2004-2440

Coordinating Learning Styles and Teaching Styles in Undergraduate Engineering Education

JoAnne Larsen, Ph.D., PE, Paul R. McCright, Ph.D., Gregory Weisenborn, Ph.D.
University of South Florida

Abstract
A student's success in undergraduate engineering classes is determined in part by the student's innate ability, life experiences and the compatibility of the student's learning style with the instructor's teaching style. Felder's Index of Learning Styles (ILS) provides a measurement of a student's preference to receive, process, and understand information. Use of the ILS provides an instructor with valuable insight into teaching strategies that appeal to a larger sample of the engineering student population and in turn contributes to better retention rates. This study investigates the use of a multifaceted teaching strategy designed to enhance learning, satisfaction and, ultimately, success in a basic core engineering class. This paper explores the relationship between this instructional technique and the broad spectrum of learning styles. The study examines the correlation between the student reported learning style preferences, satisfaction, and success in the course.

Why Are Learning Styles a Hot Topic in Engineering Education?

The paradigm shift in the 1950's from a more hands-on approach to engineering education to a more theoretical approach has resulted in graduate engineers with less ability to solve practical problems. This has created an outcry from industry that engineers are not prepared for the practical applications that define engineering in the "real world".[4]

Over the last several years, the concept of measuring outcomes has come to the forefront in engineering and has focused learning measurements toward more practical goals. The Accreditation Board for Engineering and Technology (ABET) now requires engineering college programs to develop class objectives and measures for assessing the level of achievement of the stated goals. These goals must include both technical and social measures of student growth and development and consequently require newer approaches to instruction. Few students become proficient in practical applications of engineering only through lectures. Engineering faculty members are being exposed to newer techniques that include active learning and cooperative problem solving. Despite some reluctance, they are beginning to apply these newer techniques.[1]

In an effort to make engineering colleges more responsible for assessment of their programs, the National Science Foundation also has funded educational research and development with considerable assessment planning being included in grant proposals. [1]

Learning Styles of Engineering Students

After examining the learning styles of engineering students, Richard Felder and Linda Silverman have developed the Index of Learning Style Inventory based on the learning style models of Myers-Briggs Type Indicator, Kolb Learning Style Model, Herrmann Brain Dominance Instrument, and the Felder-Silverman Learning Style Model.[2]

The Index of Learning Styles is a simple self-scoring instrument that measures an individual's preferences on four dimensions: sensing/intuiting, visual/verbal, active/reflexive and sequential/global. The sensing/intuiting scale reflects the types of information the learner prefers. The visual/verbal scale indicates the sensory channel that is used more readily. The active/reflective scale refers to the information-processing pattern preferred. The sequential/global scale shows the information comprehension model generally used.[3]

Felder's research has indicated that engineering students tend to be visual, sensing, active and often global. Unfortunately, engineering education methods tend to be at the opposite polar ends of these dimensions. [3]

Instructional Methods of Engineering Professors

Felder's research has found that engineering professors are inclined to use teaching methods that are auditory (verbal), intuitive, passive and sequential. It is Felder's contention that minor modifications to teaching techniques can better accommodate students with diverse learning styles.[3]

Tested Instructional Method

We tested an instructional method used in the basic engineering class of Engineering Economy. For this course, students purchase both a textbook and a "workbook". The workbook contains the PowerPoint® slides used in the class with key points being replaced by blank lines. Students then enter the information into the blanks as the instructor discusses and explains the course material. This presentation method appears to encompass a large number of the learning style dimensions. Use of the workbook encourages instructors to employ a wider range of teaching methods that should match more students' learning styles, thus contributing to greater student success. This paper addresses the sequential/global dimension with specific examples from the instructional method that has been tested. The following figures provide examples from the workbook that offer a sequential/global model for the students.

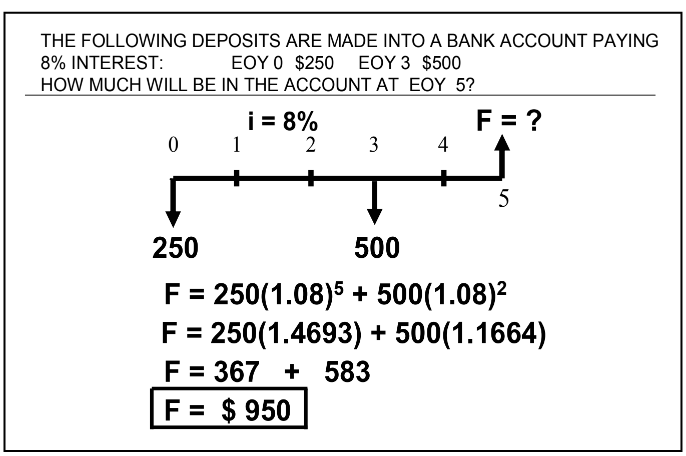

Figure 1: Sequential Example

This example shows how the material is being presented in a linear, logical manner. Engineering courses are naturally presented in a logically ordered succession of topics. The rate of learning is influenced by the progression of time, interspersed with periodic mastery testing, followed by movement to the next stage.

PERSONAL USE OF ENGINEERING ECONOMY CONCEPTS

HOME PURCHASES AND RENTALS
AUTOMOBILE PURCHASES
LARGE APPLIANCE PURCHASES
INVESTMENT PLANS
RETIREMENT PLANS

Figure 2: Global Example
Global learners need to see the big picture or some goal before viewing the steps to achieve the large picture. Relating the material to the real world applications can provide the global learner with an anchor upon which to begin to connect the theories.

Results and Conclusions

In two large classes of Engineering Economy (approximately three hundred students) Dr. Greg Weisenborn used the workbook technique. Two hundred forty of the students took the Index of Learning Styles questionnaire and reported their results. Then, students answered a simple survey to determine their level of satisfaction with the workbook technique. The survey examined each dimension of the preferred learning style. Students' grades were collected with the survey as a measure of student success. In the future this measure will be correlated with the level of student satisfaction with the preferred learning style.

For this paper we examined the students' satisfaction with the means by which the student assimilates material. Felder indicates that a student either prefers a sequential, step-by-step approach to understanding or a global or contextual method of comprehension. Students in the study were defined as having a preference for a particular dimension on a bipolar scale if they scored a 5 (out of 11) or greater on that dimension. In the instructions associated with the results given by the Index of Learning Styles, a preference for one pole of the dimension is a score of 5 or greater. Larger preference scores indicate stronger preferences. Any result less than 5 indicates a fairly balanced use of the two dimensions.[5] The distribution of our students in this assimilation mode is shown below:

Table 1: Distribution of Learners in Our Class

Student Preference	% of Total	% of Total
Sequential Preferential Learners (Group #1)	29.7 %	
Global Preferential Learners (Group #2)	11.7%	
Total Preferential Learners		41.3%
Balanced Learners		58.7%
Total		100%

Our survey contains two questions associated with each of the sequential/global dimensions, one in a satisfaction direction and one in a dissatisfaction direction. Each question had the following possible responses:

Least satisfied	1
Somewhat unsatisfied	2

Neutral, neither satisfied, nor unsatisfied	3
Somewhat satisfied	4
Most satisfied	5

Our basic statistical results for the questions associated with the sequential/global dimension are provided below in Table 2. Only Group #1 students' responses (sequential preferential learners) were evaluated for Questions #5 and #12 of the satisfaction survey. Only Group #2 students' responses (global preferential learners) were evaluated for Questions #6 and #13 of the satisfaction survey.

Table 2: Survey Results for Sequential/Global Dimension for Students with a Preference

Question	Mean Result	Median	Standard Deviation	Mode
Satisfaction Survey Analysis of Group #1: Sequential Learners (N = 71)				
Question #5: Satisfaction question for sequential dimension	3.859	4	1.150	4
Question #12: Dissatisfaction question for sequential dimension	2.479	2	1.217	2
Satisfaction Survey Analysis of Group #2: Global Learners (N=28)				
Question #6: Satisfaction question for global dimension	3.643	4	0.989	4
Question #13: Dissatisfaction question for global dimension	2.214	2	1.031	2

A mean of greater than 3, with a median and mode of 4 in the satisfaction questions indicates that the students are somewhat satisfied with the sequential/global material presented in the workbook. A mean of less than 3, a mode and median of 2 indicates students were not dissatisfied with the workbook's ability to address their styles. This teaching method appears to suit the needs of students with both preferences of the sequential/global dimension of learning. In fact, the data from the entire class of students including those balanced in the area of the sequential/global dimension, indicates that the workbook technique met their needs in this area (see Table 3).

Table 3: Survey results of the Sequential/Global Dimension for all Students

Question	Mean Result	Median	Standard Deviation	Mode
Satisfaction question for sequential dimension	3.938	4	1.094	5
Dissatisfaction question for sequential dimension	3.654	4	.929	4
Satisfaction question for global dimension	2.351	2	1.953	2
Dissatisfaction question for global dimension	2.201	2	.997	2

Future research will analyze the workbook method's ability to meet the remaining three dimensions. This research can aid engineering professors in developing techniques that meet the learning styles of the majority of their students with types of presentation, assignments and evaluation.

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JOANNE LARSEN
Dr. Larsen is an instructor in Industrial Engineering at the Lakeland Regional Campus of the University of South Florida. Her research areas include distance education and learning in industry and college. She teaches courses in engineering economy, all areas of statistics, manufacturing, and human factors.

PAUL MCCRIGHT
Dr. McCright teaches Industrial Engineering and Engineering Management courses at the University of South Florida Tampa Campus. His areas of interest include engineering economics, white collar productivity, ergonomics, safety, and environmental issues. He teaches graduate courses in work design, policy and strategy, management of technological change, and occupational safety and undergraduate courses in engineering economy and ergonomics.

GREGORY WEISENBORN
Dr. Weisenborn is an adjunct professor in the College of Engineering at USF, and works as a research associate at the V.A. Patient Safety Research Center in Tampa. His areas of research include scarce resource allocation, barriers to implementing patient safety interventions, and the learning styles of engineering students. He teaches a variety of courses at USF including engineering economy, manufacturing processes, and engineering ethics.