

## Analysis of learning styles in engineering students after the COVID-19 pandemic

### Análisis de estilos de aprendizaje en estudiantes de Ingeniería después de la pandemia de COVID-19

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#### Abstract

The research was carried out with the objective of knowing aspects that are interesting for researchers about learning; such as the analysis of the learning styles currently in the post-pandemic period, manifested by students of different degrees. Identifying and analyzing learning styles and relating them to current teaching practices will allow applying teaching strategies that could reduce the current high dropout and failure rates. The results obtained show the trends by educational institution, by semester and by career. Significant differences were found in the results in the active style between schools; by semester, most of the students of the initial semesters are visual and sensitive, in later semesters, there is a tendency to be intuitive and by career they show a tendency to be sensitive and visual; As a conclusion, a student can have different learning styles, but in general they have a certain affinity for a learning profile.

Objective. Identify and analyze the current learning styles in Engineering students, derived from the abrupt changes in study modalities that occurred due to the Covid 19 pandemic.

Methodology. A validated survey (Cronbach's  $\alpha$ : 0.872) was applied to students of Electrical Engineering, Electronic Engineering and Biochemical Engineering. The following learning styles were considered to be identified and analyzed: active-reflexive, sensitive-intuitive, visual-verbal, and sequential-global. A scale of dichotomous variables was chosen, they were valued according to the proposal of Felder and Silverman (Felder and Silverman, 1988), the answers were set in the categories of learning styles proposed by the author in active or reflective, sensitive or revealing, visual or verbal, and sequential or global, were quantified, tabulated, and analysis of variance (ANOVA) for parametric samples.

Contribution. This research made it possible to identify the learning styles of undergraduate students in the post-pandemic period, to find out the current learning preferences, which can be applied to propose, where appropriate, the necessary adjustments within the teaching strategies of teachers interested in reduce the current high rate of failure and dropout

Learning styles, dropout rate, failure rate

#### Resumen

Esta investigación se realizó con el objetivo de conocer aspectos que resultan interesantes para los investigadores acerca del aprendizaje, como es el análisis de los estilos de aprendizaje que actualmente en periodo pospandemia, manifiestan los estudiantes de diferentes licenciaturas. Identificar y analizar los estilos de aprendizaje y relacionarlos con las actuales prácticas docentes, permitirá, aplicar las estrategias de enseñanza que pudieran disminuir los elevados índices de deserción y reprobación actuales. Los resultados obtenidos muestran las tendencias por Institución educativa, por semestre y por carrera. Se encontraron diferencias significativas en los resultados en el estilo activo entre escuelas; por semestre, la mayoría de estudiantes de los semestres iniciales son visuales y sensitivos, en semestres posteriores, hay una tendencia a ser intuitivos y por carrera muestran tendencia a ser sensitivos y visuales; a manera de conclusión, un alumno puede tener diferentes estilos de aprendizaje, pero en general tiene cierta afinidad a un perfil de aprendizaje.

Objetivos. Identificar y analizar los estilos de aprendizajes actuales en estudiantes de Ingeniería, derivado de los cambios abruptos de modalidades de estudio que se dieron por la pandemia de Covid 19.

Metodología. Se aplicó una encuesta validada ( $\alpha$  de Cronbach: 0.9728) a estudiantes de Ingeniería Eléctrica, Ingeniería electrónica e Ingeniería Bioquímica. Se consideraron los siguientes estilos de aprendizaje a identificar y analizar: activo- reflexivo, sensitivo-intuitivo, visual-verbal y secuencial-global. Se eligió una escala de variables dicotómica, fueron valoradas de acuerdo a la propuesta de Felder y Silverman (Felder & Silverman, 1988), se ubicaron las respuestas en las categorías de estilos de aprendizaje propuestos por el autor en activo o reflexivo, sensitivo o intuitivo, visual o verbal y secuencial o global, se cuantificaron, se tabularon y se hicieron análisis de varianza (ANOVA) para muestras paramétricas.

Contribución. Esta investigación permitió identificar los estilos de aprendizaje de estudiantes de nivel Licenciatura en el período pospandemia, para conocer las preferencias de aprendizaje actuales, que pueden aplicarse para proponer, en su caso, los ajustes necesarios dentro de las estrategias de enseñanza de los docentes interesados en disminuir la alta tasa de reprobación y de deserción actuales

Estilos de aprendizaje, índice de deserción, índice de reprobación

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## Introduction

Much research has been done considering learning styles, Gibson's original idea (Gibson, E.J., 1969), but the term was proposed by Keef (Kolb, 1984) who explained them as the intellectual and affective attributes with which learners understand and interact with their learning environments; learning styles provide insight into different ways of approaching, planning and undertaking learning needs and can be classified in a variety of ways (Rivas *et al.*, 2018).

Education systems need to consider that students experienced different and varied learning practices during the period from 2020 to 2022, depending on the conditions for distance learning, at home, influenced by educational level, motivation, mood, access to devices and connectivity, socio-emotional and mental health challenges when there were family losses, time available and quality of materials offered by schools, to name a few, highlighting the need to implement appropriate interventions to overcome this stage. There is no one-size-fits-all solution to the challenges faced by education systems. Among the priorities to be taken into consideration are the need to look for initiatives to re-engage students who have dropped out or failed; to focus on review and reinforcement of unseen topics for skills development; in case of proposing hybrid digital and face-to-face teaching schemes, to create quality content for these purposes; to offer support outside school hours; and to develop activities to promote mental health and decrease post-pandemic stress (UNICEF and UNDP report *Evidencia Impacto de La Pandemia En La Educación*, n. d.).

As part of the development of these ideas, recognising that different learning styles exist and identifying how they are now manifesting themselves and the conditions that enable them to apply their skills should be an important aspect of the development of the current conditions of the learning process.

For a long time, traditional education favoured a formal, rigorous, strict and theoretical education in which students were passive elements of the learning process: the teacher dictated, they took notes, memorised and were evaluated with a final exam, those who did not conform to this model were considered bad students, the grades obtained were accepted as a measure of the student's intellectual capacity.

Later research showed that it was not always the student with the best grades who was the most successful in their professional performance and that some students with dubious academic backgrounds were able to develop the necessary activities that allowed them to progress in their profession; traditional teaching assessment began to be considered less reliable because in many cases it became evident that people can learn and develop particular skills depending on the environment in which they find themselves.

Learning styles refer to individual differences in learning, expressed as responses to different stimuli and information that determine the most appropriate conditions for students to develop competences, and to which the actions mentioned in the previous paragraph can be attributed (Díaz Mosquera, 2012).

The knowledge of learning styles dates back to the second half of the last century, a great variety of learning styles are mentioned, from visual, verbal, logical, auditory, social, intrapersonal, physical or physical learning, logical, auditory, social, intrapersonal, physical or kinaesthetic and kinaesthetic and naturalistic learning. Although there is no single classification, the following are some of those referred to by different authors, the Neurolinguistic Programming (NLP) of Grinder and Bandler, refers to the preference of people for visual, auditory or kinaesthetic activities to process information, to learn, being dynamic processes that can interact with each other and that at any given time there may be a dominant one. This model, questioned as a "myth", can be considered within the learning process as a possible tool to improve academic performance (Jaruffe Romero, Arlinthon David; Pomares Jacquin, 2011). According to Kolb (Kolb, 1984), plausible learning requires processing the knowledge transmitted in four aspects: concrete experience, reflective observation, abstract conceptualisation and active experimentation. Also Felder and Silverman (Felder & Silverman, 1988), trying to know the learning preferences of engineering students proposed the following dimensions of learning styles: sensory or intuitive, visual or verbal, active or reflective, sequential or global and likewise, students may have a preference for any of these, or use some aspects of the others.

Hermann's Brain Preference Model proposes that the brain can be divided into 4 different areas of cognitive development and explains the way of learning according to the major area of development that can be presented, it is still used as a reference to know the personality styles and how they influence their abilities or talents (Rojas et al., 2006). The VARK model provides a quantification of students' learning styles, assessing four sensory modalities: visual, auditory, textual and kinaesthetic, and each individual can present from one to all four, with all their combinations, as a learning style.

Similarly, there are different proposals to evaluate the student's learning style in each of the proposed models, among them is the ILS questionnaire (Sabry & Baldwin, 2003) which is integrated with four cognitive aspects: processing, perception, comprehension and representation, which evaluates perceptual preferences along with environmental, emotional, sociological and information processing preferences. The VARK Questionnaire, developed by Fleming (Fleming, 1992), which assesses learning preferences without considering personality characteristics, information processing and social relationships in the classroom, consists of 16 questions with four response options, each corresponding to a different learning style (visual, auditory, reading/writing and kinaesthetic).

### Methodology to be developed

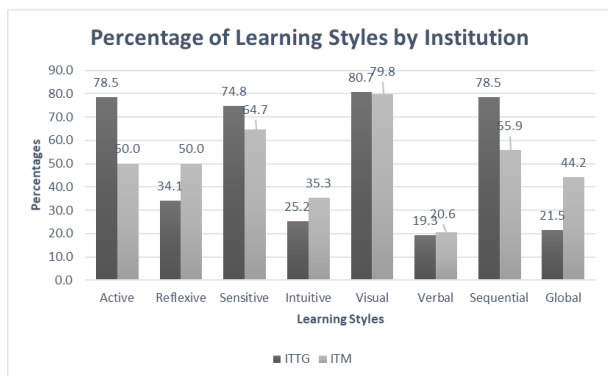
The universe of this analysis was 169 engineering students from the courses of Calculus, Algebra, Unit Operations and Food Specialty of the Tecnológico Nacional de México, Campus Mérida (ITM) and Campus Tuxtla Gutiérrez (ITTG). These students are taking these subjects, which are curricularly obligatory and from different degree courses such as Electrical Engineering, Electronic Engineering and Biochemical Engineering. Students from different degree courses and semesters participated: from Electronic Engineering (ITM) students were studying from the 1st to the 4th semester; from Electrical Engineering and Electronic Engineering from the 1st to the 4th semester and from Biochemical Engineering (ITTG) from the 6th to the 8th semester.

They were selected because they represent a group of students of interest to the research, being from different academic areas, different subjects and semesters and although they are all TecNM students, they are from different campuses, considering that the main objective of the research is to know the learning styles currently preferred by undergraduate students, to manage this knowledge in the form of a diagnosis and to be able to make them known in a general way to the teachers responsible for the different areas of study, in an attempt to support the idea of avoiding as far as possible the high degree of failure and desertion that is currently occurring in our institutions. The learning style expressed by the students can be applied by teachers to improve their educational practice. For the very purpose of the research a purposive sampling was carried out, characterised by obtaining representative samples by introducing typical groups, varied in terms of the area of knowledge. The purpose of the research was explained to each group of students in each subject, and their cooperation was requested in answering a survey in an objective and reflective manner, with the observation that their answers would be anonymous and that those who did not wish to answer could do so. The Felder and Silverman survey (Felder & Silverman, 1988) was sent out, a Google form was developed for this purpose and shared in the respective groups to be answered during a face-to-face class in each of the subjects. This survey was used, after analysis of the options of evaluative questionnaires of learning styles by the teachers participating in the research, who decided to use it due to the characteristics and versatility in terms of the learning style options that could be detected with this questionnaire, which has a high reliability index (0.9728, Cronbach's  $\alpha$ ), being a survey that allows the student to express their acceptance or not in each question. The total of the responses obtained were evaluated according to Felder and Silverman's proposal (Felder and Silverman, 1988), the responses were placed in the categories of learning styles proposed by the author in active or reflective, sensitive or intuitive, visual or verbal and sequential or global, they were quantified, graphed and analyses of variance (ANOVA) were carried out to find out if there is a significant difference between the results of learning styles between institutions, semesters and degrees. These results could be applied, in a propositive way, to act assertively in teaching activities, with the aim of reducing the high rates of failure and desertion present.

**Results**

There are different abilities in young people to process information, some individuals prefer visual information, with diagrams, presentations, etc., while others opt for verbal instructions, lectures and guides.

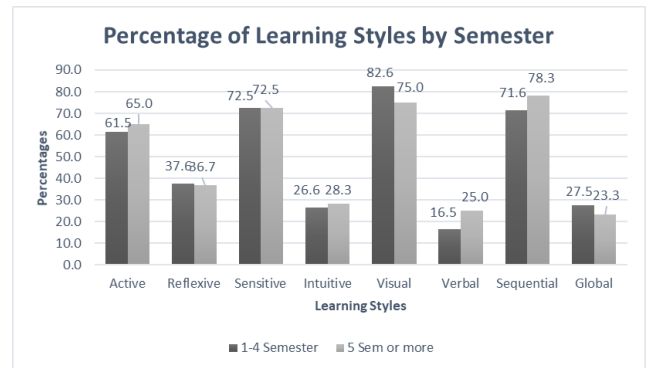
There are also those who learn through practice, others prefer to work with concrete information and experiments, while others like abstractions, mathematical models and theory, i.e. they present different learning styles, among others. The learning styles of the total sample of students from the Tuxtla Gutiérrez Campus (ITTG) and the Merida Campus (ITM) are as follows: The largest number of students from ITTG turned out to be visual (80.74%), and from ITM (79.41%), in both institutions were classified as active 78.52% and 50%, reflective 34.07% and 50%, sensitive 74.81% and 64.71%, Intuitive 25.19% and 35.29%, verbal 19.26% and 20.59%, sequential 78.52% and 55.88%, global 21.48% and 44.18% respectively, finding significant difference only in the active status between both institutions. Graphic 1 summarises the above information.



**Graphic 1** Results of the survey to determine learning styles by educational institution  
Source: Own elaboration

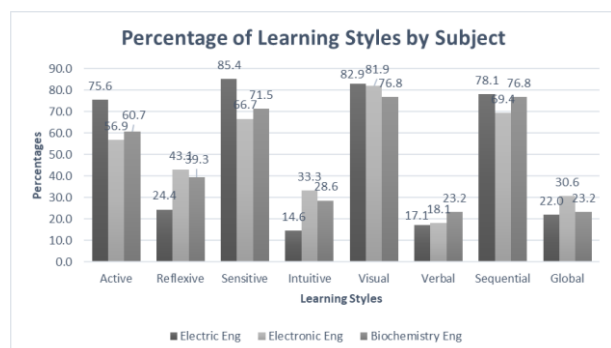
Analysing the learning styles by semester (graphic 2), the following results were obtained: The highest percentage (82.57%) in students from 1st to 4th semester (1-4th semester) was in visual style and from 5th semester onwards (5th semester or more) 78.33% was sequential. In students of 1-4 semester the active style was 61.47% and the reflective 37.61%, and in students of 5th semester and above the active style was 65% and the reflective 36.66%; in students of 1-4 semester the sensitive style was 72.48% and the intuitive 26.6%, in those of 5th semester and above the sensitive was 72.47%, while the intuitive style was 28.33%.

In the verbal strategy, students in the 1st-4th semester accounted for 16.51% and those in the 5th semester and above for 25%. Finally, in the sequential strategy 1-4 semester students accounted for 71.56% and in the global strategy 27.52%; students in 5th semester or more in the global strategy accounted for 23.33%. In none of these cases was there a significant difference between groups.



**Graphic 2** Results of the survey to determine learning styles by semester  
Source: Own elaboration

For the analysis of the answers given by degree courses, the following results were found (see graphic 3). The students of Electronic Engineering (IEL) with 81.94% in visual style and Electrical Engineering (IE) both in visual and sensitive style presented the highest percentages, being 82.92% and 85.36% respectively. In the active style Electrical Engineering (IE) showed 75.61%, IEL 56.94% and IBQ 60.71% and in the reflective style IE with 24.39%, IEL 43.05% and IBQ 39.28%. In the sensitive-intuitive style pair, IE reached 85.36% and 14.63%, IEL had 66.66% and 33.33% and IBQ 71.46% and 28.57% respectively. In the visual-verbal styles IE obtained 82.92% and 17.07%, IEL 81.94% and 18.05% and IBQ 76.78% and 23.21% respectively; finally in the sequential-global styles the values of IE 78.05% and 21.95%, IEL 69.44% and 30.55% and IBQ 76.78% and 23.21% are shown in the given order, with no significant differences between active-reflective, Sensitive-intuitive, visual-verbal and sequential-global pairs.



**Graphic 3** Results of the survey to determine learning styles by degree

Source: Own elaboration

Taking into consideration the objective of this research, to identify and analyse the learning styles of the students of different areas of Engineering of the two campuses of the TecNM, it was found that the students of the two Institutions have predominance by the visual style, who learn preferably with the use of images, diagrams, animations, figures, they can use this style to carry out all or some of their activities; By semesters, being 1-4 semesters, students of Basic Sciences, were visual in a 82.57% and in second place sensitive with 72.48%; students from 5th semester onwards, 78.33% were sequential and in second place visual with 75%. Students with sensitive styles prefer to obtain information by immediate application of theorems, they like to learn with concrete materials, with practices or practical applications, with real-life facts, project-based learning, applicative problems, giving less importance to developing the imagination, and sequential students develop linear, step-by-step ways of thinking, preferring activities in which they solve problems with continuous solutions, which do not require them to go beyond knowing a defined, unchanging sequence. In a similar analysis to the previous ones, applied by career, IE students were 85.36% sensitive and in second place visual with 82.92%; IEL obtained 81.94% as visual and in second place as sequential with 69.44%, in visual and sequential styles with the same percentage of 76.78 and in second place with 71.46 sensitive were IBQ students. It is observed that the predominant learning styles among the students are visual, sensitive and sequential, which were obtained as a personal decision, optional but not exclusive of the other learning styles.

No specific learning style profile is known for Engineering students, however, according to (Caballero, 2014) Engineering students could, by the very nature of the profession, be more active, sensitive, visual and sequential learners than reflective, intuitive, verbal or global learners, characteristic styles that have also been reported in Biochemistry and Nursing students (G. Campos & Campos, 2018). The results obtained show that they have very marked styles, in the sense that the three learning styles indicated are dominant, many of the recommended teaching activities are in line, commonly used by TecNM teachers, applying visual presentations, carrying out and developing problems, case analysis, laboratory practices, teamwork, industrial visits; The result of this research also allows to visualize the possibility of stimulating in the academic formation of the students all the learning styles and not only those in which they demonstrate to have certain strengths, as an example if their main learning style is the visual, why not stimulate their learning to the reflective style, so that they can be more versatile in their academic performance.

### Acknowledgement

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### Conclusions

The main learning styles in Engineering students were reviewed and identified according to Felder and Silverman's proposal (Felder & Silverman, 1988) mostly as visual, sensitive and sequential.

In addition to the above, it is necessary to support the student by applying teaching strategies according to their learning style, recognising that the high failure and dropout rate is a complex problem that depends on many other factors such as personal interests, motivation, social context, etc., and must be taken into account. and should be taken into account, considering that even when teachers apply a diversity of teaching strategies and resources, a subject should incorporate activities for all learning styles, varying the strategies and being flexible in teaching in order to take advantage of the strengths and seek to develop those styles less applied by the students.

From the results obtained, it can be seen that there is a great variety of styles in the process of acquiring competences; learning is defined by the environment, social and economic conditions of the context in which the pedagogical activity is developed. As a consequence, learning styles oscillate from visual to sensitive in the course of their academic training, perhaps due to prolonged exposure to digital devices in their daily lives on a permanent basis, so it will be necessary in future research to determine whether this factor or another is a determining factor in the development of learning styles.

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