Similarities and Differences in Learning Styles among Students in University Programs: a Mexican Sample

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Abstract

This article makes two different contributions: an analysis of learning styles among undergraduate students in different academic programs, and a proposed regrouping of programs in order to improve teaching practice.

The study was conducted in Mexico City in a Mexican private university (Instituto Tecnológico Autónomo de México - ITAM), among a sampling of 753 first-year students in 11 undergraduate degree programs, applying the learning styles questionnaire developed by Felder and Silverman.

The results of our research showed that there were similarities between the learning styles of some programs, which can be grouped into four major categories: 1) active, sensitive, visual and sequential learning styles in the Administration, Business Engineering, Economics, Industrial Engineering and Law programs; 2) active-reflective, sensitive, visual and sequential learning styles in the Actuarial and Accounting programs; 3) active-reflective, sensitive-intuitive, visual and sequential-global in the Applied Mathematics, Computer Engineering and Telematics Engineering programs; 4) active, sensitive-intuitive, visual and sequential-global in the International Relations program.

The results of our investigation imply that courses should be planned taking into account learning styles shared by the students in different programs, adjusting teaching techniques–electronic media, for example–in order to optimize learning.

Keywords

Learning styles, higher education, Felder and Silverman questionnaire, freshmen, undergraduate programs.

Introduction

Research has shown the students learn in many ways and prefer to use different resources in the process. Most investigators in the field of educational technology agree that learning material should be designed for specific types of students and their learning styles, and not just the teaching style of the professor (Dagger, Wade and Conlan, 2003; Paredes and Rodriguez, 2002; Triantafillou, Pomportsis and Georgia, 2002; Stern and Woolf, 2000).

Individuals have different ways of learning: some are better able to assimilate knowledge by seeing, others by hearing, or by some other sense. The traditional teaching styles generally tend to favor just one type of representation system, whether visual, when everything is written on the blackboard, or by lecturers, who resort only to spoken explanations. Students are assigned different groups of course requirements based on the program of studies they have selected and the content of the curriculum, without taking into account whether there are differences or similarities in their learning styles. Furthermore, the professor freely chooses learning techniques that he or she considers most appropriate for the class, using them for students in different programs, without taking their different learning styles into account.

Interest in research into learning styles has been fueled by the need to improve the quality of the educational process, examining the ways to best teach students, to orient their learning appropriately (Juarez et al., 2011). Meanwhile, Alonso, Gallego and Honey (1999) found that students at various educational levels learn more effectively when they are taught in a manner consistent to their predominant learning style.

There are a number of studies focused on comparing learning styles in programs that belong to a common area, particularly the engineering fields (Bekerman et al., 2010; Franzoni and Assar, 2007; Durán and Costaguta, 2007; Figueroa et al., 2005). Unlike previous research conducted into programs in a single field of knowledge, this investigation was conducted across 11 university programs, including both administrative and engineering degrees.

Taking into account previously conducted research into learning styles, we define the objective of this study: to determine whether or not there were differences and/or similarities in learning styles among students of University programs offered by ITAM, in order to serve as a basis for academic and administrative decisions on the courses.

Felder and Silverman Learning Styles Model

There are a number of theories regarding learning styles. For this research, however, we chose the Felder and Silverman learning styles model (1988) because it has successfully been used in previous work on individual adaptation to the didactic content of electronic learning (Hong and Kinshuk, 2004; Paredes and Rodríguez, 2002).

Felder and Silverman (1988) defined a learning style as a set of characteristics, strengths and preferences in the way that people receive and process information. In other words, it refers to the fact that each person has his or her own method or set of strategies when it comes to learning.

Felder and Silverman's model proposes that a student's learning style is made up of four dimensions: the way that they *Perceive* (sensitive or intuitive), what sensorial organ they use in *Capture* the information (visual or verbal), how they *Process* the information (Active or Reflective), and what process they follow for *Understanding* or comprehension (Sequential or Global).

To identify the type of learning that corresponds to each student Felder and Silverman (1988) recommend answering the following questions:

- What type of information does the student perceive best: sensitive (external)--places, sounds, physical sensations, or intuitive (internal)--possibilities, ideas, hunches?
- Through what sensorial channel the students most effectively perceive information: visual--through images, diagrams, and graphs; or verbal, through words or sounds?
- How does the student process information: actively, through physical activity or discussions; or reflectively, through introspection and reflection?
- How does the student progress in learning: sequentially, using a series of steps; or globally, with great leaps toward an overall vision?

The following describes the characteristics of each type of learning style identified by Felder and Silverman (1988).

Sensitive students prefer facts, data and experimentation; they are patient with details but they do not like complications. Intuitive students prefer principles and theories, are bored with detail, and except complications.

For visual learners, it is easier to remember what they see: images, diagrams, timelines, films, demonstrations. Verbal learners find it easier to remember what they have heard, read or said.

Active learners learn better working in groups and by manipulating things, while reflective learners learn when they can think and reflect about the information presented to them. They work better alone, or with one other person at most.

Sequential learners follow a process of linear reasoning when they resolve problems. They can work with the material once they have partially or superficially understood it. Global learns make intuitive leaps in the information, and may find it hard to explain how they reached a solution; they need the big picture.

Methodology

Participants and Procedure

The research was conducted in the Mexican private university located in Mexico City, called the Instituto Tecnológico Autónomo de México (ITAM). ITAM is a nonprofit higher educational institution with approximately 4800 undergraduate students enrolled. This university is internationally renowned, accredited by the AASCB for business programs and ABET for engineering programs. In addition to his teaching programs, it is considered an autonomous center for high quality research. ITAM students come from high schools in various cities of Mexico. The Institute offers 14 undergraduate programs, but only 11 were included in this research project.

All the participants were first semester students at ITAM, between 17 and 21 years of age. The study did not take into account any class-groups already created, but rather the entire population sample, consisting of 503 men and 245 women (total of 748). The distribution among the degree programs was as follows: Actuarial (total = 87), Administration (total = 38), Accounting (total = 83), Law (total = 61), Economy (total = 201), Computer Engineering (total = 30), Business Engineering (total = 77), Industrial Engineering (total = 60), Applied Mathematics (total = 46), International Relations (total = 35), and Telematics (Total = 30).

Questionnaire

The questionnaire we chose was the Index of Learning Styles (ILS). This is an online instrument applied to evaluate students' preferences in four dimensions of learning (active/reflective, sensitive/intuitive, visual/verbal and sequential/global), according to the learning styles model formulated by Richard M. Felder and Linda K. Silverman. The instrument was developed by Richard M. Felder and Barbara A. Salomon of the North Carolina State University, and adapted into Spanish. The questionnaire was chosen because of its focus on the academic sphere; because of the conceptual base that sustains it, the experiential learning theory of David Kolb (1984); because it has been successfully used in previous works (Hong and Kinshuk, 2004), (Paredes and Rodriguez, 2002), and because it is been validated by its author and others (Zywno, 2003, Felder and Spurlin, 2005). It is also easy to use, and the results are simple to interpret (Paredes and Rodriguez, 2002).

The questionnaire consists of 44 questions, balanced in such a way that each learning style corresponds to 11 items for measuring it. Each question has two dichotomous values. A preference is obtained on a scale ranging from 1 to 11. A score of 1 to 3 indicates a slight preference for one style; but the student is essentially well-balanced and can learn from both styles; for example, visual and verbal. A score of 5 to 7 indicates a moderate preference for one style and the student will learn more easily in a learning medium that favors that style. A score of 8 to 11 indicates an intense preference for one style, meaning the student will have difficulty learning in a form different from the characteristic of that style. For example, if the verbal type is predominant, the student will have difficulty assimilating information presented visually.

Method of Analysis

The statistical techniques used in the study were as follows: calculating the means for the students in each of the degree programs in the four dimensions measured by the ILS questionnaire on learning styles: active-reflective, sensitive-intuitive, visual-verbal and sequential-global.

Once the measures obtained from each of the dimensions are calculated, we proceeded to calculate a two-tailed t-test for related samples, to see if there was a statistically significant difference, first between global means, and second between the styles of each dimension of learning in each program. The results of the t-test enabled us to identify the learning style

characteristic of each program studied. The level of competence selected for the t-test was .05.

Finally, we use the ANOVA technique to test whether there was a statistically significant difference in each of the dimensions of learning styles among students in the different degree programs. We used .05 as the minimum point score to accept a significant difference among groups.

Results

The following section discusses the results of our investigation.

In Table 1, we show the means obtained in each dimension of learning styles, corresponding to each degree program.

[Table 1 near here]

After calculating the global mean for all the programs by learning style, we conducted a t-test to identify whether there was a predominant style in all the programs studied. We compare the global mean for active (5.9655) with the global mean for reflective (5.0 345), the global mean for sensitive (6.3234) with the global mean for intuitive (4.6766), and so on successfully. When only comparing global means we found a uniform pattern in the learning styles of ITAM students, regardless of the program to which they belong, because there is a statistically significant difference in the measures obtained between the active and reflective, sensitive vs. intuitive, visual vs. verbal and sequential vs. global styles.

The typical style of learning of students at ITAM is Active ($t = 6.56$), Sensitive ($t = 13.115$), Visual ($t = 23.865$) and Sequential ($t = 11.357$).

Since our objective was to test whether there were differences among the degrees programs studied, we then calculated the t-test again, but this time comparing the mean obtained for each program individually, on the presumption that the global means could be hiding significant differences in the learning styles of the different programs.

Table 2 shows the t-test calculation for each learning style dimension, to determine whether there are statistically significant differences between the means for each program studied. We compared the mean for active vs. reflective, sensitive vs. intuitive, visual vs. verbal, and sequential vs. global, corresponding to each degree program.

Based on the results of the t-test, we identified the typical learning style of students in each program. For example, in the Actuarial program, we found no statistically significant difference in the means obtained by students in the active-reflective types, while the mean obtained in the sensitive type was higher than the mean in intuitive. Meanwhile, the mean in the visual type was higher than the verbal type, and finally, the mean in sequential was statistically different from and higher than the mean for global. Taking these four results into account, we concluded that the learning style of the Actuarial student is: active-

reflective, sensitive, visual and sequential. We went on to obtain a typical learning style for each program (see Table 3).

[Table 2 near here]
[Table 3 near here]

According to the results of the t-test (Table 2) there is statistical evidence of different learning styles among students in some of the programs studied, which had not been identified when calculating the t-test of the global means. At the same time, there is statistical evidence that not all programs have different learning styles, since some of them share the same learning style.

The statistical results permit us to group together the program studied into four categories:

Group 1:

Learning style: active-sensitive, visual and sequential
Programs: Administration, Economics, Law, Business engineering, and Industrial engineering

Group 2:

Learning style: active-reflective, sensitive, visual and sequential
Programs: Actuarial and Accounting

Group 3:

Learning style: active-reflective, sensitive-intuitive, visual and sequential-global
Programs: Applied Mathematics, Computer Engineering, Telematics Engineering
Note that unlike Applied Mathematics and Computer Engineering, Telematics is solely sequential.

Group 4:

Learning style: active, sensitive-intuitive, visual and sequential-global
Program: International Relations
Students in the International Relations degree program present the learning style different from the other programs studied.

After identifying the learning style that corresponds the students in the program, we proceeded to compare the means for all the programs in each of the dimensions of learning styles, to test whether there were statistically significant differences between them. For example, the visual learning style predominated in every program, but we were interested to see if students in some programs were more visual than others.

Table 4 shows the level of significance obtained in the ANOVA by students in the different academic programs in the active-reflective dimension. The minimum accepted level of significance in the ANOVA was .05.

[Table 4 near here]

According to the results of the ANOVA, there is statistical evidence that students in the Computer Engineering program are more reflective than students in Administration, Law, Economics, Business Engineering, Industrial Engineering and International Relations.

Table 5 shows the level of significance obtained in the ANOVA by students in the different academic programs in the sensitive-intuitive dimension.

[Table 5 near here]

The results of the ANOVA show statistical evidence that students in the Applied Mathematics, Computer Engineering and Telematics are more intuitive than students in Actuarial, Administration, Accounting, Law, Economics, Business Engineering and Industrial Engineering.

Table 6 shows the level of significance obtained in the ANOVA by students in the different academic programs in the visual-verbal dimension.

[Table 6 near here]

Although the visual style of learning predominates in all the programs studied, there is statistical evidence that students in International Relations and Law are more verbal than students in the rest of the programs we compared.

Table 7 shows the level of significance obtained in the ANOVA by students in the different academic programs in the sequential-global dimension.

[Table 7 near here]

According to the results of the ANOVA, there is statistical evidence that students in the Industrial Engineering, Applied Mathematics and International Relations programs are more global than those of only two programs. Meanwhile, students in Actuarial Studies are more global than those of three programs: Computer Engineering, Applied Mathematics and International Relations.

The sequential-global dimension was where we found the least significant differences in the means for the different programs.

Discussion

In this investigation comparing global means obtained in the learning styles questionnaire, we found that there was a predominant style of learning among students at ITAM: active, sensitive, visual and sequential. These results are consistent with those obtained by Bekerman (2010). This study was based on four areas, according to the career path chosen: Health, Engineering, Exact Sciences and Others (Systems Analysis, Accounting, Economics, Communications, History, Law, Graphic Design, Arts and Agronomy), and

found that since there were no significant differences between the programs chosen and the learning style, the central result of the investigation was that there was one predominant general style: Active, Sensitive, Visual and Sequential. Our own investigation, however, has shown that there are significant differences in learning styles when we analyze the means obtained for each of the programs, and not just the global mean.

In our study, we analyzed the learning styles of each program in particular, we found that there are significant differences depending on the program studied. This conclusion coincides with the results obtained by Camarero et al. (2000), which indicated that the type of university studies and students' learning styles and strategies, differed depending on the discipline they were studying.

Although we might assume that students in any engineering program have the same learning style, the results of our investigation found that this was not the case. Computer engineers and telematics engineers share one style; while business engineers and industrial engineers share the learning style of students in the administrative programs, which include economics, administration, and law.

The results of our study coincide with conclusion reached by Figuero et al. (2005), which was that learning styles differ for students in different engineering specialties. They grouped together degree programs in informatics and non-informatics programs. As with the results obtained in their investigation, they found that there were differences in the learning style for non-informatics programs.

It is also interesting to note that students in Economics share their learning style with administrative programs, like Administration, Industrial Engineering and Business Engineering, when one might expect that students of Economics had the same learning style as programs with a heavy quantitative content, like Applied Mathematics, Computer Engineering and Telematics.

Another finding different from what was expected is that the Actuarial and Accounting programs share the same learning style.

Finally, students in the international relations degree program have a learning style different from all of the other programs studied.

Conclusions and Suggestions

The results we obtained indicate that there are significant differences in the learning styles of the four groups identified in this investigation.

We suggest that in making administrative and teaching decisions, universities regroup their programs into the four categories identified in this study: 1) learning style Active, Sensitive, Visual and Sequential for the Administration, Business Engineering, Economics, Industrial Engineering and Law programs; 2) Learning style Active-Reflective, Sensitive, Visual and Sequential in the Actuarial and Accounting programs; 3) Learning style Active-Reflective, Sensitive-Intuitive, Visual and Sequential-Global in the Applied Mathematics,

Computer Engineering and Telematics Engineering; and 4) Learning Style Active, Sensitive-Intuitive, Visual and Sequential-Global in the International Relations program.

We suggest that when universities make academic and administrative decisions, they consider differences in learning style among the four groups identified. For example, for programs with a common core, it would be a good idea to open specific courses for each group identify in our study, in which teachers adapt their teaching techniques to the learning style of the students. As students advance through the course requirements for their degree program, we recommend that professors use didactic techniques that correspond to the abilities and competencies required in that profession. For example, although the initial learning style of lawyers is visual, they must develop their verbal capacity, both written and oral. In other words, we suggest the professors in the early semesters of the program take into account the learning style with which students arrive at the University, and little by little develop the complementary dimension of each style, as required by the career they have chosen.

Upon comparing the means obtained in each of the dimensions of learning styles in one program against the others, we may conclude that students in Computer Engineering are more reflective than students in administrative programs. Meanwhile, students in the Applied Mathematics, Computer Engineering and Telematics Engineering are more intuitive than students in Actuarial, Administration, Accounting, Law, Economics, Business Engineering and Industrial Engineering. Although the visual style of learning predominates in all of the programs studied, there is statistical evidence the students in International Relations and Law are more verbal than students in the other programs we compared. In the sequential-global dimension, there was very little significant difference among the means of the different programs.

Further investigation might be useful among students in the later years of the degree programs examined in this study, to see if the students' learning styles change over time. If this is the case, teaching techniques should be adjusted to the evolution of the learning styles.

References

Alonso, C.M., Gallego, D.J., and Honey, P. 1999. *Los estilos de aprendizaje. Procedimientos de Diagnóstico y Mejora*. España: Ediciones Mensajero, Bilbao.

Bekerman, D., Calleri, P., Doce, L., Vaccaro, D., Vallarino, F., and Galagovsky, L. 2010 *Estilos de aprendizaje de los estudiantes: datos para la enseñanza de la primera asignatura de Química universitaria* (CBC-UBA-Sede Montes de Oca). http://www.aqa2010.org.ar/docs/educaci%C3%B3n%20en%20qu%C3%ADmica-034.pdf

Camarero, F., Martín del Buey, F., and Herrero, J. 2000. Estilos y estrategias de aprendizaje en estudiantes universitarios. *Psicothema* 12, no. 4: 615-622.

Dagger, D., Wade, V., and Conlan., O. 2003. An Architecture for Candidacy in Adaptive eLearning Systems to Facilitate the Reuse of Learning Resources. Paper presented at In Proceedings of AACE ELearn'03 Conference. Phoenix.

Durán, E., and Costaguta, R. 2007. Minería de datos para descubrir estilos de aprendizaje. *Revista Iberoamericana de Educación* 42: no. 2: 1– 10.

Felder, R. M., and Silverman, L. K. 1988. Learning and Teaching Styles in Engineering education, *Engr. Education* 78, no. 7: 674-681.

Felder, R., and Spurlin. J. 2005. Applications, Reliability, and Validity of the Index of Learning Styles. *International Journal of Engineering Education,* 21, no. 1:103-112.

Figueroa , N., Cataldi, Z., Méndez, P., Rendón Zander, J., Costa, G., Salgueiro, F., and Lage, F. 2005. Los Estilos de Aprendizaje y el desgranamiento universitario en carreras de informática. Paper presented at JEITICS 2005 - Primeras Jornadas de Educación en Informática y TICS en Argentina.

Franzoni, A., L., and Assar, S. 2007. Using Learning Styles to enhance an e-Learning System. Paper presented at the 6th European Conference on e-Learning *(ECEL 2007).* Academic conference management (ACI), October 4-5, in Copenhagen, Denmark.

Hong, H., and Kinshuk. 2004. Adaptation to Student Learning Styles in Web Based Educational Systems. Paper presented at World conference on Educational Multimedia, Hypermedia & Telecomunications. June 21-26 in Lugano, Switzerland.

Juárez, C. S., Hernández, S. G., and Escoto, M., C. 2011. Rendimiento académico y estilos de aprendizaje en estudiantes de psicología. *Revista Estilos de Aprendizaje* 7(1): 79-92.

Kolb, D., A. 1984. Experiential Learning: Experience as the Source of Learning and Development. USA: Prentice-Hall, Inc.

Paredes, P., and Rodriguez., P. 2002. Considering sensing-intuitive dimension to exposition-exemplification in adaptive sequencing. Paper presented at the AH2002 Conference. Malaga, Spain, 556-559.

Stern, M., and Woolf., P. 2000. Adaptive content in an online lecture system. Paper presented at the International Conference on Adaptive Hypermedia and Adaptive Web-based systems. Trento, Italy. 291-300.

Triantafillou, E., Pomportsis, A., and Georgia. AES-CS: Adaptive Educational System base on cognitive styles. Paper presented at the AH2002 Workshop. Malaga, Spain. 10-20.

Zywno, M. S. 2003. A Contribution to Validation of Score Meaning for Felder-Soloman's Index of Learning Styles. Paper presented at *ASEE Conference.* Nashville, Tennessee.