Goal setting		Action		Initiative	
	β	R^2	β	R^2	β	R^2	β	R^2	β	R^2	β	R^2	β	R^2	β	R^2	β	R^2	β	R^2	β	R^2	β	R^2
AC-CE	-.14*	.06	-.22***	.06	-.24***	.06	.06	.01	-.01	.00	.20***	.04	.30***	.10	.33***	.11	.21***	.04	.16**	.04	.03	.01	-.15**	.07
AE -RO	.19***		.08		.07		.10		.04		.07		.10		-.01		.02		.13*		.09		.22***	
F	8.27***		8.26***		9.54***		1.92		.26		6.58**		15.12***		17.18***		6.36**		6.39**		.89		11.08***	
df	2, 285		2, 285		2, 285		2, 285		2, 285		2, 285		2, 285		2, 285		2, 285		2, 285		2, 285		2, 285	

N = 288
* p < .05
** p < .01
*** p < .001

Table 10. Correlations Between LSI 2 and the Learning Skills Profile (Mainemelis et al. 2002)

N	Interpersonal /CE	Information /RO	Analytic /AC	Behavior /AE	Anal.- Interp. /AC-CE	Behav.- Info. /AE-RO
198	.31	-.14	.54	.12	.57	.23

r's> .14 p< .05, r's>.24 p<.001 two-tailed

The Adaptive Style Inventory

The Adaptive Style Inventory (ASI) was developed to assess situational variability in learning style in response to different kinds of learning task demands (Kolb 1984). It uses a paired comparison method to rank learning preferences for the four learning modes in eight personalized learning contexts. It measures adaptive flexibility in learning, the degree to which individuals systematically change learning styles to respond to different learning situations in their lives. Earlier studies found that adaptive flexibility is positively related to higher levels of ego development on Loevinger's instrument (Kolb and Wolfe 1981). Individuals with high adaptive flexibility are more self-directed, have richer life structures, and experience less conflict in their lives (Kolb 1984).

Mainemelis, Boyatzis and Kolb (2002) employed the LSI 2, the Adaptive Style Inventory (Boyatzis and Kolb 1993), and the Learning Skills Profile (LSP, Boyatzis and Kolb 1991, 1995, 1997) to test a fundamental ELT hypothesis: The more balanced people are in their learning orientation on the LSI, the greater will be their adaptive flexibility on the ASI. To assess a balanced LSI profile, two different indicators of a balanced learning profile using absolute LSI scores on the Abstract/Concrete and Active/Reflective dimensions were developed. The results supported the hypotheses showing that people with balanced learning profiles in both dimensions of the LSI are more adaptively flexible learners as measured by the ASI. The relationship was stronger for the profile balanced on the Abstract/Concrete dimension than the Active/Reflective dimension. Other results showed that individuals with specialized LSI learning styles have a greater level of skill development in the commensurate skill quadrant of the LSP. The study also produced some unexpected results. For example, while it was predicted that specialized learning styles would show less adaptive flexibility on the ASI, the results showed that this is true for the abstract learning styles but not for the concrete styles.

The ASI also produces total scores for the sum of the eight different learning contexts on the four basic learning modes. Table 11 shows the correlations between these total ASI scores and the scales of the LSI 2, indicating high concurrent validity between the two instruments.

Table 11. Correlations between LSI 2 and Adaptive Style Inventory Scale Scores

Source	N	CE	RO	AC	AE	AC-CE	AE-RO
Mainemelis *et.al.* (2002)	198	.43	.37	.49	.42	.53	.44

r's>.28 p< .001 two-tailed

The Honey-Mumford Learning Styles Questionnaire

Honey and Mumford (1982, 1992) developed the Learning Styles Questionnaire (LSQ) based on ELT with the aim to create an instrument that was phrased in the language of U.K. managers and of pragmatic value to them, not "something that was academically respectable" (1986: 5). While they based their learning styles on the learning cycle, they defined the four learning modes somewhat differently. Three of the learning modes, on the face of it, appear similar to ELT—Reflector and RO, Theorist and AC, and Pragmatist and AE—but the fourth mode, Activist and CE is not, confusing Concrete Experience and Active Experimentation. This appearance is supported by a cluster analysis and factor analysis of the LSQ by Swailes and Senior (1999) who found a three-stage learning cycle of action, reflection, and planning instead of the ELT four-stage cycle. Honey and Mumford's (1982) correlation of the LSI 1 and the LSQ is also consistent although the sample is quite small. In a larger study of undergraduate students by Sims, Veres, and Shake (1989), there was very little relationship between any of the LSI 2 and LSQ scales. Another study by Goldstein and Bokoros (1992) of 44 students and faculty found similar small correlations between the LSQ and LSI 1 and LSI 2 scales (See Table 12). They argued with some justification that the proper correspondence between the LSQ and LSI is between the LSQ scales and the LSI learning style types (eg., Activist = Accommodating) but found little evidence to support it. Only 41% were correctly classified with the LSI 1 and 29% with LSI 2. In addition, a factor analysis of the LSQ by De Ciantis and Kirton (1996) failed to support the two bipolar dimensions, AC-CE and AE-RO, predicted by ELT, as did a study by Duff and Duffy (2002). Finally, Mumford in Swailes and Senior (2001:215) stated, "the LSQ is not based upon Kolb's bi-polar structure as the academic community seems to think".

Given these results, caution should be used in equating scores from the LSI and LSQ and in interpreting LSQ research as either confirming or disconfirming ELT.

Table 12. Correlations of the Honey-Mumford Learning Styles Questionnaire with the LSI 1 and LSI 2

Source	N	LSI Version	Activist-CE	Reflector-RO	Theorist-AC	Pragmatist-AE
Honey and Mumford 1982	29	LSI 1	.23	.73	.54	.68
Sims, et al. 1989	279	LSI 2	.22***	.28***	.11*	.01
Goldstein et al. 1992	44	LSI 1 LSI 2	.23 .43**	.09 .14	.36* .23	.38* .38*

*** $p < .001$, ** $p<.01$,* $p < .05$ No sig. levels reported by Honey and Mumford

Aptitude Test Performance

Studies of the relationship between learning style and aptitude test performance have consistently found that individuals with abstract, and sometimes active, learning styles perform best on tests of this type. Boyatzis and Mainemelis (2000) found significant correlations ($p<.001$) between the total GMAT scores of MBA students and their LSI 2 scores on AC-CE (.16 for 576 full time students and .19 for part-time students) and on AC (.23 FT and . 21 PT). Data from the research university freshmen normative sample showed significant correlations ($p<.001$) between their total SAT scores and the KLSI 3.1 AC-CE (.32) and AC (.37) scales. Kolb (1976b) reported significant correlations between the LSI 1 and the LSAT for a sample of 43 law students for RO (-.29 $p< .05$) and for AC (.30 $p<.05$).

Two studies have examined the relationship between the Wonderlic test of general mental ability and the LSI. Kolb (1976b) reported data from 311 industrial managers indicating significant positive relationships between the LSI 1 AC-CE (.18 $p<.01$) and AE- RO (.24 $p<.001$) scales and Wonderlic scores. Cornwall and Manfredo (1994) studied the relationship between learning style and the Wonderlic in a group of 74 students and young working professionals. They scored the LSI 2 using a nominal scoring method and found that those whose primary learning mode was AC scored significantly higher than those with the other primary learning modes.

While some have concluded that these relationships between AC and aptitude test performance indicate that abstract persons have greater mental ability (eg., Cornwall and Manfredo 1994), it is also possible that the one-best-answer format of tests of this type is biased toward the converging learning style (See below).

Assessment of Academic Performance

A number of studies have examined the relationship between learning style, assessment method, and academic performance. While some studies show relationships between grades and the converging learning style (Rutz 2003, Boyatzis and Mainemelis 2000), other studies indicate that these learning style differences in student performance may be a function of the assessment technique used.

Lynch, Woelfl, Steele, and Hanssen explored the relationship between learning style and three different academic performance measures in a third-year surgery clerkship in a medical school. Two cohorts of third-year medical students took the United States Medical Licensing Examination step1 (USMLE 1), the National Board of Medical Examiners (NBME), and NBME computer-based case simulations (CBX). The USMLE 1 and NBME subject examination rely on a single-best-answer, multiple-choice, question format to assess performance, whereas CBX is a complex computer simulation intended to measure clinical management skills: the CBX consists of eight patient management simulations, each involving a patient with an unknown surgical problem. The simulation allows the student to obtain results of the history and physical examination, to order laboratory studies, to request radiology procedures, and to perform invasive/interventional procedures of surgeries. Beyond the presenting complaint, management is unprompted, and the student must balance the clinical evaluation with the acuity and progression of the clinical problem. Time advances during the simulation in proportion to the time necessary to perform each examination, laboratory study, or intervention (1998: 63). Of the 227 participants in the study, 102 (45%) were Converging learners, 59 (26%) Assimilating, 48 (21%) Accommodating, and 18 (8%) were Diverging learners. The result indicated that Converging and Assimilating learners scored significantly higher on the two multiple-choice performance measures, while no learning style difference was found on the CBX computer simulation. The authors concluded that the results support the Kolb (1984) and Newland and Woelfl (1992) assertions that Converging and Assimilating learners may have a performance advantage on objective, single-best-answer, multiple choice examination. They also concluded that the absence of relationships between learning style and CBX simulation suggests that multiple- choice examination and clinical case simulations measure different capabilities and achievements. Clinical management may require not only an abstract orientation supporting the acquisition, organization, and synthesis of preclinical basic science data, but also a concrete orientation involving pattern recognition and instinct. The data demonstrate the importance of evaluating learning outcomes by applying more than one type of examination format. Multiple-choice examinations favor abstract learners; however, clinical performance requires additional cognitive skills and abilities, and behaviors that are not adequately reflected in objective measures of performance.

Oughton and Reed (2000) measured the relationship between graduate students' learning styles and performance outcome in a hypermedia environment in which students were required to structurally map out their acquired knowledge and grasp the interrelationships among various ideas and concepts. The dependent measures included the number of concepts, number of nodes, number of links, number of bidirectional links, number of multiple concept nodes, number of nodes with multiple links, levels of depth, preserved concepts, omitted concepts, and added concepts on each student's map. The results showed that Assimilating and Diverging learners were the most productive on their concept maps. The authors concluded that this result can be attributed to the common traits shared by the two learning styles: the ability to see many perspectives and the ability to generate many ideas.

Holley and Jenkins (1993) examined the impact of learning style on four different accounting exam question formats: multiple-choice theory (MCT), multiple-choice quantitative (MCQ), open-ended theory (OET), and open-ended quantitative (OEQ). Their results indicated that there was a significant performance difference by learning style for all but the multiple -choice quantitative format. On the active-reflective learning style continuum, there was a significant difference in students' performance on the multiple choice theory format ($p < .01$) and the open-ended quantitative format ($p < .05$) with active students performing better. On the abstract-concrete learning style continuum, abstract students performed better on the open-ended theory format ($p < .062$). The authors concluded that students with different learning styles perform differently depending on the examination format, and that performance cannot be generalized for similar subjects if the testing format varies.

This research suggests that educators need to exercise caution in evaluating performance based on a single outcome measure. Diverse assessment strategies are required to adequately measure student overall competence and performance.

Experiential Learning in Teams

Current research, involving different methodologies and different educational and workplace populations, has shown that ELT is useful for understanding team learning and performance (Adams, Kayes, and Kolb 2005a). A number of studies support the proposition that a team is more effective if it learns from experience and emphasizes all four learning modes. Summarized below are studies of team member learning style, team roles, and team norms.

Team Member Learning Style

In the first experimental study of the effect of learning styles on team performance, Wolfe (1977) examined how homogeneous three-person teams of accommodators, divergers, assimilators, or convergers performed on a complex computer business simulation compared with heterogeneous teams. The four groups of homogeneous teams had similar performance results. However, the teams that had members with diverse learning styles performed significantly better, earning nearly twice the amount of money of the homogeneous learning style teams. Similarly, Kayes (2001) found that teams made up of members whose learning styles were balanced among the four learning modes performed at a higher level on a critical thinking task than teams whose members had specialized learning styles.

Sandmire and Boyce (2004) investigated the performance of two-person collaborative problem-solving teams in an allied health education anatomy, physiology, and pathology course. They compared a group of high abstract/high concrete student pairs with a group of abstract pairs and a group of c oncrete pairs. The abstract/concrete pairs performed significantly better on a simulated clinical case than the abstract pairs and slightly better than the concrete pairs, indicating the value of integrating the abstract and concrete dialectics of the learning cycle. However, a similar study by Sandmire, Vroman, and Sanders (2000) investigating pairs formed on the action/reflection dialectic showed no significant performance differences.

Halstead and Martin (2002) found that engineering student teams that were formed randomly to include all learning styles performed better than self-selected teams. Furthermore, in her studies of engineering students, Sharp stated, "Classroom experience shows that students can improve teamwork skills with Kolb theory by recognizing and capitalizing on their strengths, respecting all styles, sending messages in various ways, and analyzing style differences to resolve conflict and communicate effectively with team members" (2001, F2C-2). In his study of a six-week team building program, Hall (1996) reported difficulty with self-selected teams that tended to group on the basis of friendship. He advocated random team assignment, concluding, "If we had taken this approach there would have been more disagreement to work through, personality clashes to cope with and conflict to resolve. The stress would have been greater, but the learning probably more profound" (1996: 30).

Using another approach, Jackson studied the learning styles of ongoing workgroup team members who participated in a paired team competition. The exercise was designed to require teamwork skills. Results showed that teams with balanced learning styles performed better. In 17 of the 18 team pairs, the winning team's average score was higher than that of the losing team. Jackson concluded, "Designing teams that reflect the dynamic nature of team activities has great appeal in that it gives all team members a more equal opportunity to contribute and a more equal opportunity to be valued. . . . The process model advocates that different team members lead in different team activities or learning situations (2002, p. 11).

Team Roles

Park and Bang (2002) studied the performance of 52 Korean industrial work teams using the Belbin team role model, which is conceptually linked to ELT (Jackson 2002). They found that the best-performing teams were those whose members adopted at a high level all nine of Belbin's roles covering all stages of the learning cycle. They also found that teams with roles that matched the particular stage of a team's work/learning process performed best.

McMurray (1998) organized his English-as-a-foreign-language classroom using ELT principles. He divided his Japanese students into four-person teams with maximally diverse learning styles. Students were assigned to one of four roles that matched their strongest learning mode: leader (concrete experience), artist (reflective observation), writer (abstract conceptualization), and speaker (active experimentation). The leader's role was to direct classmates in completing assignments; the artist's, to create ideas for presentations; and the writer's, to compose messages for speakers to read. Class lessons were organized to include all four stages of the learning cycle. Classroom observations supported the idea that students benefited from the team role assignment and from accounting for learning style in the course design.

Gardner and Korth used ELT, learning styles, and the learning cycle to develop a course for human resource development graduate students that focused on learning to work in teams. They found strong relationships between learning styles and preference for learning methods-assimilators preferred lectures, reading, writing, and individual work, while accommodators and often divergers and convergers preferred partner and group work. They advocated providing different student roles during team learning activities to develop appreciation for, and skill in, all learning styles. "Part of the class could actively participate in a role play (accommodating), while a second group observes and provides feedback to the participants (diverging), a third group develops a model/theory from what they have seen and shares it with the class (assimilating, and the fourth group develops a plan for applying what they have seen to a new situation and shares it with the class (converging)" (1999: 32).

Team Norms

Carlsson, Keane, and Martin used the ELT learning cycle framework to analyze the biweekly reports of research and development project teams in a large consumer products corporation. Successful project teams had work process norms that supported a recursive cycling through the experiential learning cycle. Projects that deviated from this work process by skipping stages or being stuck in a stage "indicated problems deserving of management attention" (1976: 38).

Gardner and Korth used ELT to design a course in group dynamics, group development, and group effectiveness. They taught student learning teams to use the experiential learning cycle to improve the transfer of learning. They concluded, "The use of learning groups in conjunction with the experiential learning model enhances the learning process, reinforces the link between theory and practice, and facilitates the transfer of learning to the workplace" (1997: 51).

Pauleen, Marshall, and Ergort used ELT to construct and implement web-based team learning assignments in a graduate-level course in knowledge management. Students worked on projects in virtual teams. Follow-up student evaluations indicated that 75% "agreed or strongly agreed that experiential learning was a valuable way of experiencing and learning about a variety of communication channels in a team environment" (2004: 95); 99% found experiential learning to be more valuable than simply reading about something.

Two studies have explicitly examined team conversational learning spaces with norms that support the experiential learning cycle. Wyss-Flamm (2002) selected from a management assessment and development course three multicultural student teams who rated themselves as high in psychological safety, defined as the ability of the team to bring up and talk about difficult or potentially psychologically uncomfortable issues. Three of the teams rated themselves as low in psychological safety. Through intensive individual and team interviews, she analyzed the teams' semester-long experience. In teams with high psychological safety, the conversations followed a recursive experiential learning cycle: differences were experienced among team members, were examined through reflective juxtaposition that articulated learning, and culminated in either an integration of the differences or an affirmation of the contrast. Teams with low psychological safety tended to have early disturbing incidents that limited conversation and made the conversational flow more turbulent and conflict-filled. Lingham (2004) developed a questionnaire to assess the norms of conversational space in a sample of 49 educational and work teams. He found that the more the teams supported the experiential learning cycle through norms that focused their conversation on interpersonal diverging (concrete experience and reflective observation) and task-oriented converging (abstract conceptualization and active experimentation), the better they performed, the more satisfied they were with their membership on the team, and the more they felt psychologically safe to take risks on the team.

Based on the above research, a workbook of structured experiential learning exercises designed to promote team learning has been developed, *The Kolb Team Learning Experience* (Kayes, Kayes, Kolb, and Kolb 2004). The workbook program uses the experiential learning cycle and members' learning style information to help teams learn about their purpose, work process, team membership, roles, context, and action plans. Initial research on the impact of this educational intervention suggests that the program is effective in promoting team learning in educational and organizational settings (Adams, Kayes, and Kolb 2005b).

Educational Applications

The primary purpose of the LSI and ELT is to increase individuals' understanding of the process of learning from experience and their unique individual approach to learning. By providing a language for talking about learning styles and the learning process, the inventory can foster conversation among learners and educators about how to create the most effective learning environment for those involved. There have been many studies that have used ELT and the LSI in this way to improve the learning process in education. The following two sections summarize some of this work. The first section examines those studies that have used the LSI to understand and manage differences between student and faculty learning styles. The second section describes studies in a number of different disciplines that have used the experiential learning model in curriculum development. For a complete review of the applications of the LSI and ELT in higher education, see Kolb and Kolb (2006).

Managing Faculty and Student Learning Style Differences

Several studies have examined the differences between faculty and student learning styles. These studies suggest that educators need to adapt their teaching styles and instructional methods to facilitate the learning process by offering a variety of learning opportunities appropriate to different student learning styles and to different subject matters. (Baker, Simon, and Bazeli 1986; Buch and Bartley 2002; Cartney 2000).

In their study of learning style differences among pediatric residents and faculty, Kosower and Berman (1996) found that that while most residents preferred accommodating or diverging styles (81%), most faculty preferred either converging or assimilating learning strategies (73%). A longitudinal study comparing undergraduate nursing students' learning styles and faculty learning styles reported similar results: nursing students preferred concrete thinking (59%) over abstract thinking (41%), while their faculty preferred abstract thinking (82%) over concrete thinking (18%) (Kalsbeek 1989).

Kruzich, Friesen, and Soest (1986) conducted a study of student and faculty learning styles in social work at two universities and two private colleges and found significant learning style differences among undergraduate students, graduate students, field instructors, and social work faculty. Overall, faculty most often had converging learning styles, whereas the majority of graduate students and field instructors were diverging learners. The undergraduate students were mostly accommodating learners, suggesting a preference for action.

In a similar study conducted in the field of social work, Raschick, Maypole, and Day (1998) found that students whose learning styles were similar to their field supervisors along the active experimentation-reflective observation continuum would rate their field experience with them higher. The authors suggest that the finding is most relevant for the supervisors at the beginning point of the learning cycle, when matching their teaching techniques to their students' preferences presents with added benefits to encourage students to move through the rest of the learning cycle.

In their study of differences and similarities of perception of learning among internal medicine residents and faculty, White and Anderson (1995) found that one of the restraining factors that prevented learning from occurring was related to the discrepancies in what residents and faculty perceived to be the most relevant aspect of the learning process. In most situations, faculty tended to focus on abstract and reflective modes of the learning process, while residents emphasized the concrete mode of learning.

Sadler, Plovnick, and Snope (1978) report some of the difficulties of teaching in an environment in which the learning style of the faculty and the students differ. Their study suggests that faced with such a situation, instructors may be required to use instructional methods valuable to the students but not necessarily appealing or intellectually rewarding to the instructors themselves.

To help students deal with difficulties caused by faculty/student learning style differences, John Reese at the University of Denver Law School conducts "connecting with the professor" workshops in which students select one of four teaching styles, based on the four predominant learning styles, that they have difficulty connecting with. The workshop gives multiple examples of remedial actions that the learner may take to correct the misconnection created by differences in teaching/learning styles. Peer group discussions among law students give an opportunity to create new ideas about how to get the most from professors with different learning/teaching styles (Reese 1998).

Concerning whether faculty member are capable of learning to teach in ways that are incongruent with their own learning styles, Kosower and Berman argue that "because we all engage in all of the strategies to some degree, it seems to be more a matter of willingness to learn rather than ability"(1996: 217). Baker, Simon, and Bazeli (1987) contend that teaching is an art requiring the instructor to select from among a wide variety of instructional strategies to reach students with a diversity of learning preferences. Harrelson and Leaver-Dunn (2002) suggest that experiential learning requires that teachers assume a facilitator mind set, which might be a difficult mindset for some. Lipshitz (1983) underscores the complexity of the role of an experiential teacher who needs to have a firm grasp of the relevant conceptual material and also develop sensitivity and skill in managing students' emotional reactions to the learning process.

McGoldrick, Battle, and Gallagher (2000) indicate that the less control instructors exert on the students' experiences, the more effective the learning outcome will be. However, instructors may run the risk of losing control over course structure as well as failing to keep the learning activities bounded within a specific time frame. Most risks associated with the experiential method, contend the authors, can be mitigated through careful planning, unambiguous course structure, establishing of clear expectations and firm deadlines for each class activity. Furthermore, students will have varying levels of interest as well as difficulties with certain stages of the learning cycle. It is incumbent upon the instructor to grasp the diverse needs of the students and be aware of the challenges certain students will face in the various phases of the cycle. Students may also react to the shifting role of the instructors in the experiential classrooms from that of a knowledge purveyor to one who creates the learning environment and facilitates the holistic learning process. For example, November (1997) describes how difficult it was for many of his students to accept that he had a different role: "I had stopped using the textbook. Instead I used lecture time for looking at common problems or for experiential activities. Rather than being the fount of knowledge who dispensed what needed to be learned to get through this course, I had become a 'reaming facilitator.' I created the situations from which students could learn if they wished. Some students did not see this way, particularly in the early weeks of struggle, and they did not keep their views to themselves." (1997: 293)

Leonard and Harris (1979) used the knowledge of learning style in a small-group teaching and clinical supervision conducted in a primary care internal medicine residency program at the University of Minnesota. They found that knowledge of learning style can be effectively used to recognize distinct patterns of behaviors, attitudes, and reactions learners exhibit in a given learning context and thus allow the teacher to flex his or her teaching approach to fit the learner's immediate learning needs. It is also important to point out that in clinical sessions, the instructor was equally effective in creating learning situations in which students could function within the safety of their preferred learning mode but also be challenged to recognize the weaknesses associated with those learning styles.

Some studies suggest that the identification of learning strategies best suited for different learning styles may increase the learning effectiveness of each individual student and, conversely, increase students' adaptive flexibility to alter their learning styles to respond to the learning demand of a specific environment (Brenenstuhl and Catalanello1979; Curry 1999; Fritzsche 1977; Lynch, Woelfl, Steele, and Hanssen 1998). ELT posits that effective learners are able to flex their learning styles according to the demands of different learning tasks. To the extent that the individual learning preferences are respected and recognized, it is also important for the students to be exposed to diverse learning situations where their abilities and competencies can be stretched beyond the comfort of their preferred learning modes. Several studies suggest that in fact students shift their learning strategies to match the learning demands of a particular discipline (Cornett 1983, Entwistle 1981, Kolb 1984, Ornstein, 1977).

Jones, Reichard, and Mokhtari (2003) examined the extent to which community college students' learning style preferences vary as a function of discipline. They found significant differences in students' learning style preference across four different subject-area disciplines: English, math, science, and social studies. The results indicate that 83% of the 103 participants switched learning styles for two or more disciplines, suggesting that students are capable of flexing their learning strategies to respond to the discipline-specific learning requirements.

Stutsky and Laschinger (1995) examined the effect of the preceptorship experience on the learning styles, adaptive competencies, and environmental press perception of senior baccalaureate nursing students to investigate the nature of learning style/learning environment interaction in nursing education. The results, according to the authors, support Kolb's (1984) assertion that an effective learner is able to apply skills from each of the learning modes in whatever combination the learning requires. The study also suggests that students' successful learning experiences are dependent upon careful design and selection of instructional strategies that allow them to demonstrate mastery of knowledge and skills associated with each learning mode.

Lengnick-Hall and Sanders (1997) designed a learning system in the graduate and undergraduate level management courses structured around the learning cycle to give students a variety of ways to master each segment of the course material. Results indicate that despite their wide variety in learning styles, experiences, academic levels, and interests, students demonstrated consistently high levels of personal effectiveness, organizational effectiveness, ability to apply course materials, and satisfaction with both course results and learning process. The study also showed learning style differences in student ratings of various outcome measures: divergent learners rated their personal effectiveness higher than the nondivergent learners, while assimilating learners rated the lowest on the same outcome measure. Converging learners on the other hand, rated their ability to apply course material significantly higher than did the nonconverging learners, an indication of their tendency to seek out opportunities to apply what they have learned. Looking at the positive learning outcomes generated by the courses, the authors contend that high-quality learning systems are ones in which extensive individual differences are matched with a variety of options in learning methods, thus creating opportunities for student behavioral, emotional, and intellectual transformation in a lasting impact.

The Experiential Learning Model as a Guide for Curriculum Development

In this section we review studies of experiential learning methods applied in sixteen different professions and academic disciplines in higher education. The studies reported here cover a broad range of applications using ELT and the LSI. Some educators have used an experimental design to compare the effectiveness of an experiential learning method with a more traditional course format, whereas others have developed and implemented assessment methods for teacher-student interaction. While instructional strategies and methods were designed to fit the academic requirements of a specific field, many of the experiential activities reported in the studies can be broadly applied to different fields with adequate modifications.

Accounting. Siegel, Khursheed, and Agrawal (1997) conducted a controlled field experiment to test the effectiveness of video simulation as a way to integrate experiential learning theory in the teaching of auditing in their accounting course. The videotape used in the experiment followed the principles of experiential learning in teaching the fundamental steps in auditing. The experiment involved four sections of an undergraduate course in auditing. Two sections were used as control groups and two others as the experimental group. The instructor presented the videotapes at various times during the semester to the experimental group, while no videotape presentation was made to the control group. Both groups were given identical assignments, problems, and lecture material covering audit procedures and concepts. Examinations were scheduled and administered to both sections at the same time. The results of the experiment indicated significantly higher examination scores for the experimental groups, supporting the value of experiential learning for improving effectiveness in teaching auditing. In auditing courses, the authors suggest, the initial learning phase, concrete experience, is often missing from the learning process.

Specht (1991) examined the effect of an experiential learning method in student learning in an undergraduate accounting course compared with another class conducted using a traditional lecture method. The results were measured by quizzes in both classes to compare the students' knowledge of concepts, both specific and general, directly after the class and six weeks after the learning activities have taken place. The results revealed no significant differences in short-term learning between the two course formats; however, the experiential class demonstrated retention of knowledge over a six-week period, whereas a significant decrease in the scores of the lecture class was observed. The authors concluded that students in the experiential learning classroom may have formed a better understanding of the concepts, thus successfully retaining knowledge better than students in the lecture class.

In applying experiential learning in his accounting course Umapathy (1985) underscores the importance of the role of the experiential instructor for a successful adoption and implementation of experiential learning curricula. Experiential exercises have proven to be effective in generating considerable student involvement and participation in the learning process, with increased student capacity to retain knowledge for a longer period of time. However, for the experiential curricula to be effective, the instructors need to be properly trained in the design and delivery of the experiential activities, if both instructors and students are to benefit from the experience.

Business and management. Certo (1976) designed a series of experiential training activities for an undergraduate management course, based on the four dimensions of the learning cycle. In conducting those activities, the instructor assumed the role of an experiential facilitator by "encouraging high levels of student participation; creating a learning environment conducive to learn new behaviors; providing theoretical clarification; and emphasizing both content and process" (Certo 1976: 22). In a later study he further articulated the value of experiential learning as a methodology of education that focuses on the whole person and emphasizes the critical role of the facilitator as an active experiential instructor who blends, with a proper balance experience, reflection, conceptualization, and action in the classroom activities (Certo 1977).

In order to respond to mounting criticism of the inadequacy of business education Sims and Sauser (1985) proposed the experiential learning model as a theoretical basis to design management curricula intended to develop managerial competencies in business students. The authors offer seven core principles that need to be in place if such curricula are to be successfully implemented: 1) ability to face new situation and problems; 2) emphasis on both theory and practice; 3) opportunity to have a direct managerial experience; 4) relevant and reliable assessment methods; 5) effective feedback; 6) increased self-knowledge; and 7) reflection and integration as a key final step in the acquisition of competency. In designing his organizational communication course, Pace (1977) emphasized the relevance of experiential pedagogy that gives primacy to learners' experience, action, and opportunity for students to test out newly learned concepts and theories.

In their organizational behavior course McMullan and Cahoon (1979) applied Kolb's (1971) experience-based learning evaluation instrument. The Personal Application Assignment (PAA) was designed to raise student awareness of the distinct learning process involved at each step of the learning cycle. For example, students often have difficulty in differentiating objective experiences from personal reactions to those experiences. Similarly, the tendency to focus only on personally useful concepts makes it difficult for students to discriminate between abstract conceptualization and active experimentation in a given situation. By discriminating between the abstract conceptualizing and the active experimentation, students are forced to clarify the implicit assumptions and values that guide their actions. The PAA requires students to rigorously evaluate their own learning process and encourage behavioral patterns that lead to meaningful and purposeful actions. Such rigorous examination of one's learning process was foreign to most of the students and consequently frustrating to many. PAA activities made the familiar and obvious way of learning uncertain and problematic for most of them. As the authors suggest, "such a situation is ripe for learning, challenging students to move beyond the safety of their predictable and familiar ways of learning." (McMullan and Cahoon, 1979: 457).

Lipshitz (1983) designed and implemented an experiential behavioral science course in the Israeli Military Academy focused on the development of problem-solving, decision-making, and crisis-management skills in their officers. The aim was to use the experiential learning model to counter the organizational environment of the Israeli Defense Force characterized by overall "lack of proper training, job pressures such as uncertainty and overload, competitiveness coupled with high regard for results, preference of action coupled with dislike of reflection, and preference for the concrete coupled with distrust of the abstract." (Lipshitz 1983: 125) A key finding from the experiential courses was that the success of the course was largely a function of the instructor, as students' reactions ranged from enthusiasm to deep disappointment. The instructors skilled in integrating the content of the course and the learning process were able to generate high levels of satisfaction and achievement in their students. In those successful courses, there was a shift from the student tendency to analyze a case study purely in terms of its outcome to a more careful and thoughtful attention given to the problem-solving and decision-making process embedded in the case.

Gopinah and Sawyer (1999) developed a computer-based enterprise simulation based on experiential learning in a business course to bridge the gap between knowledge and its application in the business world. The results of the simulation show that the recursive nature of experiential learning promotes strategic decision making and group behavior consistent with long- term strategy.

Marketing. Dissatisfied with the application of experiential methods in business classrooms, Dyer and Schumann (1993) developed an experiential learning laboratory classroom in their marketing course. In order to create a true laboratory experience in marketing classrooms, the authors developed the Knowledge/Experience Integration Learning Model in a senior-level marketing advertising/promotion class. In this class, the text assignments and lectures were integrated with experiences generated from two types of learning tasks, multiple group projects and multiple individual case studies. The traditional performance evaluations (multiple-choice and essay exams) were eliminated altogether to give central focus to the recursive cycle of lecture, discussion, feedback, and hands-on experiences. At the completion of the course, students reported an increased level of critical thinking ability and capacity to apply and connect theoretical knowledge with real-life business application.

Education. Svinicki and Dixon (1987) published an influential paper describing a comprehensive instructional model to deal with the constraints and challenges instructors and students encounter in adopting experiential learning as an instructional design framework. The instructional design model incorporates a broad range of classroom activities that lead students through the full cycle of learning, thus presenting instructors with a rich array of instructional choices that give students a more complete learning experience gained from multiple learning perspectives. It broadened the scope of application of experiential activities to a wide range of academic fields by illustrating possible course design options suited to the learning objectives of different disciplines. Using the model, instructors are able to design their classroom activities based upon how much student involvement would be appropriate given the time constraints most instructors face. The model has been successfully applied in various academic fields such as geography (Healey and Jenkins 2000), theatre (Gressler, 2002), and political science (Brock and Cameron 1999) and affords instructors great flexibility in designing courses based on the specific educational goals, knowledge, and skill demands of their academic discipline.

As part of a counseling curriculum, Pelsma and Borgers (1986) developed an experience-based ethics course around the experiential learning cycle, with focus on the "how" rather than "what" of learning. The authors suggest that the emphasis on four modes of the cycle promotes learning and development of skills for responsible, ethical reasoning. McGlinn (2003) used experiential learning cycle in a teacher education program, emphasizing the reflective component of the cycle to overcome students' lack of reflection on their teaching. The author claims that the experiential learning model is effective in promoting change and development in students' self-knowledge about their teaching practices by providing time for reflection. Similarly, Hatcher and Bringle (1997) report the effectiveness of the learning cycle in designing reflection activities in service learning settings. Sugarman (1985) promotes the usefulness of the experiential learning model for curriculum planning, implementation, and evaluation in the counseling field. The experiential learning framework, the author contends, helps students expand their repertoire of learning skills thorough the conceptualization of the total learning process.

Nursing. Stiernborg, Zaldivar, and Santiago (1996) conducted a pre-test post-test quasi-experimental design study to assess the comparative effectiveness of didactic teaching and experiential learning in a HIV/AIDS training program for nursing students in the Philippines. The program focused on improvement of HIV/AIDS knowledge levels and attitudinal change toward HIV/AIDS patients. The authors hypothesized that experiential learning would yield significantly higher knowledge levels and favorable attitude changes in the students than didactic teaching. Three groups of nursing students participated in the study: the first group received didactic teaching in the form of lectures, while the second group had training with an experiential learning approach. Both groups included participation by a person with HIV/AIDS. The third group served as a control group and did not receive any formal HIV/AIDS training. The didactic and experiential groups covered the same content, including AIDS epidemiology, infection control, socio-ethical issues related to HIV infection, and nursing care of patients in the hospital and community. The didactic group had a two-hour presentation by the instructors, followed by a 30-minute Q & A session on the presentation. The session finished with 30 minutes with an AIDS patient. The experiential learning group had the presentation and discussion of a number of short case situations and a number of role-plays with student participation. The session ended with 30 minutes with an AIDS patient. Knowledge post-test scores indicate that both didactic and experiential learning approach produced a significant increase in the students' knowledge levels. However, the experiential learning group achieved a significantly higher knowledge level than the didactic group. While both groups reduced fear of attracting HIV (an indication of a positive attitude change), only the experiential learning group showed a consistent positive change on all attitudinal scales.

The authors concluded that the experiential learning approach was more effective than the didactic approach for knowledge acquisition in five significant ways: first, the problem-posed approach prompted students to get actively involved in the learning process through role-play. Second, it emphasized personal involvement through reflection. Third, the cases reflected the real world and encouraged integration of theory and policy and their practical applications. Fourth, the experiential learning session was flexible and learner centered. Fifth, the participation of an AIDS patient formed an integral part of the experiential learning session, whereas in the didactic session, the lecture, the Q & A session, and the patient with HIV-AIDS testimonial were separate parts with no opportunity for integration.

Medicine. Cleave-Hogg and Morgan (2002) designed an anesthesia simulation based on experiential learning for undergraduate medical students. Students reported high levels of satisfaction with the anesthesia simulation experience based on three grounds: 1) it provides opportunity to activate relevant prior knowledge and raise awareness of the gaps in their knowledge, 2) offers a learning context that closely resembles a real-life anesthesia practice, and 3) provides freedom to integrate their knowledge, to improve their skills, and to exercise their judgment without endangering a patient. The authors contend that the results of the study support the value of integrating the experiential simulation exercise in the anesthesia undergraduate curriculum.

Sandmire and Boyce (2004) investigated the performance of two-person collaborative problem-solving teams in an allied health education anatomy, physiology, and pathology course. They compared a group of high abstract/high concrete student pairs with a group of abstract pairs and a group of concrete pairs. The abstract/concrete pairs performed significantly better on a simulated clinical case than did the abstract pairs and slightly better than the concrete pairs, indicating the value of integrating the abstract and concrete dialectics of the learning cycle. However, a similar study by Sandmire, Vroman, and Sanders (2000) investigating pairs formed on the action/reflection dialectic showed no significant performance differences.

Psychiatry. Milne, James, Keegan, and Dudley developed an empirical method of assessing the effectiveness of mental health trainers' transaction patterns and their impact on student learning. The instrument, Teacher's PETS (Process Evaluation of Training and Supervision), was derived through operationalization of the experiential learning theory with the main purpose of providing empirically valid and reliable data on the trainers' behaviors during training sessions. The instrument was designed around the four dimensions of the learning cycle and "is an explicitly transactional one in which learners play an essential role in relation to the trainers, who will be at times responsive and at times proactive" (2000: 189) in any given learning situation. The key feature of the model, the authors suggest, is the fluid, dynamic transactions that occur between the levels of the model, as learners move backward and forward between different learning modes, and trainers using several methods to move the learner on to a new mode of the experiential learning cycle. The authors summarize the usefulness of the instrument to measure trainers' effective behaviors as follows:

"…the effectiveness of the trainer can be assessed functionally, in terms of the learner's mini-outcomes (a 'good' profile would show that the learner made use of all four learning modes); structurally, in terms of the trainer's use of the observed facilitating behaviors (i.e., a 'good' profile would tend to show that the leader had utilized a range of such behaviors)." (2000: 91)

The study was conducted to assess one trainer's performance in an eight-day in-service workshop on psychosocial interventions for severe mental illness held at a psychiatric hospital in the U.K. Participants in the workshop were 31 mental health professionals who were allocated to two different training groups. The workshops lasted for three months and were scheduled in four blocks of two days each. Two months elapsed between the first group's workshops and the second group's. The study was conducted in three distinct phases: a baseline phase in which the workshop leader served as his own control; intervention phase in which the leader received feedback from consultants on his performance based on the PETS instrument, followed by discussion and modeling of alternative teaching techniques; and finally, the maintenance phase in which the consultants were withdrawn from the training session. The workshop was video-taped for the duration of the study. A random selection of segments of the training was analyzed using PETS. Four baseline sample sessions, followed by two from intervention, and one from the maintenance period were selected for analysis. The relevant behaviors of the trainers and the participants were coded from the tapes. The results of the study indicate that during the baseline phase, the observed teaching method was primarily didactic in nature and accounted for the greatest impact (46.4%) on learner behavior in the reflection mode of the learning cycle, followed by smaller overall impacts on the remaining phases of the cycle (range from means of 12.2% for abstract conceptualization to 5.7% for active experimentation). In the intervention phase, by contrast, the greatest impact of the trainer's behavior on learners was on the concrete experience (59. 5%), followed by reflective observation (33%) and active experimentation (4.5%) phases of the learning cycle.

The authors conclude that the intervention phase produced trainer behaviors that promoted learners' ability to take advantage of the full range of the experiential learning cycles, thus maximizing their learning outcomes. Finally, PETS yielded a good inter-rater reliability as well as adequate empirical and concurrent validity, indicating its effectiveness as an observational instrument in educational settings. As such, PETS serves as an exemplary model for assessing and enhancing trainers' skills in mastering experiential learning methods that is applicable in diverse teaching and training situations.

Engineering. In order to revitalize the engineering education, in 1989 the College of Engineering and Technology at Brigham Young University initiated a faculty training program based on the experiential learning model (Harb, Terry, Hurt, and Williamson 1995). Volunteer faculty members were introduced to the concepts of the experiential learning model and methods of teaching to four different learning modes and asked to implement experiential methods in their courses. Volunteers were encouraged to visit each other's classes, individual teaching was videotaped for a later review, and follow-up support was offered through peer discussions about the successes and problems encountered in their teaching. The benefits of the program have been many. Several faculty members redesigned their courses to reach the full spectrum of the experiential learning cycle, using a variety of teaching strategies. Furthermore, there was a renewed interest in and enthusiasm for teaching throughout the engineering school, and students responded positively to the new learning strategies used.

The School of Engineering at Murdoch University, in Australia, decided to include a section on "understanding your learning styles" in the newly developed foundation units in the first year, with the aim of empowering students in their pursuit of university and life-long learning requirements. Due to the broad interdisciplinary nature of the foundation units, the school decided that students needed to master some fundamental meta-cognitive skills to succeed in various courses (Fowler, McGill, Armarego, and Allen 2002).

Stice argues that the low knowledge retention rate of engineering students can be attributed to the ineffective teaching methods used by most faculty in engineering courses. The most frequently used teaching methods rely heavily on abstract ideas and concepts, without providing opportunities to test the practical value of a theory. As an alternative teaching strategy, the author designed a mathematics course on differential equations to use all four stages of the learning cycle: beginning with lecture (RO); followed by the students' thinking about the ideas presented (AC); completing homework assignment (AE); and closing the cycle with demonstration (CE). At the end of the experiment, Stice concluded, "the rewards are sizeable: students learn more and derive intellectual satisfaction from the experience" (1987: 296).

Engineering educators have also paid close attention to the impact of dialectical tension created by the diverse learning-style composition of the student teams and have capitalized on the differences to broaden students' skill levels and competencies associated with learning in teams. Halstead and Martin (2002) found that student engineering teams that were formed randomly to include all learning styles performed better than self-selected teams. Furthermore, in her studies of engineering students, Sharp stated, "Classroom experience shows that students can improve teamwork skills with Kolb theory by recognizing and capitalizing on their strengths, respecting all styles, sending messages in various ways, and analyzing style differences to resolve conflict and communicate effectively with team members" (2001).

Mathematics. Travers (1998) investigated the impact of experiential learning methods on students' self-regulation of their own learning process in mathematics. The author contends that the critical difference between academically low, and high-achieving students is the capacity to self-regulate their learning by actively processing and controlling information, affect, and behavior to acquire critical knowledge and skills. The purpose of the study was to examine whether the treatment group taught mathematics through an experiential learning method demonstrated higher levels of self-regulation than the control group, which was taught mathematics through a traditional lecture format. The results indicate that the experiential learning group demonstrated a higher level of self-regulation. The difference was explained by how the two groups regulated the learning outcomes. Students in the traditional lecture format were taught rule-based learning, in which the rules given by the teacher were the only guide to deal with the new experiences. In the rule-based learning, students were given information about what to do, but not how to deal with unexpected situations when things did not work the way they expected. Students taught experientially, on the other hand, were exposed to a variety of situations from which to compare a new experience with previous ones, thus developing the ability to critically evaluate what worked and didn't work in a given learning situation.

Political Science. Building on Svinicki and Dixon model, Brock and Cameron (1999) developed instructional sequences for a political science course based on the experiential learning cycle. The authors contend that teaching to all learning modes is crucial for students' acquisition of higher-order thinking and problem-solving skills. They offer, as an illustrative example, how each phase of the cycle can be designed as a process of exploration of the experience of involvement in a political campaign. During the CE phase, students can explore their reactions about the various experiences during the election: Did they vote on policy or personality? Was the ballot clear or confusing? If discrimination and representation are key themes of the course, the instructor can encourage students to consider what role the race, gender, sexual orientation, or religion of the candidates and the voters played in the determining the outcome of the election. In the RO phase of the class, discussion, brainstorming sessions, and journals can be used to encourage reflection about the political situations or policies. The AC phase of the learning process can be devoted to intellectual modeling by the instructors in lectures. It is very important, emphasize the authors, that students observe the instructor "thinking out loud," for it is by seeing the instructor's mind at work that students learn how to think like political scientists. When instructors present only conclusions or solutions to problems, students' ability to develop higher-order thinking can be substantially diminished. Finally, in the AE phase of the learning cycle, students can be asked to project the outcome of the election in a specific district using the data generated by the polling firms or an analysis of socio-political and income profile of the target area. Next, they can track the fortunes of the parties following the development of the campaign, adjust their model, and offer final predictions on voting day. The cycle can be restarted when the election results are known (CE phase), and students are encouraged to reflect on the election outcomes (RO phase) and analyze the strength and weakness of their prediction model. The authors concluded that, while there is great merit in following the four-stage learning cycle, the purpose of the model is not to set a rigid learning pattern that takes away spontaneity and flexibility from both students and instructors.

Geography. Healey and Jenkins (2000) applied the Svinicki and Dixon model to the teaching of a geography course. In their view, two central practical applications of the experiential learning theory are relevant to different types of learning environment, be it a lecture course or a seminar-based course: 1) how a session or a whole course can be designed to take students systematically around the learning cycle, and 2) the selection of teaching methods appropriate to different stages of the cycle.

Economics. McGoldrick, Battle, and Gallagher (2000) developed a managerial economics course based on experiential methods applied to one form of service learning, student-based instruction. Service learning is an example of an experiential activity many educators have embraced as a valuable venue to link the theory and its application to the real world (Rubin 2000, Stanton and Grant 1999). While service learning creates powerful learning opportunities for students outside of the classroom it also introduces new challenges to properly assess those learning experiences and outcomes. The service learning course was aimed at engaging business students in a student-based instruction project as an opportunity for them to master some fundamental economic concepts by teaching those concepts to second- and third-grade students. The project was highly structured to respond to the high degree of coordination needed between business school faculty, economics students, and grade-school teachers. The economic students were required to form teaching groups, choose their economic topic and lesson, coordinate a teaching time and location, complete their lesson plan, turn in all required materials, and they were asked to follow a strict deadline for the completion of each component of the project. To assess the impact of student-based instruction on the economics students, each student was required to complete a two-to-five page reflective summary of his or her teaching experience, consisting of two main components: a description of the lesson and the teaching environment, a presentation of the student's opinion on the success of the project. In addition to student teahers' reflective summaries, each elementary teacher was asked to complete an evaluation form to assess the overall performance of each economics student, as well as to offer their perspective on the quality of the experience for their own students.

As an experiential activity outside the classroom, student-based instruction has a number of positive learning outcomes for business students, elementary teachers, and college faculty, concluded the authors. The students need to master the basic economic concepts as well as develop lesson plans appropriate to the intellectual level of their young audience. The elementary teachers benefit from an exposure to alternative lesson topics for teaching young children and take advantage of the resources available to support their classroom activities. The schoolchildren gain knowledge about the world in which they live through examples of the economic decision-making process drawn from the most basic aspects of everyday life. Finally, by expanding their learning activities into the real world, college professors can enrich their students' experiences in a way that cannot be replicated in the classroom. The main challenge to the student-based instruction project is the significant start-up costs involved. Still, the project is worth the effort, contend the authors, given the support that can be drawn from outside organizations and "the potential for self perpetuation once a network of local school teachers are enlisted." (McGoldrick, Battle, and Gallagher 2000: 49)

English. In her undergraduate course on Shakespeare, Rustici (1997) recounts a note one student had left in her mail box at the end of the semester: "I did want to mention that I really like the concept of experiential learning. After reading the sonnets I just had a natural impulse to want to create one of my own. The reading left a rhythm in my head that my mind naturally sought words to fill out with meaning. I am sure that this is not an uncommon experience..." The student's experience was a byproduct of the author's sonnet-writing course, which experientially guided the students through the learning cycle: Students were invited to draw upon their own personal stories, attitudes, and emotions to compose their sonnets (concrete experience); to shift their perspective from poet to critic and describe the connections between the form and content of their sonnets (reflective observation); to grasp the precise metrical and rhythmic pattern of the sonnets through the systematic planning and manipulation of symbols (abstract conceptualization); and attempt to create something unfamiliar and determine the intended effect of their sonnet (active experimentation). Expanding on Kolb's (1984) observation that "all learning is relearning... Thus one's job as an educator is not only to implant new ideas but also to dispose of or modify old ones," the author often encourages students to move beyond preconceived ideas about poetry by several forms of modeling: adopting self playful languages that students are asked to try out, employing culinary metaphors to explain "how to whip up a sonnet," and offering some of the best essays from previous semesters as a guide.

History. Sprau and Keig, contend that "for many undergraduates, history courses are inherently uninteresting and the required papers are boring"(2001:101). According to the author, students overall lack of interest in history can be attributed to the way courses are generally taught. History educators have typically relied on lectures, note taking, textbooks, tests, and term papers as the main teaching methods in the history course. What is often lacking is the mechanism that allows for students' emotional as well as intellectual engagement in the learning process. They suggest that appealing to students' hearts and their minds both deserve consideration by history teachers; teaching devoid of emotion is quite dull, not to mention virtually impossible." (2001:103)

In their attempt to create an intellectually stimulating as well as emotionally appealing learning experience, the authors introduced films in the history survey courses based on experiential learning model. Each film served as a tool for the students to distinguish between historical fact and fiction, reflect upon its themes and characters, research an issue from it, and write an analysis paper based on those reflections and research. The authors recommend that the experiential learning model can best serve the students' interests if instructors envision the learning cycle not as simple stages to be followed sequentially but as a conical structure, so that students are guided to acquire higher-order thinking skills to deal with subsequent learning experiences.

Theatre. In his book *Theatre as the Essential Liberal Art in the American University*, Gressler makes a compelling argument that theatre is the only liberal arts discipline that is almost entirely based on an experiential learning approach to education. It requires students, whether working individually or in groups, to integrate all its parts in order to communicate the end result to the audience. "Fortuitously, nearly every theatre course and production activity I can think of disallows passivity; nearly every course and activity follows the active-based, experiential learning patterns proposed by Kolb and others. For example, the acting student has 1) personal involvement with a script, 2) reflects on its meaning by searching for internal and external evidence, 3) decides logically as well as intuitively how it should be played, and 4) offers these conclusions to the class or audience. Their responses or non-responses and critiques help inform the next scene or play that student reads/and or acts. The costume design student experiences a play in a manuscript form, reflects on its meaning by investigating internal and external sources, draws logical conclusions as to the form, color, line, and texture that will most accurately reflect new and more informed perceptions, or to an audience or critic whose response indicates whether or not those conclusions were logical, acceptable, and valid." (2002: 79-80)

For those who want to adopt experiential learning methodologies in the classrooms, Gressler has one important message to share. "One caveat must be mentioned when accepting the superior quality of experiential learning methodologies: they take time. More active strategies, such as experiential learning techniques, take more time because there is more active exploration, testing, discovering, and hypothesizing. However, there are also likely to be higher retention rates, a higher degree of motivation, and more potential for integrating new ideas into the learner's store of knowledge. It seems clear that, because the modern world has made comprehension of all knowledge a useless quest, as measured by standardized tests, it may be more efficacious to study through methods that are apprehensive, as measured by motivation levels, retention levels, and integrative capabilities." (2002: 84)

Arts Education. In her book dedicated to building a bridge between art inquiry and student processes of self-understanding, Rasanen developed a model of experiential art interpretation in which students reflect and construct aesthetic meaning through an integration of art history, criticism, and aesthetics guided by the experiential learning model. The author suggests that "experiential art interpretation increases students' expressive skills and results in products that are meaningful both to their makers and others." (1997: 9)

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APPENDIX 1. KLSI 3.1 Raw Score to Percentile Conversion

Concrete Experience

Raw Score		Frequency	Percent	Valid Percent	Cumulative Percent
	12	12	.2	.2	.2
	13	56	.8	.8	1.0
	14	72	1.0	1.0	2.0
	15	103	1.5	1.5	3.5
	16	178	2.5	2.6	6.0
	17	223	3.2	3.2	9.2
	18	315	4.5	4.5	13.7
	19	342	4.8	4.9	18.6
	20	360	5.1	5.2	23.8
	21	423	6.0	6.1	29.9
	22	450	6.4	6.4	36.3
	23	468	6.6	6.7	43.0
	24	410	5.8	5.9	48.9
	25	444	6.3	6.4	55.3
	26	399	5.6	5.7	61.0
	27	368	5.2	5.3	66.3
	28	334	4.7	4.8	71.0
	29	309	4.4	4.4	75.5
	30	246	3.5	3.5	79.0
	31	234	3.3	3.4	82.4
	32	209	3.0	3.0	85.4
	33	202	2.9	2.9	88.2
	34	160	2.3	2.3	90.5
	35	131	1.9	1.9	92.4
	36	123	1.7	1.8	94.2
	37	88	1.2	1.3	95.4
	38	63	.9	.9	96.3
	39	57	.8	.8	97.2
	40	54	.8	.8	97.9
	41	40	.6	.6	98.5
	42	30	.4	.4	98.9
	43	33	.5	.5	99.4
	44	15	.2	.2	99.6
	45	12	.2	.2	99.8
	46	6	.1	.1	99.9
	47	4	.1	.1	99.9
	48	4	.1	.1	100.0
	Total	6977	98.7	100.0	
Missing	System	89	1.3		
Total		7066	100.0		

Reflective Observation

Raw Score		Frequency	Percent	Valid Percent	Cumulative Percent
	12	8	.1	.1	.1
	13	47	.7	.7	.8
	14	53	.8	.8	1.5
	15	75	1.1	1.1	2.6
	16	111	1.6	1.6	4.2
	17	130	1.8	1.9	6.1
	18	159	2.3	2.3	8.4
	19	205	2.9	2.9	11.3
	20	216	3.1	3.1	14.4
	21	288	4.1	4.1	18.5
	22	310	4.4	4.4	23.0
	23	337	4.8	4.8	27.8
	24	348	4.9	5.0	32.8
	25	365	5.2	5.2	38.0
	26	362	5.1	5.2	43.2
	27	354	5.0	5.1	48.3
	28	332	4.7	4.8	53.0
	29	350	5.0	5.0	58.0
	30	346	4.9	5.0	63.0
	31	305	4.3	4.4	67.4
	32	287	4.1	4.1	71.5
	33	305	4.3	4.4	75.9
	34	283	4.0	4.1	79.9
	35	235	3.3	3.4	83.3
	36	230	3.3	3.3	86.6
	37	188	2.7	2.7	89.3
	38	170	2.4	2.4	91.7
	39	145	2.1	2.1	93.8
	40	123	1.7	1.8	95.6
	41	93	1.3	1.3	96.9
	42	69	1.0	1.0	97.9
	43	43	.6	.6	98.5
	44	38	.5	.5	99.0
	45	29	.4	.4	99.5
	46	28	.4	.4	99.9
	47	7	.1	.1	100.0
	48	3	.0	.0	100.0
	Total	6977	98.7	100.0	
Missing	System	89	1.3		
Total		7066	100.0		

Abstract Conceptualization

Raw Score		Frequency	Percent	Valid Percent	Cumulative Percent
	12	5	.1	.1	.1
	13	8	.1	.1	.2
	14	7	.1	.1	.3
	15	16	.2	.2	.5
	16	23	.3	.3	.8
	17	33	.5	.5	1.3
	18	67	.9	1.0	2.3
	19	100	1.4	1.4	3.7
	20	107	1.5	1.5	5.2
	21	120	1.7	1.7	7.0
	22	177	2.5	2.5	9.5
	23	201	2.8	2.9	12.4
	24	243	3.4	3.5	15.9
	25	245	3.5	3.5	19.4
	26	287	4.1	4.1	23.5
	27	301	4.3	4.3	27.8
	28	313	4.4	4.5	32.3
	29	334	4.7	4.8	37.1
	30	351	5.0	5.0	42.1
	31	335	4.7	4.8	46.9
	32	352	5.0	5.0	52.0
	33	351	5.0	5.0	57.0
	34	315	4.5	4.5	61.5
	35	351	5.0	5.0	66.5
	36	290	4.1	4.2	70.7
	37	280	4.0	4.0	74.7
	38	271	3.8	3.9	78.6
	39	251	3.6	3.6	82.2
	40	225	3.2	3.2	85.4
	41	201	2.8	2.9	88.3
	42	173	2.4	2.5	90.8
	43	144	2.0	2.1	92.8
	44	131	1.9	1.9	94.7
	45	114	1.6	1.6	96.3
	46	110	1.6	1.6	97.9
	47	84	1.2	1.2	99.1
	48	61	.9	.9	100.0
	Total	6977	98.7	100.0	
Missing	System	89	1.3		
Total		7066	100.0		

Active Experimentation

Raw Score		Frequency	Percent	Valid Percent	Cumulative Percent
	12	2	.0	.0	.0
	13	1	.0	.0	.0
	14	8	.1	.1	.2
	15	15	.2	.2	.4
	16	10	.1	.1	.5
	17	16	.2	.2	.7
	18	19	.3	.3	1.0
	19	51	.7	.7	1.7
	20	52	.7	.7	2.5
	21	98	1.4	1.4	3.9
	22	105	1.5	1.5	5.4
	23	114	1.6	1.6	7.0
	24	139	2.0	2.0	9.0
	25	150	2.1	2.1	11.2
	26	195	2.8	2.8	14.0
	27	238	3.4	3.4	17.4
	28	228	3.2	3.3	20.7
	29	282	4.0	4.0	24.7
	30	308	4.4	4.4	29.1
	31	333	4.7	4.8	33.9
	32	328	4.6	4.7	38.6
	33	317	4.5	4.5	43.1
	34	386	5.5	5.5	48.7
	35	418	5.9	6.0	54.7
	36	431	6.1	6.2	60.8
	37	370	5.2	5.3	66.1
	38	357	5.1	5.1	71.2
	39	360	5.1	5.2	76.4
	40	342	4.8	4.9	81.3
	41	312	4.4	4.5	85.8
	42	282	4.0	4.0	89.8
	43	241	3.4	3.5	93.3
	44	183	2.6	2.6	95.9
	45	148	2.1	2.1	98.0
	46	77	1.1	1.1	99.1
	47	46	.7	.7	99.8
	48	15	.2	.2	100.0
	Total	6977	98.7	100.0	
Missing	System	89	1.3		
Total		7066	100.0		

Abstract Conceptualization – Concrete Experience

Raw Score	Frequency	Percent	Valid Percent	Cumulative Percent
-35	1	.0	.0	.0
-31	1	.0	.0	.0
-30	2	.0	.0	.1
-29	1	.0	.0	.1
-28	3	.0	.0	.1
-27	6	.1	.1	.2
-26	5	.1	.1	.3
-25	7	.1	.1	.4
-24	10	.1	.1	.5
-23	12	.2	.2	.7
-22	20	.3	.3	1.0
-21	12	.2	.2	1.1
-20	19	.3	.3	1.4
-19	23	.3	.3	1.7
-18	31	.4	.4	2.2
-17	32	.5	.5	2.7
-16	36	.5	.5	3.2
-15	53	.8	.8	3.9
-14	54	.8	.8	4.7
-13	65	.9	.9	5.6
-12	81	1.1	1.2	6.8
-11	73	1.0	1.0	7.8
-10	86	1.2	1.2	9.1
-9	87	1.2	1.2	10.3
-8	114	1.6	1.6	12.0
-7	121	1.7	1.7	13.7
-6	131	1.9	1.9	15.6
-5	129	1.8	1.8	17.4
-4	162	2.3	2.3	19.7
-3	140	2.0	2.0	21.7
-2	165	2.3	2.4	24.1
-1	186	2.6	2.7	26.8
0	179	2.5	2.6	29.3
1	210	3.0	3.0	32.4
2	218	3.1	3.1	35.5
3	193	2.7	2.8	38.2
4	213	3.0	3.1	41.3
5	192	2.7	2.8	44.1

Raw Score		Frequency	Percent	Valid Percent	Cumulative Percent
	6	243	3.4	3.5	47.5
	7	206	2.9	3.0	50.5
	8	220	3.1	3.2	53.6
	9	225	3.2	3.2	56.9
	10	234	3.3	3.4	60.2
	11	216	3.1	3.1	63.3
	12	228	3.2	3.3	66.6
	13	231	3.3	3.3	69.9
	14	192	2.7	2.8	72.6
	15	197	2.8	2.8	75.5
	16	171	2.4	2.5	77.9
	17	149	2.1	2.1	80.1
	18	176	2.5	2.5	82.6
	19	181	2.6	2.6	85.2
	20	162	2.3	2.3	87.5
	21	133	1.9	1.9	89.4
	22	123	1.7	1.8	91.2
	23	118	1.7	1.7	92.9
	24	89	1.3	1.3	94.1
	25	90	1.3	1.3	95.4
	26	71	1.0	1.0	96.4
	27	64	.9	.9	97.4
	28	58	.8	.8	98.2
	29	29	.4	.4	98.6
	30	30	.4	.4	99.0
	31	19	.3	.3	99.3
	32	17	.2	.2	99.6
	33	15	.2	.2	99.8
	34	11	.2	.2	99.9
	35	3	.0	.0	100.0
	36	2	.0	.0	100.0
	Total	6976	98.7	100.0	
Missing	System	90	1.3		
Total		7066	100.0		

Active Experimentation – Reflective Observation

Raw Score		Frequency	Percent	Valid Percent	Cumulative Percent
	-32	1	.0	.0	..0
	-28	3	.0	.0	..1
	-27	2	.0	.0	..1
	-25	5	.1	.1	..2
	-24	2	.0	.0	..2
	-23	19	.3	.3	..5
	-22	17	.2	.2	..7
	-21	19	.3	.3	1.0
	-20	32	.5	.5	1.4
	-19	28	.4	.4	1.8
	-18	40	.6	.6	2.4
	-17	40	.6	.6	3.0
	-16	37	.5	.5	3.5
	-15	63	.9	.9	4.4
	-14	77	1.1	1.1	5.5
	-13	89	1.3	1.3	6.8
	-12	92	1.3	1.3	8.1
	-11	89	1.3	1.3	9.4
	-10	119	1.7	1.7	11.1
	-9	114	1.6	1.6	12.7
	-8	127	1.8	1.8	14.5
	-7	148	2.1	2.1	16.7
	-6	138	2.0	2.0	18.6
	-5	137	1.9	2.0	20.6
	-4	156	2.2	2.2	22.8
	-3	168	2.4	2.4	25.3
	-2	169	2.4	2.4	27.7
	-1	155	2.2	2.2	29.9
	0	175	2.5	2.5	32.4
	1	171	2.4	2.5	34.9
	2	196	2.8	2.8	37.7
	3	170	2.4	2.4	40.1
	4	200	2.8	2.9	43.0
	5	228	3.2	3.3	46.2
	6	196	2.8	2.8	49.0

Raw Score		Frequency	Percent	Valid Percent	Cumulative Percent
	7	209	3.0	3.0	52.0
	8	224	3.2	3.2	55.3
	9	214	3.0	3.1	58.3
	10	233	3.3	3.3	61.7
	11	214	3.0	3.1	64.7
	12	222	3.1	3.2	67.9
	13	192	2.7	2.8	70.7
	14	199	2.8	2.9	73.5
	15	209	3.0	3.0	76.5
	16	211	3.0	3.0	79.5
	17	184	2.6	2.6	82.2
	18	194	2.7	2.8	85.0
	19	155	2.2	2.2	87.2
	20	143	2.0	2.0	89.2
	21	147	2.1	2.1	91.3
	22	163	2.3	2.3	93.7
	23	104	1.5	1.5	95.2
	24	78	1.1	1.1	96.3
	25	64	.9	.9	97.2
	26	63	.9	.9	98.1
	27	39	.6	.6	98.7
	28	32	.5	.5	99.1
	29	25	.4	.4	99.5
	30	15	.2	.2	99.7
	31	6	.1	.1	99.8
	32	8	.1	.1	99.9
	33	7	.1	.1	100.0
	35	1	.0	.0	100.0
	Total	6977	98.7	100.0	
Missing	System	89	1.3		
Total		7066	100.0		

APPENDIX 2. Learning Style and Age

Age Range		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
						Lower Bound	Upper Bound
Concrete	<19	631	26.23	6.882	.274	25.69	26.77
	19-24	1155	25.66	6.484	.191	25.28	26.03
	25-34	1839	24.74	6.017	.140	24.47	25.02
	35-44	1573	25.22	6.237	.157	24.91	25.53
	45-54	1171	25.66	6.665	.195	25.28	26.04
	>55	398	26.13	7.219	.362	25.42	26.84
	Total	6767	25.39	6.437	.078	25.24	25.54
Reflective	<19	631	29.79	7.046	.281	29.24	30.34
	19-24	1155	28.84	7.285	.214	28.41	29.26
	25-34	1839	27.73	7.180	.167	27.40	28.06
	35-44	1573	27.68	6.790	.171	27.35	28.02
	45-54	1171	28.02	6.959	.203	27.62	28.42
	>55	398	27.67	7.030	.352	26.98	28.37
	Total	6767	28.15	7.079	.086	27.98	28.32
Abstract	<19	631	30.80	7.153	.285	30.24	31.36
	19-24	1155	30.83	6.958	.205	30.43	31.23
	25-34	1839	32.59	7.178	.167	32.27	32.92
	35-44	1573	32.66	7.356	.185	32.30	33.02
	45-54	1171	32.87	7.428	.217	32.45	33.30
	>55	398	34.19	7.663	.384	33.43	34.94
	Total	6767	32.28	7.313	.089	32.11	32.46

Active	<19	631	33.08	6.452	.257	32.57	33.58
	19-24	1155	34.62	6.542	.192	34.24	35.00
	25-34	1839	34.87	6.415	.150	34.57	35.16
	35-44	1573	34.40	6.768	.171	34.06	34.73
	45-54	1171	33.43	6.866	.201	33.04	33.82
	>55	398	32.01	6.482	.325	31.37	32.65
	Total	6767	34.13	6.654	.081	33.97	34.29
AC-CE	<19	631	4.54	11.922	.475	3.61	5.47
	19-24	1154	5.15	11.162	.329	4.51	5.80
	25-34	1839	7.85	11.188	.261	7.34	8.36
	35-44	1573	7.44	11.715	.295	6.86	8.02
	45-54	1171	7.22	12.163	.355	6.52	7.91
	>55	398	8.06	12.763	.640	6.80	9.31
	Total	6766	6.89	11.703	.142	6.61	7.17
AE-RO	<19	631	3.26	11.409	.454	2.36	4.15
	19-24	1155	5.81	11.649	.343	5.14	6.48
	25-34	1839	7.14	11.601	.271	6.60	7.67
	35-44	1573	6.72	11.580	.292	6.15	7.29
	45-54	1171	5.41	11.831	.346	4.73	6.09
	>55	398	4.34	11.139	.558	3.24	5.43
	Total	6767	5.99	11.656	.142	5.71	6.27

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
	Between Groups	1647.824	5	329.565	7.995	..000
	Within Groups	278696.69	6761	41.221		
	Total	280344.51	6766			
	Between Groups	3019.612	5	603.922	12.152	..000
	Within Groups	336016.02	6761	49.699		
	Total	339035.63	6766			
	Between Groups	6085.709	5	1217.142	23.133	..000
	Within Groups	355729.44	6761	52.615		
	Total	361815.15	6766			
	Between Groups	4448.907	5	889.781	20.387	..000
	Within Groups	295080.66	6761	43.645		
	Total	299529.56	6766			
	Between Groups	9818.528	5	1963.706	14.480	..000
	Within Groups	916731.00	6760	135.611		
	Total	926549.52	6765			
	Between Groups	9489.806	5	1897.961	14.104	..000
	Within Groups	909809.15	6761	134.567		
	Total	919298.95	6766			

APPENDIX 3. Learning Style and Gender

Descriptives

Gender		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
						Lower Bound	Upper Bound
Concrete	M	3134	24.70	6.252	.112	24.48	24.92
	F	3203	26.04	6.525	.115	25.82	26.27
	Total	6337	25.38	6.426	.081	25.22	25.54
Reflective	M	3134	28.11	6.782	.121	27.87	28.35
	F	3203	28.29	7.357	.130	28.03	28.54
	Total	6337	28.20	7.079	.089	28.02	28.37
Abstract	M	3134	33.45	7.241	.129	33.20	33.71
	F	3203	31.00	7.133	.126	30.75	31.24
	Total	6337	32.21	7.290	.092	32.03	32.39
Active	M	3134	33.67	6.660	.119	33.44	33.91
	F	3203	34.65	6.584	.116	34.42	34.88
	Total	6337	34.17	6.639	.083	34.00	34.33
AC-CE	M	3134	8.75	11.548	.206	8.35	9.16
	F	3202	4.94	11.477	.203	4.55	5.34
	Total	6336	6.83	11.668	.147	6.54	7.12
AE-RO	M	3134	5.56	11.438	.204	5.15	5.96
	F	3203	6.38	11.836	.209	5.97	6.79
	Total	6337	5.97	11.647	.146	5.68	6.26

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
	Between Groups	2872.164	1	2872.164	70.314	..000
	Within Groups	258769.956	6335	40.848		
	Total	261642.119	6336			
	Between Groups	49.364	1	49.364	.985	..321
	Within Groups	317430.710	6335	50.107		
	Total	317480.074	6336			
	Between Groups	9568.749	1	9568.749	185.273	..000
	Within Groups	327182.431	6335	51.647		
	Total	336751.180	6336			
	Between Groups	1511.274	1	1511.274	34.466	..000
	Within Groups	277778.087	6335	43.848		
	Total	279289.361	6336			
	Between Groups	22993.472	1	22993.472	173.499	..000
	Within Groups	839434.413	6334	132.528		
	Total	862427.885	6335			
	Between Groups	1070.165	1	1070.165	7.897	..005
	Within Groups	858488.492	6335	135.515		
	Total	859558.657	6336			

APPENDIX 4. Learning Style and Educational Level

Educational Level		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
Highest Degree						Lower Bound	Upper Bound
Concrete	Elem.	83	25.77	6.554	.719	24.34	27.20
	H. S.	2078	26.08	6.397	.140	25.80	26.35
	Univ.	2756	25.08	6.316	.120	24.85	25.32
	Grad.	1688	25.15	6.649	.162	24.83	25.47
	Total	6605	25.42	6.445	.079	25.27	25.58
Reflective	Elem.	83	29.65	7.440	.817	28.03	31.28
	H. S.	2078	28.88	7.062	.155	28.58	29.19
	Univ.	2756	28.09	7.014	.134	27.83	28.36
	Grad.	1688	27.27	7.044	.171	26.94	27.61
	Total	6605	28.15	7.069	.087	27.98	28.32
Abstract	Elem.	83	28.89	6.847	.752	27.40	30.39
	H. S.	2078	30.91	7.160	.157	30.60	31.22
	Univ.	2756	32.29	7.324	.140	32.02	32.57
	Grad.	1688	34.14	7.214	.176	33.80	34.48
	Total	6605	32.29	7.348	.090	32.11	32.46
Active	Elem.	83	35.69	6.802	.747	34.20	37.17
	H. S.	2078	34.00	6.505	.143	33.72	34.28
	Univ.	2756	34.52	6.602	.126	34.27	34.77
	Grad.	1688	33.44	6.815	.166	33.11	33.76
	Total	6605	34.10	6.644	.082	33.94	34.26
AC-CE	Elem.	83	3.12	11.460	1.258	..62	5.62
	H. S.	2078	4.83	11.447	.251	4.34	5.32
	Univ.	2755	7.20	11.679	.223	6.77	7.64
	Grad.	1688	8.99	11.827	.288	8.43	9.55
	Total	6604	6.86	11.754	.145	6.58	7.14
AE-RO	Elem.	83	6.04	12.445	1.366	3.32	8.75
	H. S.	2078	5.12	11.448	.251	4.63	5.61
	Univ.	2756	6.44	11.610	.221	6.00	6.87
	Grad.	1688	6.17	11.813	.288	5.60	6.73
	Total	6605	5.95	11.634	.143	5.67	6.23

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
	Between Groups	1340.678	3	446.893	10.806	..000
	Within Groups	272997.555	6601	41.357		
	Total	274338.233	6604			
	Between Groups	2611.000	3	870.333	17.548	..000
	Within Groups	327386.205	6601	49.596		
	Total	329997.205	6604			
	Between Groups	10701.061	3	3567.020	68.073	..000
	Within Groups	345892.256	6601	52.400		
	Total	356593.317	6604			
	Between Groups	1458.381	3	486.127	11.062	..000
	Within Groups	290091.955	6601	43.947		
	Total	291550.336	6604			
	Between Groups	17716.736	3	5905.579	43.571	..000
	Within Groups	894552.211	6600	135.538		
	Total	912268.947	6603			
	Between Groups	2169.205	3	723.068	5.353	..001
	Within Groups	891650.670	6601	135.078		
	Total	893819.875	6604			

APPENDIX 5. Learning Style Type and Educational Specialization

EDUCATIONAL SPECIALIZATION			LEARNING STYLE TYPE				Total
			Accom.	Diverge	Converge	Assim.	
	Accounting	Count	39	26	42	42	149
		%	26.2%	17.4%	28.2%	28.2%	100.0%
	Architecture	Count	2	0	1	4	7
		%	28.6%	.0%	14.3%	57.1%	100.0%
	Business	Count	290	165	215	259	929
		%	31.2%	17.8%	23.1%	27.9%	100.0%
		Count	54	17	20	19	110
		%	49.1%	15.5%	18.2%	17.3%	100.0%
	Computer Sci./IS	Count	54	35	55	62	206
		%	26.2%	17.0%	26.7%	30.1%	100.0%
	Education	Count	92	46	41	61	240
		%	38.3%	19.2%	17.1%	25.4%	100.0%
	Engineering	Count	103	50	145	138	436
		%	23.6%	11.5%	33.3%	31.7%	100.0%
	App. & Fine Arts	Count	23	20	12	20	75
		%	30.7%	26.7%	16.0%	26.7%	100.0%
	Health	Count	82	48	59	72	261
		%	31.4%	18.4%	22.6%	27.6%	100.0%
	Humanities	Count	28	24	19	40	111
		%	25.2%	21.6%	17.1%	36.0%	100.0%
	Language	Count	8	4	5	9	26
		%	30.8%	15.4%	19.2%	34.6%	100.0%
	Law	Count	29	16	23	42	110
		%	26.4%	14.5%	20.9%	38.2%	100.0%
	Literature	Count	5	15	8	10	38
		%	13.2%	39.5%	21.1%	26.3%	100.0%
	Medicine	Count	88	50	96	82	316
		%	27.8%	15.8%	30.4%	25.9%	100.0%
	Other	Count	301	213	185	248	947
		%	31.8%	22.5%	19.5%	26.2%	100.0%
	Phys. Education	Count	12	5	3	4	24
		%	50.0%	20.8%	12.5%	16.7%	100.0%
	Psychology	Count	53	40	15	52	160
		%	33.1%	25.0%	9.4%	32.5%	100.0%
	Science/Math	Count	53	35	88	110	286
		%	18.5%	12.2%	30.8%	38.5%	100.0%
	Social Sciences	Count	68	51	38	72	229
		%	29.7%	22.3%	16.6%	31.4%	100.0%
	Agriculture	Count	6	6	6	1	19
		%	31.6%	31.6%	31.6%	5.3%	100.0%
Total		Count	1390	866	1076	1347	4679
		%	29.7%	18.5%	23.0%	28.8%	100.0%

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