ENVIRONMENTAL SCIENCES & PRACTICES
http://mlsjournals.com/Environmental-Science-Practices

(2024) Environmental Sciences & Practices, 2I(1), 41-59.

Learning styles of engineering students at the National Autonomous University of Honduras

Estilos de aprendizaje de los estudiantes de ingeniería de la Universidad Nacional Autónoma de Honduras UNAH

UNAH

Marco Antonio Ramos Espinal
Autonomous University of Honduras, Honduras
(marco.ramos@unah.edu.hn) (https://orcid.org/0000-0003-1389-4026)
Eduardo Joaquín Gross Muñoz
Universidad Nacional Autónoma de Honduras (Honduras)
(eduardo.gross@unah.edu.hn) (https://orcid.org/0000-0003-3082-5145

Manuscript information:

Received/Recibido: 28/07/23
Reviewed/Revisado: 03/01/24
Accepted/Aceptado: 15/01/24

Keywords:
learning style, active, reflective, pragmatic.

ABSTRACT

The present investigation serves to elucidate the way that Engineering students of the National Autonomous University of Honduras UNAH learn. The UNAH is the largest University and the one that occupies the first place in Honduras, it is a public one and with a constitutional mandate to govern higher education in the Honduran territory. Determining the learning styles of students opens a gap so that educational experiences can be built through study plans and curricular and extracurricular activities that benefit learning, that better engineers are trained to help solve problems huge amounts that overwhelm the Honduran population, in areas such as forestry, agronomy, industrial, chemical, electrical, mechanical, systems and agro-industrial. The design used is non-experimental and cross-sectional with a stratified random sample with data collection through Google Forms. The establishment of the learning style was carried out using the CHAEA questionnaire of Honey-Alonzo and analysis of variance in two factors and multiple was used to find the differences in the learning styles by careers, place of birth and place of residence, also, it was The discriminant equations were built and the Pearson correlation coefficient was calculated, a significant correlation was found at 0.001 between the active, reflective and pragmatic styles, concluding in relatively low values in the levels associated with the learning styles, which defines great possibilities. for the design of appropriate learning experiences in careers.

Palabras clave:
estilo de aprendizaje, activo, reflexivo, pragmático.

RESUMEN

La presente investigación sirve para dilucidar sobre la manera que los estudiantes de Ingeniería de la Universidad Nacional Autónoma de Honduras UNAH, aprenden. La UNAH es la Universidad mas grande y la que ocupa el primer lugar en Honduras, es una pública y con un mandato constitucional de rectorar la educación superior en el territorio hondureño. La determinación de los estilos de aprendizaje de los estudiantes abre una brecha para que se puedan construir las

	experiencias educativas a través de planes de estudio y actividades curriculares y extracurriculares que beneficien el aprendizaje, que se formen mejores ingenieros que coadyuven con la solución de los problemas ingentes que agobian a la población hondureña, en área como la forestal, agronómica, industrial, química, eléctrica, mecánica, sistemas y agroindustrial. El diseño utilizado es no experimental y transversal con una muestra aleatoria estratificada con recolección de información a través de Google Forms. El establecimiento del estilo de aprendizaje se realizó usando el cuestionario CHAEA de Honey-Alonzo y se utilizó análisis de varianza en dos factores y múltiple para encontrar las diferencias en los estilos de aprendizaje por carreras, lugar de nacimiento y lugar de residencia, también, se construyeron las ecuaciones discriminantes y se calculó el coeficiente de correlación de Pearson, se encontró correlación significativa a un 0.001 entre el estilo activo, reflexivo y pragmático, concluyéndose en valores relativamente bajos en los niveles asociados a los estilos de aprendizaje, lo cual define grandes posibilidades para el diseño de experiencias de aprendizaje apropiadas en las carreras.

Introduction

It includes the presentation of the paper and the analysis of the literature on the subject, with special emphasis on previous research that justifies the study and that will be contrasted in the discussion of the results.

All text is in 12-point Cambria font, single-spaced and with no spacing between paragraphs. The National Autonomous University of Honduras (UNAH) is the largest university in Honduras with an enrollment of more than 80 thousand students(UNAH, 2023b) the majority of its courses are undergraduate, with a smaller number of postgraduate degrees, in 10 faculties, and several regional centers. Engineering careers are developed in several centers, mainly in the CU University City, located in Tegucigalpa, Department of Francisco Morazán and in the Sula Valley, Department of Cortés, in the city of La Ceiba, Department of Atlántida and in the city of Choluteca, in the Department of the same name. It is said with great certainty that a considerable percentage of the engineers working in the Honduran territory graduated from the UNAH, even many of those who direct engineering careers in other private or public universities, were also graduates of the UNAH or had some relationship with it.

On September 19, 1847, the university was solemnly inaugurated in a public ceremony headed by President Juan lindo and Rector José Trinidad Reyes. The UNAH gained autonomy on October 15, 1957 by decree number 170, which defined the first organic law of the University. Article 160 of the Constitution of the Republic establishes that the UNAH has the exclusive right to organize, direct and develop higher and professional education in the country.

In 1881, the faculty of sciences was incorporated, which was to offer civil engineering studies for a duration of five years. In 1904, the engineering faculty was founded with 11 students, and it was named the school of topographical engineering. In 1920, the first reform of the civil engineering curriculum was made, in 1959 the semester studies began, and in 1960 the building where the School of Engineering is currently located was built. In 1967 new careers were created and in 1968 the enrollment and hiring of full-time professors in the technical careers of chemical and electrical mechanical engineering was achieved. The UNAH has an industrial information center created in 1975 and in 1981 the Industrial Engineering program was created, and in 2003 the Systems Engineering program was incorporated. In 2021, the curriculum for the Master's degree in Environmental Engineering was registered with the General Secretariat of the UNAH (UNAH, 2023a)

In the development of engineering careers, the question arises as to how students learn, and how they manage to make that learning become a source of memories that will help them for much of the rest of their lives (Ojeda & Herrera, 2013, p. 166). Of course, there is no one way, and even someone who at some point learns one way may later in his or her own life learn another way. But it is not only the ways in which they learn that are influential, but also how they are taught (Chowdhury, 2015) Learning is best conceived of as a process and not in terms of the products that can be obtained from such activity (Kolb, 2014)this represents a basic idea of experiential learning theory, which rests on different epistemological and philosophical views from behaviorist theory (Schunk et al., 2012). Tocci (2013) states that "cognitive, affective and physiological traits" are associated with the concepts that students define and therefore the dominant learning style defines the best way to learn.

A subject that is developed in a way that is contrary to the learning style of a student will surely cause him/her greater difficulty to study and learn it, and would limit the scope of the objective set out in the curriculum to train professionals, specialists, researchers, etc., with the minimum required characteristics, considering that both classroom and distance or online training are considered, which can have a great impact even to improve language skills (Kuzmina et al., 2021).

It is considered that success in learning is not only achieved with teachers who are highly trained in the subject they serve, but who adequately express their social and human competencies, who set their teaching objectives well, who respect and motivate students, who build appropriate evaluation mechanisms according to the way in which their students learn best (Arias Gallegos, 2011).

Tulsi et al., (2016) found that engineering students prefer active, sensitive, and sequential styles of learning. On the other hand, the CHAEA questionnaire, Honey, Alonzo questionnaire of Learning Styles, was based on the contributions of Honey and Mumford, used in Spain by Alonso, Gallego & Honey, establishing four Learning Styles: Active, Reflective, Theoretical and Pragmatic (Alonso et al., 1997, p. 110)the knowledge of learning styles becomes a tool to propose new and better teaching strategies (Molina-Cabello et al., 2023, p. 1)also, evidence is found on the treatment given to students in their learning, which could imply the reinforcement of the use of differentiated strategies depending on the learning style of each student (Rofiq & Pratiwi, 2023, p. 1).

But we do not think only of the traditional teaching that has been used in countries such as Honduras, that is, the traditional model in which the teacher is like the only source of light in knowledge. In addition to repeating the teaching of subjects confined in books, perhaps classics and others not, some very old and others the same but with updated versions, which of course is fabulous, but it also requires modifications even of paradigms both in the way of learning and teaching as could be observed in the post pandemic, where the intensive use of internet, devices, etc., requires new ways and both for teaching and learning.

In the teaching ecosystem, a new way of learning and teaching called education 4.0 where the new needs of students and teachers (ras) converge to make the process more effective (Gueye & Exposito, 2023), references of institutions that seek to reinforce knowledge in the area of engineering and previous mathematics subjects, as is the case of the Coimbra Engineering Institute and its Center for Engineering Mathematics Support (CeAMate) according to learning styles (de Almeida et al., 2023).

Design of experiments for learning, in which the student is allowed to develop their subjects in different ways, with the proper construction of experiments and pre and post evaluation, according to the idea of identifying learning styles to improve education in engineering (Yesilevskiy et al., 2022). Consequently, knowing the learning style, which is more or less stable during a good part of life, the next step is the construction of experiences according to that reality, because the main objective is to achieve new memories, that is, new knowledge, which applied to the good, serves as a basis for the construction of a better society (Haltas, 2022, p. 1). The barriers that the teacher has, i.e. their mental blocks, the diversity of ways of learning in a single room or even in a virtual space, pose a problem of adaptation or adjustment of the teacher, how to harmonize so that the teaching is effective for everyone (Bhogayata & Jadeja, 2022)

Regarding learning styles, Honey and Munford, based on Kolb's approaches, define them as active, reflective, theoretical and pragmatic, with some features indicated in Table 1 below.

Table 1

Traits of learning styles according to Honey and Mumford

Features	Features
Assets	They are fully involved, open-minded, non-skeptical and enthusiastic about new tasks.
Reflective	They like to observe from different perspectives, they gather and analyze data carefully, they are detailed and prudent, they evaluate alternatives before taking any action and they already know the situation well.
Theoreticians	They identify with complex theories, tend to perfection by analyzing and synthesizing, seeking rationality and objectivity
Pragmatists	Practical application of ideas, looking for the positive in order to experiment, they act quickly and confidently, impatient in search of a solution.

Note. Authors' own source, adapted from Alonso et al., (1997)

According to Ojeda y Herrera, (2013)the term style is used in psychology in relation to the way in which each individual performs an activity" and in the context of learning, style refers properly to education, it implies the way of obtaining knowledge. According to Smith, (1982) five elements that help learning, namely:

1. Learning is lifelong, we learn with the family, at school, with friends, always, as long as life lasts there is learning
2. Personal learning
3. Learning processes are associated with changes
4. Human development is intimately linked to learning
5. Learning and experience go hand in hand

According to the points indicated, some elements involved in learning can be established, as shown in Figure 1.

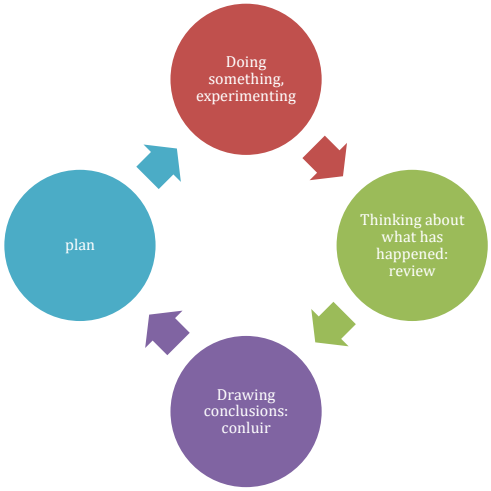
Figure 1

Elements in a learning situation

The figure shows the involvement of the environment, what the young people learn, the attitude and of course the emotions, with what a student finally does, and in the case of the results obtained from Honey Alonzo's questionnaire. These are approximately the same in each of the styles, probably so that students can learn in almost any circumstance(Alonso et al., 1997, p. 179)the phases are illustrated in Figure 2,

Figure 2

Learning cycle



Note. Diagram of the elements involved in learning, taken from (Alonso et al., 1997, p. 179)

The teacher's task is not an easy one, however, Martínez, Geijo y otros (2009) citing Alonso et al., (1997), define a series of teaching behaviors that favor each of the learning styles, and Table 2 summarizes the information:

Table 2
Behaviors that favor learning styles

Assets	Reflective	Theoretical	Pragmatic
1. Attending to spontaneous questions 2. Be up to date 3. Show genuine interest in students 4. Accept and understand what you feel 5. Frequently come up with new content and projects 6. Promoting and encouraging innovative activities 7. Requiring students to search multiple paths with feasible solutions 8. Constantly varying activities 9. Students must invent problems and come up with solutions 10. Contribute new ideas, even if they clash with precepts 11. Encourage teamwork 12. Continuous research 13. Breaking routines 14. Make short theoretical presentations 15. Use different methods of presenting the subject 16. Working on problems obtained from the environment	1. Develop few topics with the students. 2. Address issues with students in detail and depth 3. Require students to review exercises before submitting them 4. Pay no attention to the superficial 5. Do not make them explain something in public without prior explanation 6. Do not ask questions in class if not previously announced 7. Explain slowly, allowing time for reflection 8. Encourage the collection of information for analysis 9. Allow ample time for the tests to be carried out 10. Do not proceed with activities unless the possibility of analysis has been exhausted 11. Establish timely academic planning at the beginning of each term. 12. Every job you do should be created at the draft level for review prior to submission 13. Explain in detail 14. Insist on listening first and then formulating an opinion 15. Arguing from rationality always 16. The quality of the presentation of reports and assignments is unquestionable 17. Reflecting on facts or events, leaving no loose ends 18. Never improvise or force them to do so	1. Activities should always be super structured 2. All work, tasks, etc., must have clear purposes 3. Applying work pressure to students 4. Let everything in the class be questioned 5. Do not promote activities charged with emotions and feelings 6. Maintain a calm and orderly climate 7. Establish with precision the theoretical framework of the positions within the class 8. Assessing in public what students think and reason about 9. Do not emphasize trivial or superficial issues 10. Consult on criteria and principles 11. Demanding works explained in detail, informing each procedure. 12. Explanations must be logical and follow a clear order 13. Avoiding open problems 14. Insist that students be logical and avoid expressing ambiguities 15. Academic planning must be completely linked, defining a common thread in everything that happens in the classroom. 16. To promote professional relationships more than emotional ones 17. Do not allow students to speak spontaneously	1. Learning techniques 2. Doing tasks that are related to each other 3. Everything must be shown with practical examples 4. Bringing subject matter experts into the classroom 5. Reducing explanations by practical activities that enhance learning 6. Building viable and useful projects 7. If something works well, it is because it is useful 8. Search for shortcuts that lead to a solution 9. Work more on procedures than on theoretical explanations 10. Show that the important thing is that things work 11. Creating great learning experiences 12. Enhancing realism and practicality 13. Valuing the result over the procedure 14. Decrease the time of theoretical explanation.

Note. Authors' own source, adapted from (Martínez Geijo & others, 2009).

The construction of learning experiences requires a great deal of skill from the teacher but more from the will to carry them out, the great objective is to take advantage of the personal characteristics of each student and as far as possible create the conditions that allow each student to make the most of them. Countries like Honduras, mired in poverty and

backwardness, require engineers to solve problems at the lowest cost and to benefit the majority. To achieve this, or at least get closer to a possible solution, the UNAH must synchronize its administrative and academic aspects, giving priority to the latter, since it is even a constitutional obligation to direct higher education in order to contribute to solving the enormous problems that afflict the population.

All of the above implies giving priority and flexibility to the construction of curricula in accordance with the reality of the needs of science, society, the productive sectors and all the forces that make up society. It cannot be that an institution with such an obligation cannot overcome the administrative formalities and not provide educational solutions, i.e. timely offers. The construction of adequate experiences also requires the vocation of the teacher, it is archaic and stale thinking to postpone for the sake of postponing students, just because the only light of the world is the teacher, must leave, disappear from university classrooms, comprehensive education but focused on the student is the basis for progress and improve conditions.

Nor should the petty interests of sectors linked to education give way to the empire of knowledge, it is not possible to stop the advancement of the public university for political and private interests and arrangements that only aim at unbridled enrichment, sacrificing the quality of education for accumulation in the style of savage capitalism, leaving thousands of young people on the sidelines and depriving them of access to the best possible education.

It seems that the hidden interest is not to let them advance, in that sense it is important to indicate that teachers of stale thinking, too, must learn again to discard their misconceptions and be forgers of better people, or get out of the way because they are in the way.

The most important thing in the UNAH is not its authorities, nor its buildings, nor its professors, nor anyone else but the students. The establishment of learning styles in the framework of the theory constructed by Honey Alonzo, allows an adequate and fast way to formulate a research with the current tools of the Internet and allows to give lights to improve the process especially of teaching, adapting to new achievements and taking advantage of the bonus of youth that students have, since we are talking about young people whose ages range between 18 and 25 years mostly, and who demand that the arbitrary and perhaps orthodox methods of teaching are adjusted even if it is little by little, but that define a gap for the construction of a better university.

Beyond academic planning, curricula or study plans are required that in their methodological components emphasize the way of teaching, not only in the content and topics to be covered, which are important, but cannot be served in the same way always and to everyone, therefore, it requires a hard work of the teacher to plan how to achieve the construction of new memories and link them with the previous ones and thus achieve new knowledge, that is the most difficult part, that is the complicated part, how to design these activities that at least benefit the majority, since not everyone learns the same way, but the majority will be benefited, or else how can we expect the country to have better prepared children if the way to do it is just one more activity, perhaps poorly served or constructed and that has forced the student to think that the only important thing is to pass the course and get a degree, this last thought is probably the responsibility of the teacher, who transmits only that, in the worst of the cases, the most regrettable ones by the way, who serves the subject, does not have the adequate formation, and avoids questions, reacts with violence or assaults the students wanting to make them feel bad, as if the deficiency of the one who teaches should be borne by them. In the case of learning styles measured through the Honey Alonzo questionnaire, it is suggested to improve the styles when the active one obtains scores lower than 9, the reflective one when it is lower than 14, the theoretical one lower than 10 and the same for the pragmatic one (Alonso et al., 1997, pp. 180–190)

Method

The learning style of engineering students enrolled in the first academic period of 2023 at the National Autonomous University of Honduras was established through a non-experimental, cross-sectional design. Considering as the target population all students enrolled in the various careers of the Faculty of Engineering, which is developed in several study centers as shown in Table 3,

Table 3

Students enrolled in the School of Engineering careers

University Center	Number of students enrolled
Central Regional University Center CURC	551
Centro Universitario Regional del Litoral Atlántico CURLA	365
Centro Universitario Regional del Litoral Pacifico CURLP	421
Northeastern Regional University Center CURNO	181
Tecnológico de Danlí, UNAH-TEC Danlí	193
Central Regional University Center CUROC	352
CU University City	4593
Distance Education Learning Resource Centers (CRAED) in several cities in Honduras	10
Cloth I.T.S.T	2
UNAH Sula Valley	2497
UNAH TEC-Aguan	102
UNAH VS-Telecentro Cortés	1
Total	9268

Note. *Adapted from information provided by the Dirección de Ingreso Permanencia y Promoción DIPP of the UNIVERSIDAD NACIONAL AUTÓNOMA DE HONDURAS UNAH, 2023, (UNAH, 2023b)*

From the total population, stratified random sampling was developed in one stage by sending the questionnaire to those selected using the Google Forms platform, which is hosted at the address: https://forms.gle/vN7vRdCMyFHBSRqp6the details of the sample are shown in Table 4:

Table 4

Sample size

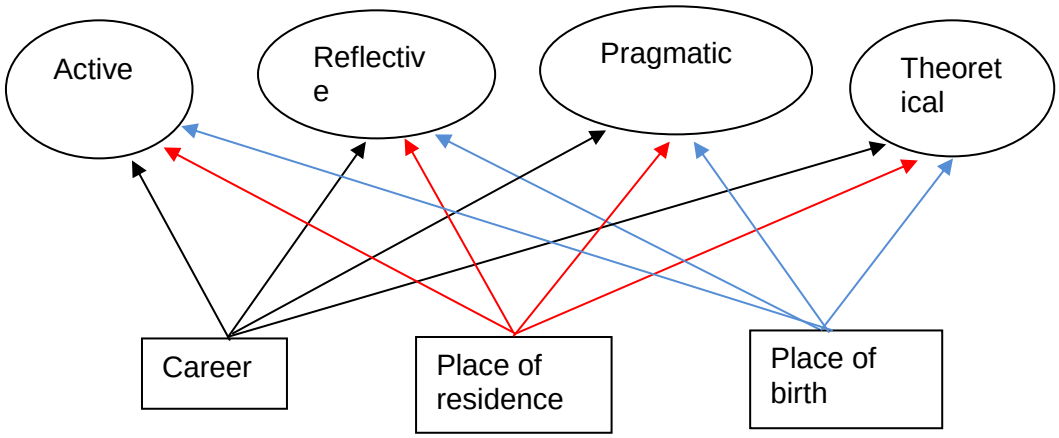
Career	Sample Size	Response obtained
Agroindustrial Engineering	60	15
Agricultural Engineering	13	1
Civil Engineering	49	32
Industrial Electrical Engineering	71	64
Systems Engineering	100	44
Forestry Engineering	3	1
Industrial Engineering	41	73
Industrial Mechanical Engineering	31	58
Chemical Engineering	25	82
Grand Total	392	370

Note. Own elaboration using stratified sampling (Mendenhall et al., 2006, p. 94)

As can be seen, the value defined in the sample was not achieved, but the analysis was performed with the information collected. The analysis of the data consisted of establishing the learning style of the students through the use of the graph associated with the Honey Alonzo questionnaire, then it is of interest to know if there is a difference between the values obtained in each learning style by the students of each career, so a two-factor analysis of variance is performed with a sample by group and also, by place of birth through the Department, said extreme is also verified with a two-factor analysis of variance and a sample by groups. To verify the existence of differences in each of the leadership styles, a multiple variance analysis was performed, using as factors the career studied, place of birth and place of residence, and the differences found are verified with a discriminant analysis as shown in Figure 4,

Figure 4

Multiple variance analysis, determination of differences in learning styles of UNAH engineering students



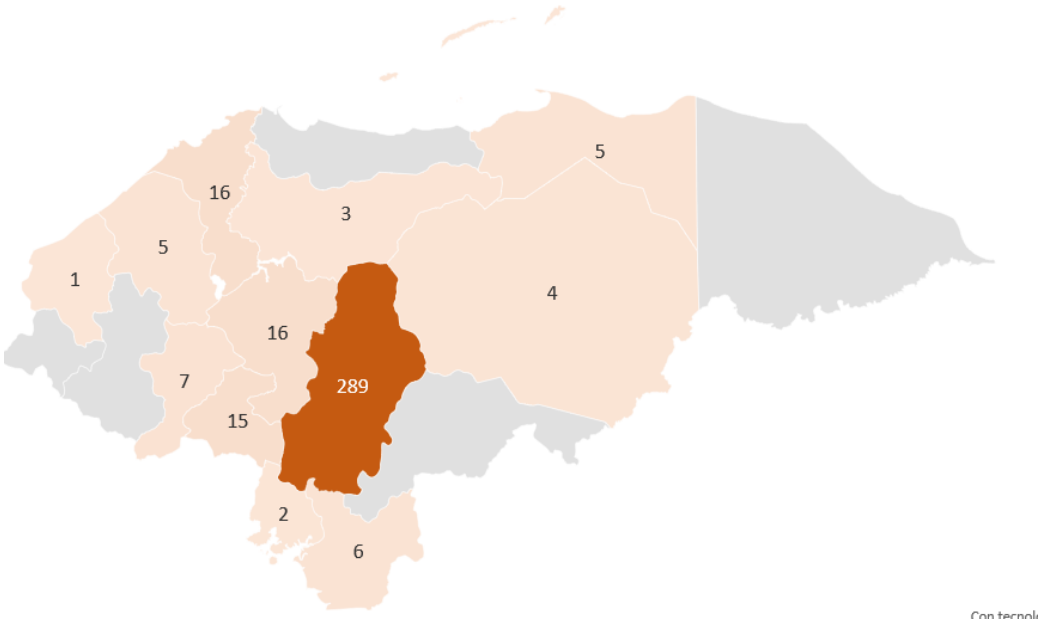
Note. This figure shows the multiple analysis on the value of learning styles.

In order to determine the relationship that may exist between the academic index of the students and their manifest learning style, the study of the relationship is proposed through a linear regression model, and the corresponding correlation coefficient is calculated. Student participation includes various regions of the country, with the highest participation in the

Department of Francisco Morazán, where the University City (CU) is located, as shown in Figure 5:

Figure 5

Geographical distribution in the Republic of Honduras, of responses from Engineering students at UNAH



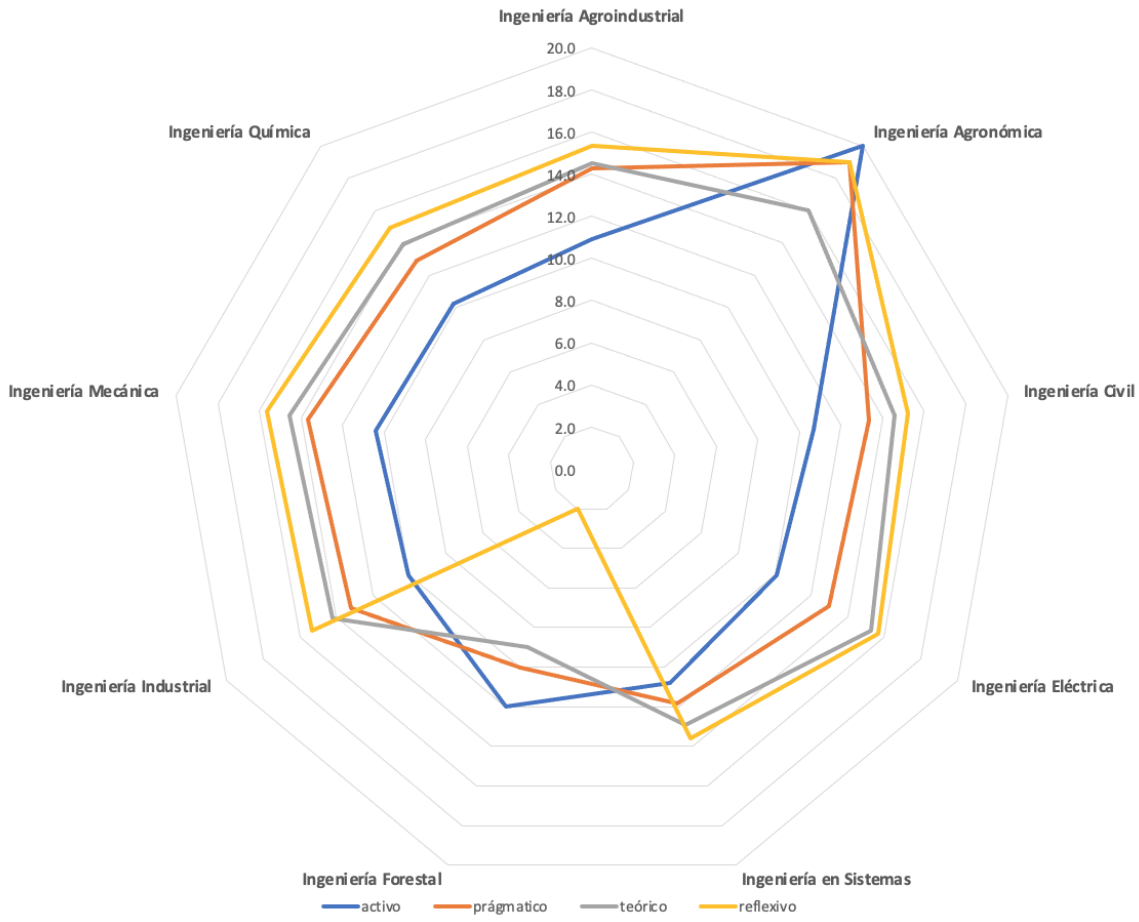
Note. This figure shows the political and geographic distribution of the Republic of Honduras in its 18 Departments, and the number of students who responded to the questionnaire. Own elaboration based on the data collected.

Method

Figure 6 shows the learning style based on the Honey Alonzo questionnaire for each of the careers

Figure 6

Learning styles of engineering students at the UNAH



Note. This figure shows the learning styles of the students of the Faculty of Engineering of the UNAH, enrolled in the first period of 2023, in the different careers. Own elaboration based on the data collected

Table 5 shows the result of the average value of the responses of the engineering students, which establishes their position in relation to the questionnaire items, as shown below:

Table 5

Assessment of learning style by career

Career	*Active*	*Pragmatic*	*Theoretical*	*Reflective*
Agroindustrial Engineering	10.9	14.3	14.53	15.3
Agricultural Engineering	20.0	19.0	16.00	19.0
Civil Engineering	10.7	13.3	14.56	15.2
Electrical Engineering	10.1	13.0	15.30	15.7
Systems Engineering	10.8	11.8	12.93	13.6
Forestry Engineering	12.0	10.0	9.00	2.0
Industrial Engineering	10.0	13.2	14.19	15.3
Mechanical Engineering	10.4	13.7	14.57	15.7
Chemical Engineering	10.2	12.9	13.91	14.9

Note. *Own elaboration based on the answers obtained*

By performing the two-factor analysis of variance and one sample per group, the following results were generated as shown in Table 6, Analysis of Variance of two factors of

leadership styles versus race and Table 7, Analysis of Variance of leadership styles versus Department of Birth,

Results

Table 6

Two-factor analysis of variance of learning style versus career

Origin of variations	Sum of squares (SC)	Degrees of freedom(gl)	Mean squares	F	Pr(>F)
Careers	216.157765	8	27.0197206	5.22707447	0.000737703**
Style	32.0360222	3	10.6786741	2.06583278	0.131428286
Error	124.060466	24	5.16918607		
Total	372.254253	35			

Note. *Own elaboration based on the data collected, ** significant difference at 0.001*

Table 7

Two-factor analysis of variance of learning style versus Department of Birth

Origin of variations	*Sum of squares*	*Degrees of freedom*	*Mean squares*	*F*	*Pr(>F)*
Department	58.7289931	12	4.894082758	2.279454097	0.028065091
Styles	275.4598958	3	91.81996528	42.76580646	5.89567E-12
Error	77.29349739	36	2.147041594		
Total	411.4823863	51			

Note. Own elaboration based on the data collected

After performing a multiple variance analysis, taking learning styles as dependent variables, and career, place of birth and place of residence as predictor variables, the results of the variance analysis are shown in Table 8,

Table 8

Result of multiple variance analysis, learning style versus career, place of birth and place of residence

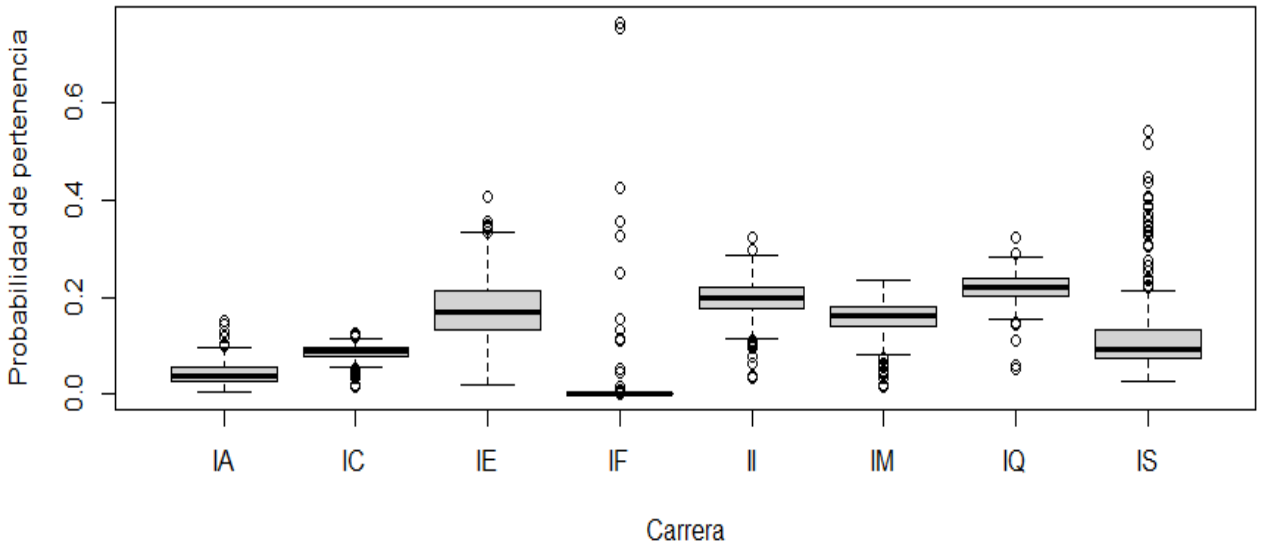
Source of variance	gl	Pillai	Approx F	Num Df	den Df	Pr(>F)
Career	8	0.21875	1.8151	32	1004	0.003912**
Place of residence	52	0.68733	1.0015	208	1004	0.484985
Place of birth	57	0.76199	1.0363	228	1004	0.357091
Residuals	251					

Note. Own elaboration based on data collected, ** difference significant at 0.001

To study the significant difference in learning style due to career, a multiple discriminant analysis was performed, obtaining the results shown in Figure 7.

Figure 7

Behavior of learning styles across centroids of predicted probabilities of belonging versus careers



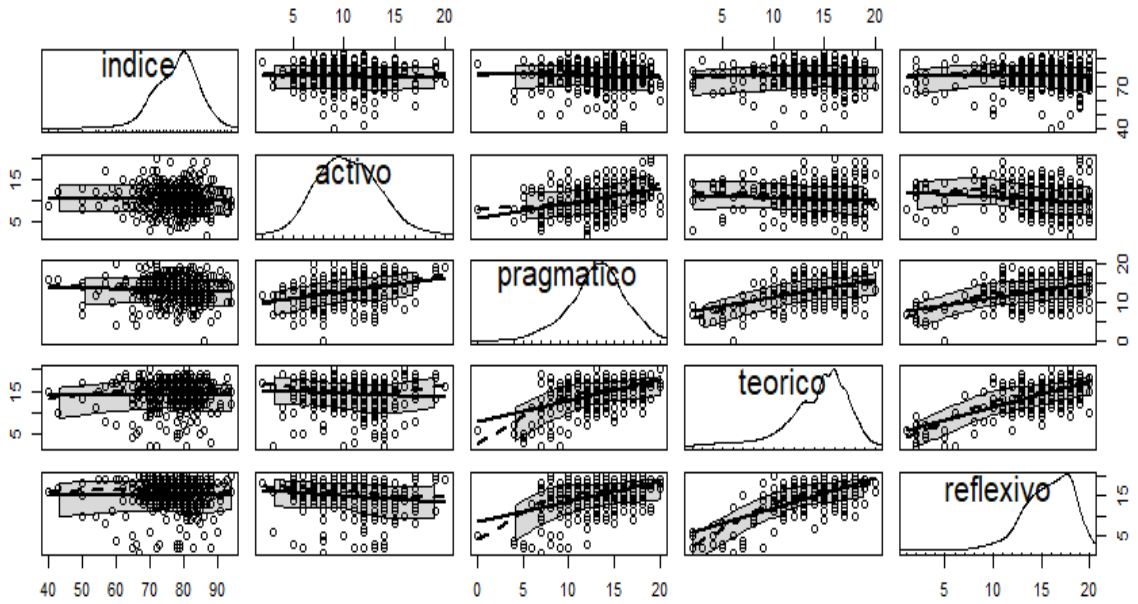
Note. *This figure shows the centroids of the discriminant functions.*

For each career, where IA is Agroindustrial Engineering, IC is Civil Engineering, IE is Electrical Engineering. IF Forestry Engineering, II Industrial Engineering, IM Mechanical Engineering, IQ Chemical Engineering and IS Systems Engineering, the centroids were calculated to know the location of the style of each career.

Figure 8 below shows the scatter plots of the academic index variable and the students' learning styles.

Figure 8

Data behavior of index styles and learning styles of UNAH engineering students



Note. This figure shows both the histograms and the relationship between each pair of variables, indicating that it is not linear, prepared from the data collected.

As shown in the figure, the index shows a linear relationship with the four learning styles, with data concentrations that show a relationship close to a linear one, so it becomes important to know this style as an element that allows establishing curricular experiences to improve learning with repercussions in the performance of future engineers.

The correlation coefficients calculated are shown in Table 9:

Table 9

Pearson's correlation coefficients between the index and learning styles

Variable	Index	Active	Reflective	Pragmatic	Theoretical
Index	1	-0.04	0.01	-0.06	0.02
Active	-0.04	1	-0.014	0.35	-0.09
Reflective	0.01	-0.14	1	0.43	0.66
Pragmatic	-0.06	0.35	0.43	1	0.47
Theoretical	0.02	-0.09	0.66	0.47	1

Note. Own elaboration based on the data collected.

The p values are shown in Table 10.

Table 10

P-values of Pearson's correlation coefficients between the index and learning styles

Variable	Index	Active	Reflective	Pragmatic	Theoretical
Index		0.4705	0.8395	0.2416	0.7264
Active	0.4705		0.0060*	0.0000*	0.0929
Reflective	0.8319	0.0060		0.0000*	0.0000*
Pragmatic	0.2416	0.0000	0.0000		0.0000*
Theoretical	0.7264	0.0929	0.0000	0.0000	

Note. *Own elaboration based on the data collected. * significant values at 0.001*

Discussion and conclusions

Finally, the conclusions of the article will be presented in a last section, followed by the main conclusions. Where appropriate, limitations and proposals for continuity will be included. From the data collected in the sampling process, it was possible to determine the learning style for each of the engineering careers that are developed in the UNAH, in the case of Agroindustrial Engineering, students have characteristics of pragmatic, theoretical and reflective styles with higher values, in the case of the active its value was lower, in fact, the active style showed a significant negative correlation with the reflective style and showed no relationship with the theoretical style; however, the reflective, pragmatic and theoretical styles showed significant direct relationships, which indicates that they enhance teaching, as shown in Table 2, behaviors that favor the styles identified in the students. In the case of Agronomy Engineering, relatively high scores were obtained in the four styles, so that the work to be done to improve learning can be oriented in the four directions, differentiating and at the same time complicating the work of the teachers; on the other hand, Civil Engineering obtains its lowest value in the active style, followed by the pragmatic, and scarcely higher values in the theoretical and reflective styles.

Despite the above, the results offer great opportunities for improvement in the teaching process, since at low levels, the implication is to work on strengthening teaching in the four ways marked by the identified styles,

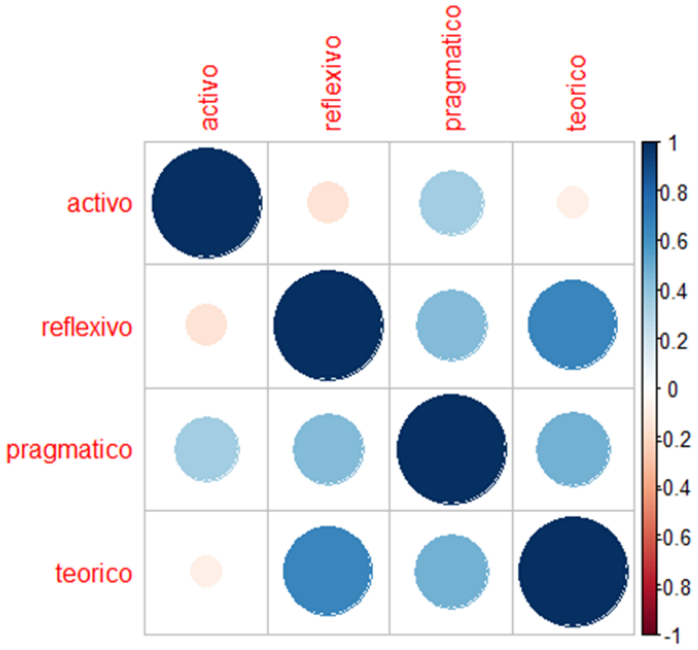
A similar situation to that of Civil Engineering was detected in Electrical Engineering with the possibility of establishing teaching and learning methodologies oriented to the four styles. One strategy that can be followed by the faculty and the authorities of the Academic Departments and the Dean's Office is to emphasize the construction of classes that involve the development of activities that offer opportunities for all students to make the most of the subjects they take. In the case of Systems Engineering, the values presented are low in all four styles, offering great opportunities for intervention through the design of appropriate experiences. Forestry Engineering requires a bold strategy and implementation to achieve significant learning in students, and for Industrial Engineering, Mechanical Engineering and Chemical Engineering, the values obtained are very similar, so there are important opportunities for intervention favoring the four learning styles.

An important concern that is elucidated by the results obtained is that, when performing the two-factor analysis of variance with a sample per group, a significant difference is found only in terms of careers, not style, i.e., when evaluating styles by style, engineering students have similar traits, but differences are found in terms of careers. The same did not happen in the case of the two-factor analysis of variance considering careers and place of birth represented by the Department, no differences were found. In spite of the above, a multiple variance analysis was performed considering the defined styles and as factors career, place of residence and place of birth, finding significant differences only in the careers. As shown in Figure 7, after constructing the discriminant functions, similarities can be found in careers such as Agricultural Engineering, Forestry Engineering and Civil Engineering, and another large group could be defined by Electrical Engineering, Industrial Engineering, Mechanical Engineering, Mechanical Engineering and Systems Engineering.

Although the values of the correlations between the academic index reported by the students do not reflect a significant relationship with the values of the learning styles, it is observed that the frequency graphs are close to normality, which gives rise to further parametric inferences of the same and other variables, a significant relationship was found between the active, reflective and pragmatic style, as shown in Figure 9 below.

Figure 9

Correlations of learning style values of UNAH engineering students



Note. This figure shows both the Pearson correlation coefficients of the values of each learning style, own elaboration from the data collected.

As a conclusion, it is established that for the active style, it should be reinforced to try new things, compete in teams, solve problems, dramatize, lead debates, find problems, try different methods, for the reflective style, design observation activities, work without pressure, investigate exhaustively, collect information, get to the bottom of the issues addressed, analyze in detail and synthesize,

Also, the requirement of detailed reports, in the case of the theoreticians, defining strongly structured schemes, working methodically, questioning with skepticism, testing methods and the logic of the resolution, and for the pragmatists, experimenting, showing shortcuts and results, the system must work because it must work, exemplifying abundantly since the training of engineers requires a lot of practical activity that helps to build adequate experiences. (Alonso et al., 1997, pp. 158–162).

The result of this research generated a snapshot at a given moment, a good alternative could be to follow up groups throughout their stay in the career, and thus build data that reflect the variation of learning styles in engineering students of the UNAH.

References

Apellido, A. A., Apellido, B. B, y Apellido, C. C. (Fecha). Título del artículo. *Nombre de la revista*, *volumen*(número), pp-pp. Alonso, C. M., Gallego, D. J., & Honey, P. (1997). *Los estilos de aprendizaje: Procedimientos de diagnóstico y mejora* (Vol. 221). Mensajero Bilbao, España.

Arias Gallegos, W. L. (2011). Estilos de aprendizaje en estudiantes universitarios y sus particularidades en función de la carrera, el género y el ciclo de estudios. *Revista de Estilos de Aprendizaje*.

Bhogayata, A., & Jadeja, R. B. (2022). Influence of Learners' Diversity on the Pedagogical Practices in Engineering Education: A Meta-Analysis of Teachers' Reflections. *Journal of Engineering Education Transformations*, *36*(Special issue 2), 566–574.

Chowdhury, R. K. (2015). Learning and teaching style assessment for improving project-based learning of engineering students: A case of united Arab Emirates university. *Australasian Journal of Engineering Education*, *20*(1), 81–94.

de Almeida, M. E. B., Branco, J. R., Margalho, L., Cáceres, M. J., & Queiruga-Dios, A. (2023). An Individual Work Plan to Influence Educational Learning Paths in Engineering Undergraduate Students. *Springer Proceedings in Mathematics and Statistics*, *414*, 285–293. www.scopus.com

Gueye, M. L., & Exposito, E. (2023). *Education 4.0: Proposal of a Model for Autonomous Management of Learning Processes: Vol. 13821 LNCS*. www.scopus.com

Haltas, I. (2022). Teaching from Multiple Angles: Aligning the Teaching Materials and Activities with Preferred Learning Styles of the Students. *ASEE Annual Conference and Exposition, Conference Proceedings*. www.scopus.com

Kolb, D. A. (2014). *Experiential learning: Experience as the source of learning and development*. FT press.

Kuzmina, N. N., Korotkova, E. G., & Kolova, S. M. (2021). Implementing E-Learning in the System of Engineering Students Training. *Proceedings of the 2021 IEEE International Conference "Quality Management, Transport and Information Security, Information Technologies", T and QM and IS 2021*, 818–823. www.scopus.com

Martínez Geijo, P. & others. (2009). Estilos de enseñanza: Conceptualización e investigación (en función de los estilos de aprendizaje de Alonso, Gallego y Honey). *Revista de Estilos de Aprendizaje*.

Mendenhall, W., Scheaffer, R. L., & Lyman Ott, R. (2006). *Elementos de muestreo*. Ediciones Paraninfo, SA.

Molina-Cabello, M. A., Thurnhofer-Hemsi, K., Molina-Cabello, D., & Palomo, E. J. (2023). Are learning styles useful? A new software to analyze correlations with grades and a case study in engineering. *Computer Applications in Engineering Education*, *31*(3), 537–551.

Ojeda, A. F. O., & Herrera, P. J. C. (2013). Estilos de aprendizaje y rendimiento académico en estudiantes de ingeniería en México. *Revista de estilos de aprendizaje*, *6*(11).

Rofiq, Z., & Pratiwi, H. (2023). The influence of collaborative strategies and cognitive styles on the results of learning to read machinery engineering images. *AIP Conference Proceedings*, *2671*. www.scopus.com

Schunk, D., Meece, J., & Pintrich, P. (2012). *Motivation in education: Theory, research, and applications: Pearson Higher Ed*.

Smith, R. M. (1982). *Learning how to learn: Applied theory for adults*. Open University Press Great Britain.

Tocci, A. M. (2013). Estilos de aprendizaje de los alumnos de ingeniería según la programacion neuro linguística. *Revista de estilos de aprendizaje*, *6*(12).

Tulsi, P. K., Poonia, M. P., & Anupriya. (2016). Learning styles and achievement of engineering students. *IEEE Global Engineering Education Conference, EDUCON*, *10-13-April-2016*, 192–196. www.scopus.com

UNAH. (2023a). *Facultad de Ingeniería UNAH*. https://www.facebook.com/ingenieria.unah.edu.hn/posts/pfbid0241xAjEMvnjRycxg6qEXnFf2WitcteBQwPdDFiESEcMJzR1Eic9WPYdYMKxytV3hYl

UNAH. (2023b). *Informe de Matricula en Ingeniería, DIPP*.

Yesilevskiy, Y., Thomas, A., Oehrlein, J., Wright, M. A., & Tarnow, M. (2022). Introducing Experimental Design to Promote Active Learning. *ASEE Annual Conference and Exposition, Conference Proceedings*. www.scopus.com