LEARNING STYLES OF FRESHMEN ENGINEERING STUDENTS

Nídia Pavan Kuri [1] and Oswaldo Mário Serra Truzzi [2 1]

Abstract - *The learning styles of freshmen engineering students in a public engineering school in Brazil were identified using the Index of Learning Styles (ILS). This is an instrument created and currently being developed by Felder and Soloman to assess the respondent's positions on four continuous learning dimensions or scales: Active/Reflective, Sensing/ Intuition, Visual/Verbal and Sequential/Global. The study was conducted in two years and the results described herein are the ILS responses from 351 freshmen engineering students, subdivided into four groups: Civil, Electrical, Mechanical and Industrial Engineering. All groups completed the ILS in their first academic year (March/April) and the overall responses showed a preference for an Active (60%), Sensing (74%), Visual (79%) and Global/Sequential (both 50%) learning style. This paper presents the overall distribution responses of freshmen engineering students to the applied instrument and also summarizes some specific ILS items, which draw out significant responses.*

Index Terms – engineering education, freshmen, learning styles

Introduction

Each person is unique, with his/her own characteristics, abilities, preferences, and ways of thinking and acting that make them different from each other. The particular way of perceiving and processing information is denominated *learning style* [1]. There are many papers, concluded or in development, about this theme and they have been used for their authors to identify individual preferences of learning. However, there are not evidences that a learning style is more effective than other is, they are distinctive and should be recognized and considered by professors in their planning of instructions.

Many authors have obtained results by performing modes of learning style [2, 3] and implementing approaches of learning, planned to attend different students' preferences [4-7]. Including some strategies developed from these modes of learning style, these approaches can be used for distinctive groups of students, course and disciplines. The results have suggested that once the diversity of personality and learning style are considered, the efficiency of learning increases and it motivates students.

This paper is part of a research fulfilled in an engineering public school in Brazil, which objectives identify the students' learning profile. The results presented here were collected based on students who started their Engineering course in 1999 and 2000 (N=351), subdivided in four groups: Civil (110), Electric (91), Mechanic (94) and Industrial Engineering (56).

In order to identify personal learning styles it was used the Index of Learning Styles (ILS), an instrument created by Felder and Soloman, in the North Carolina State University. The ILS determines the preferences of learning in four dimensions of the Learning Styles Model, formulated by Felder- Silverman [8]: active/reflective, sensing/intuition, visual/verbal and sequential/global. This model also includes a fifth dimension – inductive/ deductive, but this instrument does not consider it.

The ILS covers in each of the four dimensions, two opposite styles of learning: active/reflexive, sensing/intuition, visual/verbal and sequential/global. The answers obtained from the instrument supply two scores corresponding to two styles covered by each dimension. The difference between both scores indicates which one is dominant or preferred by the respondent.

The version in use encloses forty-four simple questions (alternatives a or b), eleven for each dimension. When a student chooses six or more alternatives, among the eleven from each dimension, he/she is expressing his/her preference for one of the learning styles in the dimension.

The main characteristics of learning style in ILS and the results obtained from the research made among engineering students in two years will be presented in the following sections. In each dimension, will be included students' answers indexes and the relevant results will be showed.

ILS: Four Dimensions of Learning Styles

Students have different styles and preferences of learning; in other words, they differ in the way of receiving and processing the information and building new knowledge. The ILS considers the students' preferences of learning in four dimensions: active/ reflective, sensing/intuition, visual/verbal and sequential/ global. The dictomies in the dimensions do not exclude each other, they represent a *continuum*, that is, the student's preference can be strong, moderate or almost non-existent in one of the poles' dimension and changes according to the time, the subject or the environment of learning. The following descriptions are about the main characteristics of opposite learning styles in each dimension are based on Felder's papers [8,9,10].

Sensing/Intuition Dimension

What type of information does the student preferentially perceive: sensory or intuitive?

[1]Nídia Pavan Kuri, University of São Paulo, Engineering School of São Carlos, CEP 13566-590, São Carlos, São Paulo, Brazil
[2]Oswaldo Mário Serra Truzzi, Federal University of São Carlos, CEP 13565-905, São Carlos, São Paulo, Brazil

Sensing students tend to prefer external information that is perceived by the sense. They are practical, careful and good at memorizing things. They appreciate facts, observations and solving problems by using usual methods, because they do not like innovations. The *intuitive students* tend to prefer the internal information, according to their memory, reflection and imagination. They prefer theory, concepts and interpretations, appreciate the diversity and complexity of situations because they like learning new possibilities and connections. They get bored with to many details and repetition.

Visual/Verbal Dimension

Which way the external information is most effectively perceived: by seeing or hearing?

Visual students remember easily the information they got from graphics, maps, diagrams, images and experiences. If the information is presented in a written or verbal way, they will probably forget it. The *verbal students*, on the other hand, apprehend better the oral information.

Active/Reflective Dimension

What is the best way to process an information: actively or reflexively?

The *active students* learn better by their own experiences and action. They have no problems on working in groups and feel more comfortable in situations that offer opportunities of acting, testing, applying, manipulating, discussing or explaining the information he learnt to the others. The *reflexive students* do not learn in situations like those, they tend to be more theoretical and feel more comfortable working by themselves or, with only one partners.

Sequential/Global Dimension

How does a student progress to the understanding: sequentially or globally?

Sequential students learn better when the content is presented in a logical, ordered way, and in a progressing way of complexity and difficulty. They use linear mental methods to solve problems and can even deal with a partial or superficial comprehension. They are convergent and good at analysis. *Global students* are more intuitive and sometimes cannot explain how did they get to the solution of a problem. They cannot learn without a 'big picture', they are divergent and also good at synthesis.

Learning Styles of Freshmen Students Engineering

According to the answers obtained from the ILS, the general percentage shows that freshmen engineering students prefer to learn from the active, sensorial, and visual learning styles. However, in the dimension that covers sequential and global style, the preference is balanced.

TABLE I

AVERAGE RESPONSES ON FOUR ILS DIMENSIONS

Dimensions	Civil (n=110)	Electrical (n=91)	Mechanical (n=94)	Industrial (n=56)	Total (n=351)
Active/Reflective	69% Act	57% Act.	53% Reflec.	66% Act.	60% Act.
Sensing/Intuition	86% Sens.	68%Sens.	67% Sens.	70% Sens.	74% Sens.
Visual/Verbal	76% Vis.	80% Vis.	84% Vis.	73% Vis.	79% Vis.
Sequential/Global	54% Seq.	51% Seq.	55% Glob.	50% Seq./Glob	50% Seq./Glob

There are some differences in the subgroups: mechanical engineering freshmen prefer reflexive and global styles, civil engineering students are prone to the sequential style and electrical and industrial engineering freshmen have a balanced preference between sequential and global styles. In the Sensing/ Intuition dimension, the Civil group indicated a preference to the sensorial style rather than the other groups; in the Visual/Verbal dimension was the Mechanical group and in the Active/Reflexive dimension Civil and Industrial groups had better indexes.

What the student responses to each of the ILS dimensions reveal

The students' answers, referring to sensing/intuition dimension are illustrated on average in Figure 1.

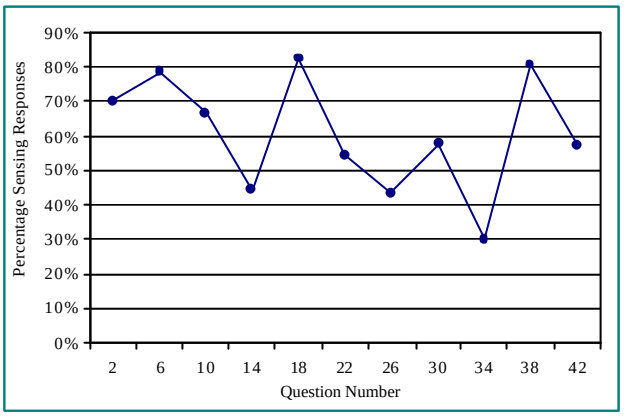

FIGURE. 1
ILS – Sensing/Intuition Responses for All Engineering (n=351)

Most of freshmen engineering answers reveal they are potentially sensorial. A great number of the students consider themselves more realists than innovator (Question 2), preferring disciplines that emphasize concrete material (data and real situations) rather than the abstract (ideas, theories), because they believe that is easier to learn facts than concepts (Questions 6, 10 and 38). It is clear that they prefer the idea of the right and theoric (Question 18).

Sensing/Intuition questions pointed out, which have taken greatest percentages are described below:

2. I would rather be considered
(a) realistic. [70%]
(b) innovative. [30%]

6. If were a teacher, I would rather teach a course
(a) that deals with facts and real life situations. [79%]
(b) that deals with ideas and theories. [21%]

10. I find it easier
(a) to learn facts. [67%]
(b) to learn concepts. [33%]

18. I prefer the idea of
(a) certainty. [82%]
(b) theory. [18%]

38. I prefer courses that emphasize
(a) concrete material (facts, data). [81%]
(b) abstract material (concepts, theories). [19%]

The averages on students' answers to the questions from Visual/Verbal dimension are showed in Figure 2.

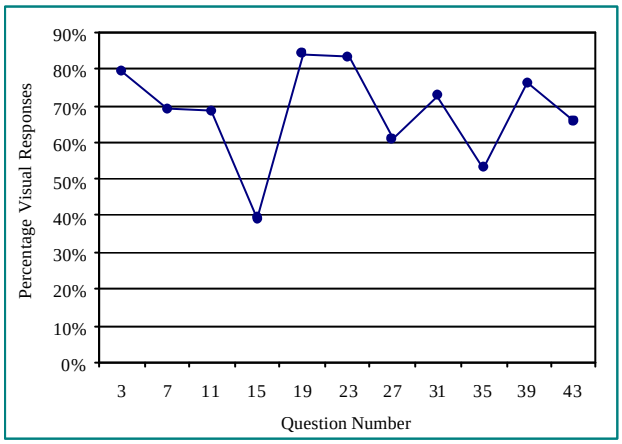

FIGURE. 2
ILS – Visual/Verbal Responses for All Engineering (n=351)

Most of freshmen engineering students prefer getting information from figures diagrams or maps (Question 7). Because they spend special attention to figures and draws displayed on books and texts (Question 11), they probably remember what they see better than what they hear (Question 19) and when they look for direction, they prefer indications supplied by maps, not the written ones (Question 23). The diagrams, graphics and schemes, because of the data visualization (Question 31), are not only preferred but also the most effective helping to make students remember what was said in the lessons. (Question 27).

Visual/Verbal questions pointed out, which have taken greatest percentages are described below:

7. I prefer to get new information in
(a) pictures, diagrams, graphs, or maps. [69%]
(b) written directions or verbal information. [31%]

11. In a book with lots of pictures and charts, I am likely to
(a) look over the pictures and charts carefully. [69%]
(b) focus on the written text. [31%]

19. I remember best
(a) what I see. [84%]
(b) what I hear. [16%]

23. When I get directions to a new place, I prefer
(a) a map. [84%]
(b) written instructions. [16%]

27. When I see a diagram or sketch in class, I am most likely to remember
(a) the picture. [61%]
(b) what the instructor said about it. [39%]

31. When someone is showing me data, I prefer
(a) charts or graphs. [73%]
(b) text summarizing the results. [27%]

The Figure 3 demonstrates the average on students' answers in the Active/Reflective dimension.

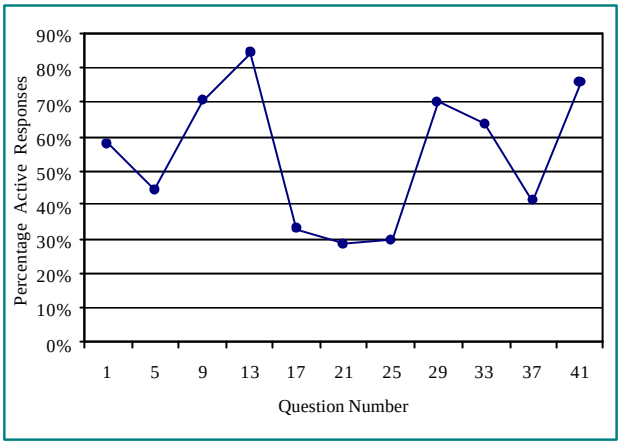

FIGURE. 3
ILS – Active/Reflective Responses for All Engineering (n=351)

The freshmen revealed that they learn better by experiencing things (Question 1); they remember something they have done rather than what they have thought about (Question 29). The only students who revealed 'talking' about a new subject they are learning were from civil engineer, in the other groups the favorite option was 'reflect about the subject' (Question 5). The answers to question 17, 21 and 25 revealed that students prefer studying alone and when they start thinking about a problem solution at home, they first try to understand the whole problem and think how it can be solved. In a group they prefer initiate a discussion and contribute with ideas (Question 9), appreciating activities that are started in a collective argument (Question 33) so that all the members can express their ideas.

Active/Reflective questions pointed out, which have taken greatest percentages, are described below:

1. I understand something better after I
(a) try it out. [58%]
(b) think it through. [42%]

5. When I am learning something new, it helps me to
(a) talk about it. [56%]
(b) think about it. [44%]

9. In a study group working on difficult material, I am more likely to
(a) jump in and contribute ideas. [70%]
(b) sit back and listen. [30%]

17. When I start a homework problem, I am more likely to
(a) start working on the solution immediately. [33%]
(b) try to fully understand the problem first. [67%]

21. I prefer to study
(a) in a study group. [28%]
(b) alone. [72%]

25. I would rather first
(a) try things out. [30%]
(b) think about how I'm going to do it. [70%]

29. I more easily remember
(a) something I have done. [70%]
(b) something I have thought a lot about. [30%]

33. When I have to work on a group project, I first want to
(a) have "group brainstorming" where everyone contributes ideas. [64%]
(b) brainstorm individually and then come together as a group to compare ideas. [36%]

The Figure 4 brings the average on Sequential/Global dimension and demonstrates the balance between sequential and global styles.

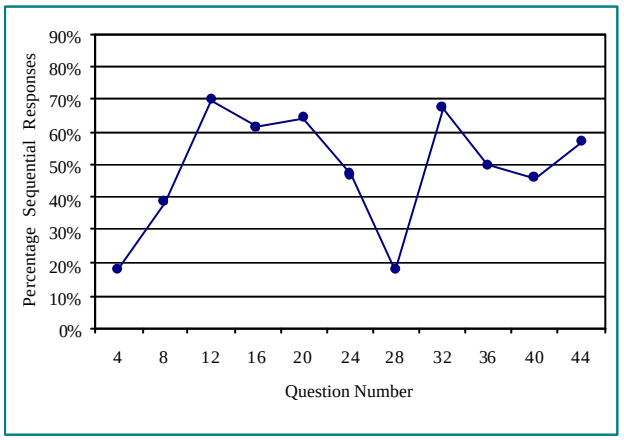

FIGURE. 4
ILS – Sequential/Global Responses for All Engineering (n=351)

The fact that engineering freshmen progress up to the understanding in a global way is expressed in the questions that reveals the tendency to comprehend the general structure of a subject giving little attention to details (Question 4 and 28). Those students need the general comprehension to accept and match some details; they stay confused for a while until the moment they have an 'insight' (Question 24). The research also shows that is very important that the professor present the subject in sequential clear stages (Question 20); and when they are solving a problem think first on the stages of the solution process (Question 44), trying to solve in a sequence (Question 12). When writing a text, prefer to discuss the first part and then move forward orderly (Question 32).

Global/Sequential questions pointed out, which have taken greatest percentages are described below:

4. I tend to
(a) understand details of a subject but may be fuzzy about its overall structure. [18%]
(b) understand the overall structure but may be fuzzy about details. [82%]

12. When I solve math problems
(a) I usually work my way to the solutions one step at a time. [70%]
(b) I often just see the solutions but then have to struggle to figure out the steps to get to them. [30%]

20. It is more important to me that an instructor
(a) lay out the material in clear sequential steps. [64%]
(b) give me an overall picture and relate the material to other subjects. [36%]

24. I learn
(a) at a fairly regular pace. If I study hard, I'll "get it"". [47%]
(b) in fits and starts. I'll be totally confused and then suddenly it all "clicks". [53%]

28. When considering a body of information, I am more likely to
(a) focus on details and miss the big picture. [18%]
(b) try to understand the big picture before getting into the details. [82%]

32. When writing a paper, I am more likely to
(a) work on (think about or write) the beginning of the paper and progress forward. [67%]
(b) work on (think about or write) different parts of the paper and then order them. [33%]

44. When solving problems in a group, I would be more likely to
(a) think of the steps in the solution process. [57%]
(b) think of possible consequences or applications of the solution in a wide range of areas. [43%].

Final Remarks

Some professors have used the ILS in order to identify their students' learning styles and the presented results have suggested that engineering learning can be improved by making new activities in the school environment. Apart from that, by providing to the students the opportunity of recognizing their own strong point and limitations, this instrument has aroused the interest for further information about models of learning styles and alternative strategies of learning that can replace or complement the currently methods.

Researches that have been done in other Brazilian engineering schools [11,12] reveal that the presentation of ILS results to the students contributes to the establishment of a favorable environment in the classrooms. And by being aware about the different preferences of learning the professors have important indications to conduct their teaching methodology practice.

In the last analysis it might be emphasized that although most of freshmen engineering have revealed a preference to active/sensorial/visual and sequential learning styles, the other styles should be considered, at least part of the time, by having a balanced distribution of several learning activities.

References

[1] Carter, C.; Bishop, J. & Kravits, S.L. – "Keys to Effective Learning". 2nd Ed. New Jersey, Prentice Hall, 2000

[2] Rosati, P. – "Gender Differences in the Learning Preferences of Engineering Students". *ASEE Annual Conference Proceedings*, 1997. On line: www.asse.org/conferences

[3] Rosati, P. - "Specific Differences and Similarities in the Learning Preferences of Engineering Students". *29th ASEE/IEEE Frontiers in Education Conference*, Session 12c1, 17-22, 1999, San Juan, Puerto Rico
[4] Montgomery, S.M. – "Addressing Diverse Learning Styles Through the Use of Multimedia". On line: http://fairway.ecn.purdue.edu/v1/fie95/3a22/3a22.htm
[5] Hein, T. L. & Budny, D.D. – "Teaching Student's Learning Styles: Approaches That Work". 29th *ASEE/IEEE Frontiers in Education Conference*, Session 12c1, 1999, San Juan, Puerto Rico
[6] Huggans, M. & Nystrom, H. E. – "Learning Styles and Engineering Management". *ASEE Annual Conference*, Session 2542, 1999, Charlotte, NC
[7] Carrizosa, K. & Sheppard, S. – "The Importance of Learning Styles in Group Design Work". *Frontiers in Education Conference*, Session T2B, 2000, Kansas City, MO
[8] Felder, R. M. & Silvermann, L. K. – "Learning and Teaching Styles in Engineering Education". *Engineering Education*, 78(7), 674-681, April 1988
[9] Felder, R. M. – "Reaching The Second Tier: Learning and teaching Styles in College Science Education". *J. College Science Teaching*, 23(5), 286-290, 1993
[10] _____ - "Matters of Style". *ASEE Prism*, 18-23, December 1996
[11] Cury, H. N. – "Estilos de Aprendizagem de Alunos de Engenharia". *XXVIII COBENGE*, Ouro Preto, MG, Brasil, 2000
[12] Correia, A. M. A. & Cheng, Liang-Yee. "Aprender a Ensinar a Aprender". *XXVIII COBENGE*, Ouro Preto, MG, Brasil, 2000