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Estilos de aprendizaje en estudiantes de pregrado de Ingeniería y Administración en la Universidad Politécnica de Tulancingo

Learning Styles in Undergraduate Students of Engineering and Administration at the Polytechnic University of Tulancingo

Estilos de aprendizagem em estudantes de graduação em Engenharia e Administração da Universidade Politécnica de Tulancingo

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Resumen

La investigación se realizó con el propósito de analizar los estilos de aprendizaje presentes en estudiantes de cinco carreras ofrecidas en la Universidad Politécnica de Tulancingo (UPT), México. El objetivo principal fue identificar los estilos predominantes de aprendizaje y examinar su distribución según el género y el área de estudio. Para lograr este propósito, se empleó una metodología que incluyó cada uno de los reactivos utilizando el Cuestionario Honey-Alonso de Estilos de Aprendizaje (CHAEA), el cual fue completado por 122 estudiantes seleccionados como muestra representativa que incluyen alumnos del área de Ingenierías y Económico Administrativas. Los resultados revelaron una moderada predominancia de los estilos activo y pragmático entre los alumnos evaluados. Específicamente, se observó que el estilo reflexivo destacaba como predominante en ambas áreas de estudio, aunque con una inclinación ligeramente mayor hacia las ingenierías.

La comparación de estos hallazgos con estándares de referencia validó la clasificación de los resultados obtenidos. Al analizar los datos desde una perspectiva de género, se observó que, entre las mujeres, en ambas áreas de estudio, prevalecía un estilo de aprendizaje reflexivo-pragmático, mientras que entre los hombres se registraba un ligero aumento en ambos perfiles. En resumen, los estudiantes mostraron una marcada inclinación hacia los estilos reflexivos con un 80% y pragmáticos con un 87% de preferencia, según los resultados obtenidos. Estos hallazgos proporcionan información valiosa sobre las preferencias de aprendizaje de los estudiantes en dicha institución educativa, lo cual puede ser útil para mejorar las estrategias de enseñanza y el diseño curricular.

Palabras clave: estrategias pedagógicas; estilos de aprendizaje; cuestionario Honey-Alonso; pragmático.

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Abstract

The research was conducted with the purpose of analyzing the learning styles present in students from five programs offered at the Polytechnic University of Tulancingo (UPT), Mexico. The main objective was to identify the predominant learning styles and examine their distribution according to gender and field of study. To achieve this purpose, a methodology was employed that included each of the items using the Honey-Alonso Learning Styles Questionnaire (CHAEA), which was completed by 122 students selected as a representative sample, including students from the Engineering and Economic-Administrative areas. The results revealed a moderate predominance of active and pragmatic styles among the evaluated students. Specifically, it was observed that the reflective style stood out as predominant in both areas of study, although with a slightly greater inclination towards engineering.

The comparison of these findings with reference standards validated the classification of the results obtained. When analyzing the data from a gender perspective, it was observed that among women, in both areas of study, a reflective-pragmatic learning style prevailed, while among men there was a slight increase in both profiles. In summary, the students showed a marked inclination towards reflective styles with 80% and pragmatic styles with 87% preference, according to the results obtained. These findings provide valuable information about the learning preferences of students at this educational institution, which can be useful for improving teaching strategies and curriculum design.

Keywords: pedagogical strategies; learning styles; Honey-Alonso questionnaire; pragmatic.

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Resumo

A pesquisa foi realizada com o objetivo de analisar os estilos de aprendizagem presentes em estudantes de cinco carreiras oferecidas na Universidade Politécnica de Tulancingo (UPT), México. O objetivo principal foi identificar os estilos de aprendizagem predominantes e examinar a sua distribuição segundo o género e a área de estudo. Para atingir esse objetivo, foi utilizada uma metodologia que incluiu cada um dos itens por meio do Questionário de Estilos de Aprendizagem Honey-Alonso (CHAEA), que foi preenchido por 122 alunos selecionados como uma amostra representativa que incluía alunos das áreas Administrativa de Engenharia e Economia. Os resultados revelaram um moderado predomínio dos estilos ativo e pragmático entre os estudantes avaliados. Especificamente, observou-se que o estilo reflexivo se destacou como predominante em ambas as áreas de estudo, embora com uma inclinação um pouco maior para a engenharia.

A comparação desses achados com padrões de referência validou a classificação dos resultados obtidos. Ao analisar os dados numa perspectiva de género, observou-se que, entre as mulheres, em ambas as áreas de estudo, prevaleceu um estilo de aprendizagem reflexivo-pragmático, enquanto entre os homens houve um ligeiro aumento em ambos os perfis. Em resumo, os alunos demonstraram uma acentuada inclinação para estilos reflexivos com 80% e estilos pragmáticos com 87% de preferência, de acordo com os resultados obtidos. Estas descobertas fornecem informações valiosas sobre as preferências de aprendizagem dos alunos dessa instituição de ensino, o que pode ser útil para melhorar as estratégias de ensino e o desenho curricular.

Palavras-chave: estratégias pedagógicas; estilos de aprendizagem; Questionário Honey-Alonso; pragmático.

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Introduction

Throughout life, knowledge is acquired and the best way to obtain practical knowledge that facilitates meaningful learning is sought. In addition, individual preferences are discovered in the study process, which can evolve over time and interaction with the educational environment. In this context, Alonso, Gallegos and Honey (1994) use the term "style" in the pedagogical field and its most common use is to describe a variety of behaviors grouped under the same name. When applied to learning, this term provides indicators that guide the person's interactions with reality.

This is why educational institutions must focus on the comprehensive training of students, adopting a coherent educational model that prioritizes learning and reinforces both the general and specific aspects of the academic project. Calderero Hernández et al., (2014).

The concept of learning styles (LS) has been the subject of an exhaustive analysis. As a result of this process, the word "style" has been defined as the set of skills, inclinations, tendencies and attitudes that a person has to perform a specific task and which are evidenced through a behavioral model and various skills (García, et al., (2009).

In contrast, academic learning is distinguished by factors such as intrinsic motivation, self-control, and the ability of students to self-regulate their activities, which facilitates the analysis of their environment. In addition, it promotes the active and efficient use of knowledge, both in formal and informal learning, allowing students to develop advanced skills in the application of what they have learned (Zimmerman, 2002).

Learning styles influence personality formation by processing information through different perceptual channels, which affects the way in which one faces, solves and acts in different situations. Although it is generally believed that these styles are mostly stable in a person, they can experience variations in different contexts. Adapting teaching to students' learning styles can improve the effectiveness of the educational process (Kolb, 1984).

This research was conducted at the Polytechnic University of Tulancingo, located in the city of Tulancingo de Bravo, Hidalgo, Mexico. The UPT offers degrees in Computer Systems Engineering (ISC); Electronics and Telecommunications Engineering (IET); Industrial Engineering (II); Manufacturing Engineering (IM); Robotics Engineering (IR); Civil Engineering (IC); Financial Engineering (IF); Business Administration and Management (AGE) and; International Business (NI).

The student community of the Polytechnic University of Tulancingo is made up of individuals from various municipalities that make up the Tulancingo region. This geographic diversity includes a significant participation of students from the state capital and from other areas located in the Sierra and Huasteca. Additionally, the institution receives students from various municipalities in neighboring states such as Mexico, Puebla and Veracruz, among others.

From a socioeconomic perspective, the majority of students come from families with incomes ranging from middle to low. This economic situation forces 40% of students to combine their studies with work activities. The objective of these jobs is to generate the income necessary to cover the financial needs related to their academic development. This double burden of

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responsibilities, both academic and work, reflects the additional challenges faced by a considerable proportion of students in their efforts to achieve their educational goals.

In the 2023 Annual Operating Program activities report, one of the UPT's objectives is to find alternatives that promote optimal academic development for its student community. Therefore, the educational institution has considered carrying out a diagnosis of the learning styles of its students in the various majors, as a priority element to improve the knowledge acquisition process and achieve increased learning. This is a commitment that the University has with the academic community.

In the literature review, a wide variety of tools for assessing learning styles has been observed. Each of these tools is based on theories that are classified as cognitive and behavioural, as well as Theoretical, Active, Reflective and Pragmatic types. In this context, the CHAEA questionnaire was chosen, since it was identified as the most frequently used in research on learning styles in higher education institutions.

The objective of this research was to corroborate the results identified in the literature, observing their correspondence in the students of the UPT. The aim is to carry out a detailed analysis of the learning styles of the students of the institution in order to make informed decisions to enhance the quality of teaching .

Consideration of EA can be crucial to improve academic performance, as this will allow us to know the individual preferences of students in the acquisition and processing of information. Knowing the results will facilitate the personalization of teaching and the creation of effective learning strategies, contributing to increasing the confidence and security of students, as the learning process will adapt to their own ways and will not be rigidly imposed.

Background

In recent decades, higher education has undergone changes and improvements worldwide, with positive effects on educational quality and social engagement in certain countries. In educational settings, teaching work must focus on learning strategies that impact the knowledge acquisition process and address the difficulties encountered by all students. It is crucial that the educational process be active, dynamic, and learning-centered, as noted by Miramontes Arteaga, J., et al. (2019). This approach involves designing activities with a clear purpose (Maina, 2020) and carrying out an assessment consistent with that purpose to support the achievement of learning objectives (Figueroa, 2021). Such functions are diversified in

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online classroom environments, thanks to the flexibility allowed by their integration into the acquisition of skills, knowledge, and abilities of students (Rotar, 2022).

Clearly, research on EA in university students is gaining importance in numerous universities in Latin America, with the purpose of reducing significant school dropout rates, improving teachers' teaching methods, increasing students' academic performance and positioning institutions, by recognizing their positive achievements in quality evaluations of educational programs, Rochin Berumen, (2021).

One of the significant challenges for students is identifying their own learning styles. At the same time, teachers face the complex task of adjusting their teaching methods to the diversity of styles presented by their students.

To address this difficulty, it is crucial to investigate and analyze the different learning styles that students use in various areas of their specialty. This implies teaching planning that includes the creation of plans, the development of educational content, and an evaluation focused on competencies, covering knowledge, skills, and attitudes (Felder & Silverman, 1988).

Various methods are used to identify learning styles. Based on his research, Alonso (1992) developed a framework that defines the characteristics that determine the skills related to each style, as presented in Figure 1. Alonso, et al. (2007).

Within the framework, four cyclical phases of learning styles are identified. The first, "Active", is characterized by enthusiasm, improvisation, exploration, boldness and spontaneity. The second, "Reflective", is distinguished by caution, thoroughness, receptivity, analysis and attention to detail.

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Figure 1. Cyclic phases of learning styles

Figure 1. Learning Styles according to Alonso, et al. (2007).

The third phase, "Theoretical," is defined by systematicity, logic, impartiality, critical thinking, and structuring. Finally, the "Pragmatic" phase focuses on experimentation, practicality, efficient direction, and realism. These phases represent different approaches to the learning process, ranging from action and experience to reflection and practical application.

The results obtained by Alonso (1992) were very important, since they set precedents in pedagogical research and have served as a basis for other research in Spain and in different Latin American countries, such as Mexico, Chile, Argentina, Peru and Costa Rica, among others.

The methods used to identify the dominant learning style among students in the Higher Mathematics course at the School of Electrical Engineering at the University of Costa Rica were investigated. The Felder-Silverman test was the main assessment tool. The results of the analysis of the instrument's axes and the cluster analysis showed that students tend to have a balance on the axes (80% in active-reflective and 70% in sequential-global), although they show notable preferences for visual (55.7%) and sensorial (45.9%) learning styles (Felder & Silverman, 1988) . The analysis by Avendaño et al. (2021), concludes that teachers' understanding of their students' learning styles could establish a competent teaching- learning process. The fact that there are similarities and differences in the learning profile has implications for the development of instruction and, therefore, for learning itself. Therefore, Avendaño et al. (2021) points out that student understanding of their own learning style can facilitate their learning process. When students understand their individual preferences, both

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positive and negative, they can learn more effectively. By remembering their particular learning characteristics and adjusting the environment, whenever possible, to accommodate these preferences, students can significantly improve their academic performance.

Methodology

To achieve this purpose, a methodology was used that included the Honey-Alonso Learning Styles Questionnaire (CHAEA), completed by 122 students selected as a representative sample from the areas of Engineering and Economic-Administrative Studies. The groups in which the instrument was applied were chosen randomly, with the authorization of the teachers and the consent of the students. The operative variable was the "learning style (LS)", measured by the Honey-Alonso Learning Styles Questionnaire (CHAEA) (Alonso et al., 1999), which consists of 80 items divided into four sections (active, reflective, theoretical and pragmatic), with a dichotomous score of "Agree" or "Disagree". The absolute score obtained in each section determined the students' learning styles.

The data were processed using the SPSS statistical program version 22, using descriptive and inferential statistical methods to analyze the data from the CHAEA questionnaire. The work was carried out in five phases: analysis of the CHAEA instrument and diagnosis of learning styles; application of the questionnaire; processing and analysis of results; evaluation of the questionnaire parameters; and determination of the correlation between majors, defining the learning styles of students in each one. This approach made it possible to establish specific learning profiles for each major, providing a basis for teachers to adapt their methodologies to different learning styles, thus optimizing teaching and learning processes in the knowledge era.

Results

For the application of the questionnaire, Google Forms was used, integrating the 80 questions, and to obtain the data, SPSS Statistics 22 was used. In a set, the divisions of the economic-administrative and engineering areas are shown in a total of 122 students.

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Table 1. Descriptive statistics to observe the normality of the data on the learning styles of UPT students.

	Average	Standard deviation	Asymmetry		Kurtosis	
	Statistical	Statistical	Statistical	Standard error	Statistical	Standard error
Asset	12.7561	3.73363	.021	.218	-.669	.433
Thoughtful	15.9180	3.07103	-1.216	.219	2.528	.435
Theorist	14.7073	3.08814	-.452	.218	.007	.433
Pragmatic	14.9262	3.06451	-.805	.219	1.457	.435
N valid (by list)						

Source: Own elaboration.

In Table 1, the four EAs of the selected sample were analyzed, and it can be observed that, on average, students scored higher in the reflective and pragmatic styles, with means of 15.92 and 14.93 respectively, indicating a tendency towards these styles. In addition, it can be noted that the distribution of scores for the reflective style has a greater variability, with a standard deviation of 3.07 and a kurtosis of 2.528, suggesting a more pointed and skewed distribution to the left compared to a normal distribution.

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Table 2. Descriptive statistics of the learning styles of UPT students, by gender.

Gender		N	Minimum	Maximum	Average	Standard deviation
Female	Asset	60	5.00	20.00	12.8500	3.68609
	Thoughtful	60	2.00	20.00	15.5333	3.51494
	Theorist	60	5.00	20.00	14.0833	3.51410
	Pragmatic	60	3.00	20.00	14.4333	3.39175
	N valid (by list)	60				
Male	Asset	63	5.00	20.00	12.6667	3.80577
	Thoughtful	62	9.00	20.00	16.2903	2.54396
	Theorist	63	10.00	20.00	15.3016	2.50570
	Pragmatic	62	8.00	20.00	15.4032	2.65169
	N valid (by list)	62				

Source: Own elaboration.

Table 2 presents descriptive statistics of the learning styles of students at the Polytechnic University of Tulancingo, broken down by gender. It is observed that, on average, women tend to score higher in the reflective and theoretical styles, with means of 15.53 and 14.08 respectively, while men score higher in the reflective style, with a mean of 16.29. This suggests possible differences in learning styles between genders at the UPT. In addition, it can be noted that the standard deviation is relatively similar between genders for each style, indicating that scores are similarly dispersed around the mean in both groups.

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Table 3. Descriptive statistics of UPT students' learning styles by area.

Area		N	Average	Standard deviation
Engineering	Asset	52	12.5385	3.78056
	Thoughtful	52	15.5385	3.45538
	Theorist	52	14.4615	3.20209
	Pragmatic	52	14.7308	3.42491
	N valid (by list)	52		
Economic-Administrative	Asset	71	12.9155	3.71770
	Thoughtful	70	16.2000	2.74311
	Theorist	71	14.8873	3.01212
	Pragmatic	70	15.0714	2.78360
	N valid (by list)	70		

Source: Own elaboration.

Table 3 shows descriptive statistics of the learning styles of students from the Polytechnic University of Tulancingo, broken down by area of study. It is observed that, in both the Engineering and Economic-Administrative areas, the predominant profile is reflective, with means of 15.54 and 16.20 respectively. This suggests that in both areas students tend to be more reflective in their learning style. In addition, it can be noted that the standard deviation, which indicates the dispersion of the data around the mean, is relatively similar between areas and learning styles, suggesting consistency in the responses within each area of study.

Regarding the variability of the information, it is identified by means of box graphs, applied in the two areas of study: engineering and economic-administrative.

As regards the reflective EA, it can be observed in Figure 2 that the data behaved as follows: in both areas, the distribution of the data is asymmetrical; in the economic-administrative view, the median of the data is around 16 correct answers, unlike engineering, where there is a greater dispersion between the first and second quartiles. The existence of a greater number of reflective students in engineering is identified.

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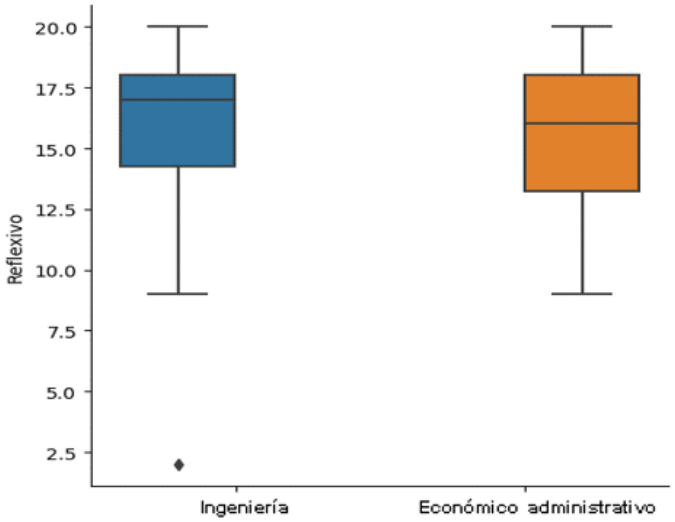
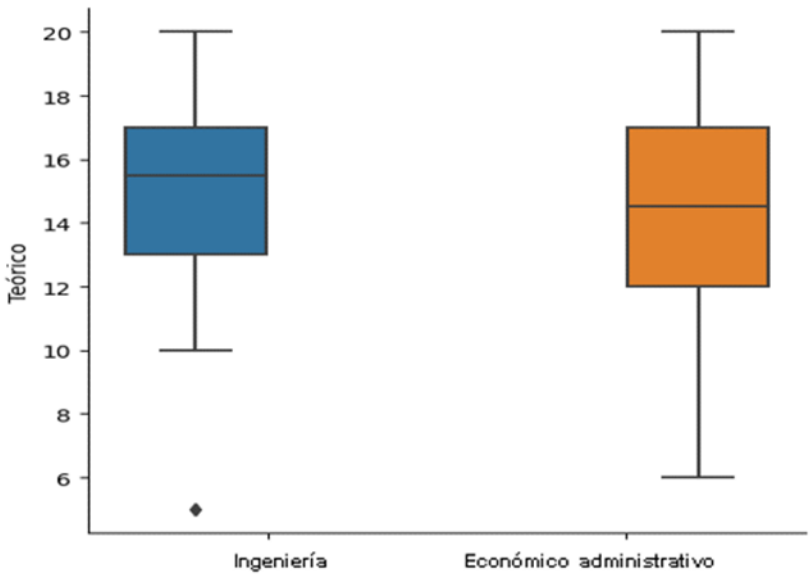
Figure 2. Boxplot of reflective attribute of UPT students.



Source: Own elaboration.

In the analysis of the theoretical attribute, it can be observed in Figure 3 that in the economic-administrative area, there is a greater distribution in the first quartile, which indicates that 25% of the respondents answered between 6 and 13 correct answers. The median of engineering and economic-administrative students, in the questionnaire scale, shows a very high preference in this area.

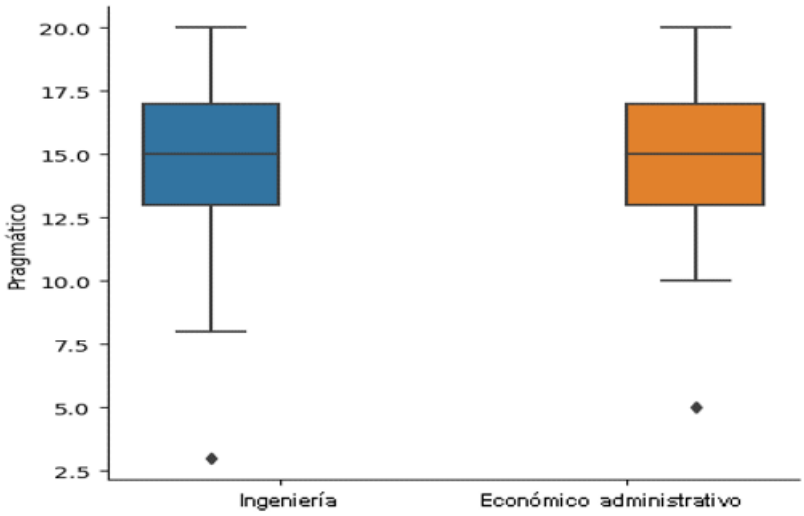
Figure 3. Boxplot of theoretical attribute of UPT students.



Source: Own elaboration.

In the case of the "pragmatic" attribute (see figure 4), it is found that both samples, engineering and economic-administrative, present a median of 15, falling within the preference scale of "high". An asymmetry is accentuated in the case of engineering, where a greater dispersion of data is observed in 25% of the respondents; that is, there is a variability of scores. In the case of economic-administrative, an almost symmetrical presentation is shown.

Figure 4. Boxplot of pragmatic attribute of UPT students.



Source: Own elaboration

In the case of the attribute "active" (see figure 5), it is found that in the preference scale in the case of engineering there is a high level, unlike economic administration, where there is a moderate level. This corresponds to the nature of the study plans of each of the areas surveyed. Likewise, it is observed that there is a similarity in both areas in that 25%, their maximum level in the reagents, is 10.

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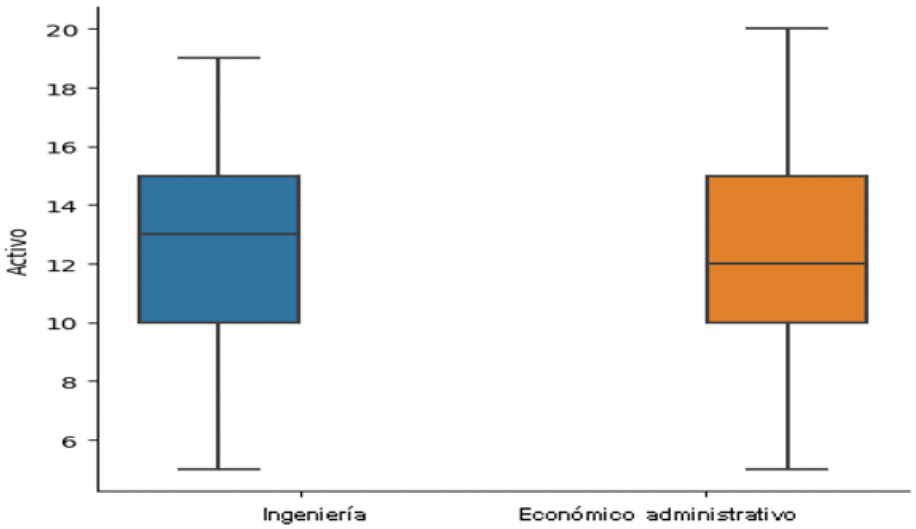
Figure 5. Boxplot of active attribute of UPT students.



Source: Own elaboration

The summary of the scale proposed by the author is shown in the following table, with the representative percentages of the results obtained.

Alonso's (1997) general scale of learning style preferences, illustrated in Table 4, was used to describe the results and student scores. Preferences for each learning style according to the score were assigned absolute numbers and classified as "Very low " , "Low", "Moderate", "High" or "Very high".

As can be seen in Table 4, there is a slight similarity with the means with respect to the original scale, which gives validity to the classification of the results obtained.

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Table 4. Scales for the Engineering and Economic-Administrative divisions.

	Feature	Very low	Low	Moderate	High	Very High
Engineering	Asset	5-8	9-12	13-16	17-20	20-23
			Average (12.54)			
	Thoughtful	2-6	7-11	12-16	17-21	22-26
				Average (15.53)		
	Theorist	5-8	9-12	13-16	17-20	20-23
				Average (14.46)		
	Pragmatic	5-8	9-12	13-16	17-20	20-23
Economic - Administrative	Asset	5-8	9-12	13-16	17-20	20-23
				Average (13.0)		
	Thoughtful	9-11	12-14	15-17	18-20	21-23
				Media (16.2)		
	Theorist	6-9	10-13	14-17	18-21	22-25
				Average (14.88)		
	Pragmatic	8-10	12-14	15-17	18-20	21-23
				Media (15-07)		

Source: Own elaboration.

Analysis of learning styles

Active learning style

In the frequency analysis of the items for the active learning style, the highest value was: "I like to seek new experiences" (95%), followed by the statements: "I feel comfortable with spontaneous and fun people" (91%); "I try to be aware of what is happening here and now" (85%); "I grow with the challenge of doing something new and different" (77%); "I contribute new and spontaneous ideas in discussion groups" (77%); and, finally: "I get bored quickly with methodical and detailed work" (64%); and "I tend to let myself be carried away by my intuitions" (62%).

On the other hand, the lowest scores are for: "Overall, I talk more than I listen" (37%); "I think it is necessary to break the rules much more often than to follow them" (41%); and "I find it uncomfortable to have to plan and foresee things" (41%).

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Reflective learning style

In this category, the statement with which students had the greatest affinity was: "I usually reflect on issues and problems" (94%), followed by: "In discussions, I like to observe how other participants act" (91%), "I like to weigh up various alternatives before making a decision" (91%); "In debates and discussions, I prefer to play a secondary role rather than be the leader or the one who participates the most" (91%); "I enjoy having time to prepare my work and do it thoroughly" (85%); and "I prefer to hear the opinions of others before expressing my own" (83%).

On the other hand, the lowest scores are found in the statements: "I make several drafts before writing a final work" (58%); "In debates and discussions I prefer to play a secondary role rather than be the leader or the one who participates the most" (67%).

Pragmatic learning style

This category is highly valued for the statements: "I think we should get to the point early, to the heart of the matter" (93%); and "I check beforehand whether things really work" (93%); followed by "I like to experiment and put things into practice" (92%); "When there is an argument, I don't like to beat around the bush" (88%); "I think the most important thing is that things work" (83%); "I often realise other, better and more practical ways of doing things" (83%); "I like realistic and concrete people more than theoretical ones" (79%); and "I am attracted to experimenting and putting into practice the latest techniques and innovations" (79%).

In this learning style, the lowest scores are: "I reject original and spontaneous ideas if I don't see them as practical" (48%); "I often judge others' ideas by their practical value" (45%); and "I am willing to hurt other people's feelings in order to achieve my goal" (36%).

Theoretical learning style

In this learning style, the predominant statement is: “I am sure of what is good and what is bad, what is right and what is wrong” (95%); followed by: “I almost always try to be consistent with my criteria and value systems. I have principles and I follow them” (91%); and “It bothers me when people don't take things seriously” (87%).

Here, the statement with the lowest average is: "I think it is necessary to break the rules many more times than to follow them" (46%).

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Discussion

The inclusion of learning styles in the educational process is a crucial aspect to improve the academic performance and learning experience of students. The Polytechnic University of Tulancingo has recognized the importance of this consideration in its 2023 Annual Operating Program, where it focuses on finding alternatives to promote optimal academic development among its student community. Understanding learning styles and adapting teaching to these styles can significantly improve the educational process, allowing students to learn according to their preferences and strengths. This personalized approach to teaching can enhance the educational experience and foster effective learning.

Learning styles are a relevant topic in today's education, and understanding them can have a significant impact on the quality of teaching and the academic performance of students. Alonso, Gallegos, and Honey (1994) define the term "style" as a set of behaviors grouped under the same name, which provides indicators to guide a person's interactions with reality. In this sense, it is crucial for educators to understand their students' learning styles in order to adapt their teaching methods and promote effective learning. Avendaño et al. (2021).

Personalizing instruction according to individual learning styles can enhance students' educational experience by allowing them to learn according to their preferences and strengths. This aligns with the idea that learning is an active and personalized process, in which students construct their own knowledge based on their experiences and learning styles (Alonso, Gallegos, & Honey, 1994).

The results obtained in this research corroborate previous findings on the importance of adapting teaching to students' learning styles. This suggests that personalizing teaching can contribute to improving students' academic performance and learning experience Coto Jiménez, (2020).

Understanding students' learning styles and adapting teaching can significantly improve the educational process. This research contributes to the existing literature on learning styles by analyzing the learning styles of students at the Polytechnic University of Tulancingo and providing recommendations to improve the quality of teaching at this institution. Using the Honey-Alonso Learning Styles Questionnaire, it was possible to identify the different styles that prevail among students at the Polytechnic University of Tulancingo, located in Hidalgo, Mexico. This analysis included students enrolled in academic programs belonging to the economic-administrative and engineering areas of the university. In addition, the levels of predominance associated with each style that was identified were verified.

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The frequency analysis of learning styles shows a high result in the style Active, with 79%, in which students say they prefer learning that occurs primarily through action, with practical activities based on direct experiences in real-world situations. They enjoy teamwork and social interactions and tend to quickly apply what they learn in concrete situations. Likewise, this style shows that, at a low level, with 39%, students tend to talk more than listen, have a perspective that values the need to break rules in certain cases, and feel uncomfortable having to plan and anticipate situations.

The reflective learning style shows, at 88%, that students tend to adopt a thoughtful and careful approach both in decision-making and in interacting with others. They prefer to observe and listen before assuming leadership roles in discussions, they value considering various alternatives before deciding, and they find satisfaction in the conscientious preparation of their activities. The preference for reflection and observation suggests a disposition towards a more contemplative and considered approach in their life and interactions. Similarly, at a lower level, at 62%, it is shown that students have a moderate disposition towards the practice of making several drafts before the final writing of a work, which indicates a certain flexibility or variability in their approach to writing.

On the other hand, there is a more evident preference towards playing a secondary role in debates and discussions, indicating a clear inclination towards observation and moderate contribution in brainstorming situations. These findings suggest a balance between flexibility in the writing process and a more marked preference for a secondary role in verbal interactions. The pragmatic learning style included 87% of the students, who display a pragmatic and action-oriented mindset. They value efficiency and functionality, prefer to approach issues directly and often look for practical ways of doing things. Their attraction to innovation and applying the latest techniques suggests adaptability and openness to new ideas. Similarly, with a lower score of 43%, students are shown to display a pragmatic approach in their learning style and evaluation of ideas. They prefer practical ideas, but do not completely reject originality. In addition, they demonstrate moderate consideration for the feelings of others when pursuing their goals.

As for the theoretical style, with 98%, students show strong confidence in their ethical values, seek coherence and adhere to their personal principles, valuing seriousness in various situations.

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Below are several strategies that teachers can use to stimulate and support students based on their predominant learning styles. These recommendations seek to promote a more effective learning environment tailored to individual needs.

To promote an active lifestyle:

- Propose short questions and motivate students to look for different ways to solve the task presented.
- Make sure that the proposed activities are varied and different and that they investigate and look for solutions.
- Ask students for volunteers to explain or share what they have done in small groups.
- It is recommended to encourage collaborative work within groups and for the teacher to only make brief theoretical presentations, always within a problem or situation to be solved.

To encourage reflective style:

- Provide students with an appropriate amount of time to work on the topic and do not move on from one activity to another until the analysis has been completed.
- Promote listening as a basis for reflection and argumentation, reasoning and giving importance to the depth and precision of the responses.
- It is desirable to develop consultation of texts, bibliography and various computer sources.
- The teacher will encourage students by insisting that they think carefully about what they are going to say and that they review the exercises before handing them in (giving them time to do so).

To promote the theoretical style:

- Present well-structured activities, asking students to be logical in their approaches and not express themselves ambiguously.
- Ask them to solve the exercises, explaining and specifying the steps they are taking.
- It is recommended that the teacher always teach the content within a broader theoretical framework and present the exercises with strategies that allow for the establishment of associations. It is also good to present complex experiences and

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problems, but the instructions for the steps to follow must be offered in a coherent and logical manner.

To foster the pragmatic style:

- Work on experiences and activities in the environment, where students provide brief, precise and direct answers.
- It is recommended that the teacher propose tasks that require their implementation to apply them in other situations and that the students seek to put them into practice.
- Provide students with plenty of examples or models to emulate.
- When teaching theoretical content, accompany it with practical examples from everyday life.
- You can invite experts to your classes to showcase their knowledge and skills.
- Promote realistic teaching and have students work with clear instructions on the objectives to be achieved.

Conclusions

Research on learning styles in undergraduate students at the Polytechnic University of Tulancingo has yielded significant results that can influence the improvement of pedagogical strategies and curricular design. The analysis, carried out using the Honey-Alonso Learning Styles Questionnaire (CHAEA), has allowed us to identify a moderate predominance of the active and pragmatic styles among the students evaluated, with a notable inclination towards the reflective style, especially in the area of Engineering.

The distribution of learning styles by gender revealed that, among women, a reflective-pragmatic style prevails in both areas of study. In contrast, among men, a slight increase in these profiles was observed, suggesting differences in learning preferences between genders that could be considered in the design of more inclusive and effective pedagogical strategies.

The finding of a strong preference for reflective and pragmatic styles (80% and 87%, respectively) underlines the importance of adapting teaching methodologies to better align with students' preferences. Implementing teaching strategies that consider these styles can enhance students' academic performance and learning experience, making it more effective and personalized.

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Furthermore, the research validates the usefulness of the CHAEA questionnaire as a tool to identify learning styles in the context of higher education, providing a solid foundation for future research and pedagogical applications at UPT and other similar educational institutions.

Understanding students' learning styles is essential to improving educational quality. The results obtained provide valuable guidance for implementing teaching methods tailored to students' specific needs, which can significantly contribute to their academic success and personal development. This student-centred approach not only promotes more effective learning, but also strengthens student engagement and motivation, preparing a new generation of competent and well-trained professionals.

Contributions to future lines of research

This study offers a detailed view of the predominant learning styles among students at the Polytechnic University of Tulancingo, Mexico, through the analysis of the Honey-Alonso Learning Styles Questionnaire (CHAEA). From this analysis, different contributions were identified that could significantly impact the improvement of the teaching-learning process and the promotion of inclusion in the classroom, in which three key contributions that could be derived from the findings of this study stand out:

1. *Development of multimedia teaching units adapted to the predominant learning styles:* the findings suggest the need to design teaching units that encourage the student's reflective role in the teaching-learning process. These units could integrate information on learning styles and provide pedagogical tools to develop specific learning skills, taking into account the students' styles.
2. *Implementing personalized teaching strategies:* The results of the learning style analysis can be used by teachers to adapt their teaching methods and provide more effective and meaningful learning experiences for students. This could involve incorporating hands-on activities, guided discussions, and action-oriented projects, based on the learning styles identified.
3. *Promoting Inclusion and Diversity in the Classroom* **:** Understanding and respecting students' different learning styles can help create a more inclusive and equitable educational environment. Educators can use this information to design activities that meet students' diverse needs and preferences, thereby promoting participation and academic success for all students, regardless of their predominant learning style.

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