PEER-LED TEAM LEARNING
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LEARNING STYLES INSTRUMENTS IN A COLLEGE INTRODUCTORY CHEMISTRY COURSE:

AN EXAMINATION OF THE USE OF THE KOLB LEARNING STYLES INVENTORY AND THE GREGORC LEARNING STYLE DELINEATOR

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Introduction

When a student fails to perform well in a college lecture course, a reason may be that there is a "mismatch between the learning styles of faculty and today's students" (Schroeder, 1993). Felder and Silverman(1988) observed that "Mismatches exist between common learning styles of engineering students and traditional teachingstyles of engineering professors. In consequence, students become bored and inattentive in class, do poorly on tests, get discouraged about the courses, the curriculum, and themselves, and in some cases change to other curricula or drop out of school" (p. 674).What is a "learning style" and how do two "learning style instruments" compare in telling us about students' styles?

What is a learning style?

The National Association of Secondary School Principals defined learning styles as "the composite of characteristic cognitive, affective, and physiological factors that serve as relatively stable indicators of how a learner perceives, interacts with, and responds to the learning environment"(quoted by Griggs, 1991). Defining learning styles, which involves cognition, conceptualization, affect, and behavior (Hainer, et al., 1990) suggests that it is not surprising that various learning styles models exist. Hainer et al. (1990) visualized "processes on a continuum" to examine approaches to learning style; "rather than being mutually exclusive, each approach represents a different way of viewing complex phenomena." Curry (1987) visualized the "onion model" to describe four major dimensions of learning styles, inherent in any individual. These include 1) personality dimensions, such as explored through the Myers-Briggs Type Indicator; 2) cognitive processing, such as Kolb's (1984) model of information processing; 3) social interaction, which addresses how students interact in the classroom, such as Reichmann's and Grasha's (1974) model; and 4) preferential learning environments, such as Human Information Processing model (Keefe, 1989), the Learning Style Model of Dunn and Dunn (1978), or Gordon's (1998) focus on environmental factors such as noise, light, or seating arrangements.

Individuals' primary mode of receiving information, such as visual, verbal/auditory, or kinesthetic, are also called "learning styles." Felder and Soloman(2004) include the dichotomous terms "sequential" or "global" among their four pairs of terms on the Inventory of Learning Styles (ILS). Others have aimed to reflect on learning as a pathway for personal meaning, and a learning style may be the way an individual combines cognitive processes, perceptual modalities, and sociological elements (Tendy & Geiser, 1997).

Learning Styles Research

Curry (1990) noted three major problems facing the learning style concept: (1) confusion in definitions, (2) weakness in reliability and validity, and (3) the identification of relevant characters in instructional settings. Learning styles research often confuses sensory with cognitive, personality and cultural differences.

A lack of research base for some of the learning styles models, and a range of quality among the assessment instruments that operationalize the various models make learning styles research suspect to some (Griggs, 1991). Irvine (1995) notes that the concept of learning styles is complicated: "Although an individual responds to educational experiences with consistent behavior and performance patterns, the complexity of the educational construct, the psychometric problems related to its measurement, and the enigmatic relationship between culture and the teaching and learning process means that the body of research on learning styles must be interpreted and applied carefully." Sewall (1986) addressed the issue of whether four learning styles instruments available then are "of sufficient psychometric quality to warrant their continued use for research or educational purposes." Among the four instruments reviewed, "which purport to measure learning styles," were the Kolb Learning Style Inventory, and the Gregorc Style Delineator. Criteria for selection were based in part on the frequency of references in the professional literature.

Research Setting

Urban commuter colleges, whether two or four-year, often have student bodies that reflect the diversity of the population of the cities in which they are located. The City College of New York, founded in 1847, is an urban commuter college of 15,000 students (2009-2010). The flagship senior college of the City University of New York (CUNY) system, it attracts students interested in science and engineering, having the only engineering school in the CUNY system. Students are pre-selected by their choice of majors, that is, to study engineering to obtain a Bachelor's degree in the CUNY system, a student would have to attend City College. Science and engineering majors at City College are required to take an introductory chemistry course.

How do two learning styles test instruments, the Kolb Learning Style Inventory, and the Gregorc Style Delineator, compare in determining the learning styles of college introductory chemistry students?

Kolb's Learning Style Inventory

David Kolb's LSI is based on his Experiential Learning Theory, which posits that all learning depends on how experience is processed; the theory derives from the works of John Dewey, Kurt Lewin, Carl Jung, Jean Piaget and Lev Vygotsky (Kolb, 1984). Learning begins with experience, continues with reflection and later leads to action, which itself becomes a concrete experience for reflection. Kolb's Learning Styles Instrument examines "cognitive styles," which are intrinsic information-processing patterns that represent a person's typical model of perceiving, thinking, remembering, and problem-solving.

Instrument: The Learning Style Inventory consists of twelve sentences with a choice of endings. The endings are to be ranked by how well the respondent thinks each one fits with how the respondent learns; the instrument ask for self-assessment, and uses a ranking system: 1 for "least true" and 4 for "most true." No scoring tie is allowed. The numerical answers form a kite-shape as four learning modes are charted: concrete experience (CE), reflective observation (RO), abstract conceptualization (AC), and active experimentation(AE). The numerical values are then graphed into a quadrant, to yield a learning style, termed Diverging (upper right), Assimilating (lower right), Converging (lower left), and Accommodating (upper left). The learning styles are described below.

Diverging (feeling and watching - CE/RO) – The Diverging learning preference is for people who are sensitive and are able to look at things from different perspectives. They prefer to observe rather than do, tend to gather information and be imaginative in solving problems. These people prefer to work in groups and to listen to others.

Assimilating (watching and thinking - AC/RO) – People with an Assimilating learning style are concise and logical in their approach. These people are more interested in ideas and abstract concepts and less concerned with people. They prefer lectures, exploring analytical models, and experimenting with ideas.

Converging (doing and thinking - AC/AE) – The Converging learners are problem solvers and will use their learning to find solutions to practical issues. They are interested in technical tasks, and are less focused on people and interpersonal aspects. People with a Converging learning preference like to experiment with new ideas and work with practical applications.

Accommodating (doing and feeling - CE/AE) - The Accommodating learners prefer 'hands-on' experiences, and relies on intuition rather than logic. These people are attracted to challenges and tend to rely on others for information to carry out their plans. They tend to work in teams, set targets, and find different ways to achieve their goals(Smith and Kolb, 1992).

The Kolb LSI has been used extensively to measure populations engaged in various disciplines. Among these are Algee and Bowers' (1993) study of Asian and American seminary students, and Smedley's (1987) study of members of the American Chemical Society (they tended to be Convergers).

Investigators using the Kolb LSI have found significant relationships between learning style and field of study of specialization (Kolb, 1984) as well as career choice, level of social adaptation and performance. Certain majors predominate in particular learning styles: engineers tend to be Convergers, and chemistry majors tend to be Assimilators; natural science majors in the fields of medicine, biology, physical science, and mathematics tend to be either Convergers or Assimilators. Kolb (1993, quoted by Cook, 1997) found that various disciplines and fields have preferred learning styles that match what is expected in the particular profession. "Yet half of students in these majors are pursuing professions where their learning style is not preferred. Perhaps the large proportion of students who drop out of the biology and premed/dental program are mismatched with the desired learning styles of the profession that they are pursuing" (Cook, 1997).

<u>The Gregorc Style Delineator</u>

Anthony Gregorc (1982) proposed that individuals mentally process material in one of four ways through learning channels. "The particular channel though which one processes material is revealed through observable behaviors that indicate the individual's learning style. …Perception abilities are the means through which one grasps information or perceives the environment. Ordering abilities refer to the systematic way information is arranged and released through the mind channels. Two bipolar concepts of perception are abstract and concrete. Two bipolar concepts of ordering are sequence and randomness" (Gregorc, 1984).

Combining the concepts of perception and ordering leads to four types of learners:

Concrete Sequential – People who have a Concrete Sequential learning style prefer hands-on activities, tactile methods, real world examples, and detailed instructions.

Concrete Random –Concrete Random learners prefer a trial-and-error approach, with breakthroughs through intuitive insight. They enjoy competing in a stimulating rich environment. These learners are agents of change and tend to be impulsive. They dislike structure.

Abstract Sequential – The Abstract Sequential learners prefer a highly verbal, logical and analytical approach based on intellect. They like solitude, well-organized materials, and are highly skeptical. These learners dislike distractions and will accept change only after much deliberation.

Abstract Random – Abstract Random learners like to focus on building relationships and their emotions. They respond well to visual methods of instruction, group discussion, time for reflection, and evaluation of personal experiences(Gregorc, 1984).

Instrument: The Gregorc Style Delineator consists of a ten-column word matrix. Each column consists of four words that are ranked from 1 to 4. A "1" is least descriptive and "4" represents the word most descriptive of the subject's sense of self. The highest score indicates the predominant learning style. The reported reliability of the Gregorc Style Delineator using standardized alpha yielded 0.89 to 0.93 on the subscales when the test retest method was used. The validity of the instrument was determined by 100 individuals taking the Style Delineator test and rating the attributes as descriptive of their learning style (Gregorc Associates, 1982).

The Gregorc Style Delineator is fairly simple to complete, and can serve as an introduction to the concept of learning styles, through a quick understanding of bipolar terms and concepts regarding their combinations. It is based on "phenomenological research [that] identifies the three levels of existence: the essence/spirit of something, the nature of the driving forces that emanate from it and the outer appearance, characteristics, behaviors and mannerisms that are the signatures of the spirit and invisible driving forces" (Gregorc Associates, 2002). Studies that have used the Gregorc instrument include Duncan's (1996) study of learning styles of practical and baccalaureate nursing students, and Wells and Higgs (1990, quoted in Duncan, 1996) study of first and fourth semester baccalaureate nursing students. Interestingly, Duncan (1996) notes a study by Hilgerson-Volk (published in 1987) that suggests that if a student does not adapt to a learning environment, educators will label that student as having a learning disability.

In keeping with the suggestion of majors and styles using the Kolb LSI, it would be expected that science and engineering majors would favor the "Abstract" and "Sequential" dimensions in the Gregorc instrument.

Methodology

A survey kit comprised of a cover letter and three instruments (Gregorc Style Delineator-Word Matrix, Kolb Learning Style Inventory and demographic questionnaire) was distributed to students in General Chemistry over three semesters (Spring 2000, Fall 2000, and Spring 2001). In Spring 2000, the test was administered to all students in two of the four sections of the class (n=150) three weeks before the semester ended, and thus the cohort tested reflects those who felt they were doing well enough not to withdraw from the course. The Fall 2000 and Spring 2001 cohorts were tested in the third week of class, before the first exam – thus before withdrawals, and the survey kit was distributed to all students in all four sections of the course (n=384 for Fall 2000 term and n=367 for Spring 2001term). The total potential number of respondents was 901 students.

The numbered survey forms were distributed at the beginning of a lecture class by student leaders, with the knowledge and permission of the instructor, and students had the option of returning the completed forms to the student leader, or dropping them off in a designated room, or disregarding the survey. No match was made between student and form, guaranteeing anonymity. The forms were edited for missing responses or

repetition of numbers, which would render them invalid. However, even if one of the learning styles instruments was invalid, if the other was completed accurately, it was retained. It must be noted that given that English is not the first language for a large number of students at this college, the use of adjectival comparisons may not have been well understood by some respondents. This may have affected both the respondents in their understanding of the terms, and the non-respondents who may not have understood the terms or were otherwise unwilling to complete a survey kit.

For the analysis of results, the data from the three semesters were combined, yielding 306 for the Kolb LSI and 319 valid instruments for the Gregorc Style Delineator. Demographic information was received from 417 students.

Results

The demographic survey was used to collect background information onthe sample of students. There were 126 (30.2%) females and 291 (69.8%) males who participated in this study. The majority of the students were in the 17-20 years old category with 229 (54.9%) students, followed by the 21-24 years old with 118 (28.3%) students (see Table 1). Of 417 students,the majority taking General Chemistry were167 majoring in Engineering (40.1%), followed by 136 students majoring in Computer Science (32.6%) (see Table 2). Computer Science is considered a department in the School of Engineering.

Seventeen to 20 year-olds are considered traditional entry college students, while the 21-32+ are non-traditional students. The latter group is drawn from post-baccalaureates returning to take courses in preparation for a career change, transfers from community colleges where students must repeat certain courses, and students who are beginning college after a hiatus.

Table 1: Age by Semester

Age	Spring 2000 (n=47)	Fall 2000 (n=115)	Spring 2001 (n=255)	TOTAL (n=417)
18-20 yrs	36.2% (17)	60.9% (70)	55.7% (142)	54.9% (229)
21-24 yrs	42.6% (20)	30.4% (35)	24.7% (63)	28.3% (118)
25-28 yrs	10.6% (5)	4.3% (5)	10.6% (27)	8.9% (37)
29-32 yrs	4.3% (2)	2.6% (3)	4.3% (11)	3.8% (16)
>32 yrs	6.4% (3)	1.7% (2)	4.7% (12)	4.1% (17)

Table 2: Majors by Semester				
Majors	Spring 2000 (n=47)	Fall 2000 (n=115)	Spring 2001 (n=255)	**Total (n=417)**
Biology (Science Division)	12.8% (6)	13.0% (15)	10.6% (27)	**11.5% (48)**
Chemistry (Science Division)	6.4% (3)	1.7% (2)	0.8% (2)	**1.7% (7)**
Physics (Science Division)	0.0% (0)	0.0% (0)	2.0% (5)	**1.2% (5)**
Computer Science (Engineering School)	23.4% (11)	40.0% (46)	31% (79)	**32.6% (136)**
Engineering (Engineering School)	36.2% (17)	34.8% (40)	43.1% (110)	**40.1% (167)**
Other	19.1% (9)	7.0% (8)	10.2% (26)	**10.3% (43)**
Undecided	2.1% (1)	3.5% (4)	2.4% (6)	**2.6% (11)**

The Kolb Learning Style Inventory (LSI) results show that a majority of the students were Assimilators(52%)across all age groups with the exception of the 29-32 year-olds; for that group, majority of the students were Convergers(see Table 3).And Convergers were the second highest group in nearly all age groups (20.5%).

Table 3: Kolb Learning Style Inventory Results– Distribution by age range						
Kolb LSI	**18-20 (N=164)**	**21-24 (N=86)**	**25-28 (N=32)**	**29-32 (N=11)**	**32+ (N=13)**	**Total (N=306)**
Diverger (CE/RO)	19.5% (32)	15% (13)	15.6% (5)	9% (1)	23% (3)	**17.6% (54)**
Assimilator (RO/AC)	50% (82)	54.6% (47)	68.7% (22)	27% (3)	46% (6)	**52% (160)**
Converger (AC/AE)	22.6% (37)	16% (14)	9% (3)	45% (5)	30.7% (4)	**20.5% (63)**
Accommodator (AE/CE)	8% (13)	16% (12)	6% (2)	18% (2)	0% (0)	**9% (29)**

The Gregorc Style Delineator results are shown in Table 4. Note that where there was a tie, e.g., two final scores for two or more styles were the same, only one is represented, thus lowering the total number reported from 319 to 306. In all age groups, the Gregorc Concrete Sequential style dominates as the preferred mode(41.2%) followed by the Gregorc Abstract Sequential (27.8%).

Table 4: Gregorc Style Delineator Results – Distribution by age range					
Style Profile	**18-20 (N=170)**	**21-24 (N=91)**	**25-28 (N=33)**	**29-32 (N=12)**	**Total (N= 306)**
Concrete Sequential	41.76% (71)	37.36% (34)	48.48% (16)	41.67% (5)	**41.2% (126)**
Concrete Random	24.71% (42)	17.58% (16)	24.24% (8)	8.33% (1)	**21.9% (67)**
Abstract Sequential	28.82% (49)	29.67% (27)	18.18% (6)	25% (3)	**27.8% (85)**
Abstract Random	4.71% (8)	15.38% (14)	9.09% (3)	25% (3)	**9.2% (28)**

Discussion

A surprising ratio of approximately 1:2 female to male students (30.2% females to 69.8% males) participated in this study, given that the number of female students nationally who graduate with a bachelor's degree in Engineering still lags behind males in approximately a 1:4 ratio (NSF, 2008).While54.9% of the students would be considered "traditional-age" (17-20), the total of all those over 21 equals 45%, nearly half the participants, who are considered "non-traditional" students. Of 417 students, the majority taking General Chemistry were Engineering and Computer Science majors (72.7%), not Science majors (14.4%). Because this is a freshman-level course, the very low level of undecided majors (2.6%) suggests that students choose to attend the college specifically for its majors. There are also "other" majors (10.3%), students who may be majoring in the humanities or social sciences in a broad preparation for medical professions.

Our study shows that the majority of the science and engineering students were *Kolb Assimilators* and *Gregorc Concrete Sequential* learners. This is contrary to the expectation that on the Gregorc test, the students would be predominantly *Abstract Sequential.*The commonality of *Sequential* may be based in mathematical thinking underlying the disciplines chosen by these majors. As Gregorc *Concrete Sequential* learners, these science and engineering students prefer hands-on activities with detailed instructions. The finding of the *Concrete* preference suggests that instruction should be based on real-world situations, perhaps using the case study method, or kinesthetic models as concrete examples, to ground learning in experience.

The results in this study support prior studies of science and engineering students predicting the majority as *Assimilators* (Kolb, 1984). According to Kolb (1985), *Assimilators*' strengths lie in the ability to create theoretical models. They have very good inductive reasoning and logic skills. They are more concerned with ideas and abstract concepts and less interested with people. This finding suggests that for these learners, a learning environment where concepts and ideas can be explored and experimentedwith would be helpful.

As numerous authors conclude, the real benefit of the learning style instruments is when the information is applied by educators (Kelly, 1997; Irvine, 1995; Krause, 1998). Providing learners with instruction that both accommodates and stretches their learning capabilities demands that those guiding learning would have to

accommodate and modify their teaching styles, from "essentialist, an approach that ignores learner experience…The LSI serves as a reminder that the internal processes of learning need just as much care as the external" (Kelly, 1997). Griggs (1991) notes that, "our style of learning, if accommodated, can result in improved attitudes toward learning and an increase in productivity, academic achievement, and creativity."

Accommodation of learning styles in higher education institutions might be supported by professional development activities and research on the use of learning styles, and faculty candidates' understanding of teaching and learning practices might even be a point of discussion in hiring (Swanson, 1995).

Further Research

Do students whose style is not compatible drop out, or are they discouraged from certain majors because their styles don't match? As Kolb (1984) notes, very few academic departments or fields intentionally promote a "style;" however, the demands in mastering a field may shape differences in learning. A study to determine if students who drop out or change majors are predominantly those whose learning styles are different from those who successfully completed the requirements of their degree program might be worth pursuing. A study that tracks individuals' learning style at the beginning of the term with successful completion of the course may provide further insights. A study on gender differences in learning styles may merit exploration since this study showed a high ratio of women engineering majors early in their academic career (taking Chemistry is required). Are there particular learning styles which help women persist as science and engineering majors? A simple conversation on the use of learning styles instruments in a college introductory chemistry course has warranted further studies that may benefit students majoring in science and engineering.

Acknowledgments

The authors thank David Gosser, Ellen Goldstein West who started this discussion, and Andrei Lalla, ElinaYusufova, and Okason Morrison for their help with the data collection.

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Cite This Article as: Dreyfuss, A.E., Liou-Mark, J. (2012). Learning Style Instruments in a College Introductory Chemistry Course: An examination of the use of the Kolb Learning Styles Inventory and the Gregorc Learning Style Delineator. Peer-Led Team Learning: Leader Training. Online at http://www.pltlis.org.
Originally published in *Progressions: The Peer-Led Team Learning Project Newsletter*, Volume 10, Number 2, Winter 2009.