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SOFT SKILLS DEVELOPMENT ACCORDING TO THE LEVEL OF UNIVERSITY FORMATION FOR ENGINEERING

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ABSTRACT

The great demand for soft skills for engineers leads to determining the development level of soft skills that undergraduate and postgraduate programs reach in their graduates since by defining this level, programs can propose strategies for their increase and become more competitive. This work focuses on determining soft skills development according to university education level for mechanical engineers. A 19-question survey evaluated 10 soft skills development applied to 81 mechanical engineers of different university education levels in 2020. Cronbach's Alpha statistics, bilateral Kolmogorov-Smirnov test, Kruskal Wallis ANOVA, Spearman and Post Hoc Game-Howell correlation were used to determine reliability, define the data type and distribution, and determine the interrelation between the different variables, respectively. The current training of soft skills in the respondents was acceptable (3 out of 5); where the soft skills such as exposure, critical thought, recognition, responsibility, integrity, and humility show the most remarkable development, and those as creativity, negotiation, and non-verbal communication are the ones that present the most significant deficiencies. Postgraduate degrees such as specialization or magister strongly enhanced emotional development; however, other soft skills remained at the same level of development compared to graduates. It is proposed to include two lectures with experiential learning pedagogical methodology in the curriculum of the Mechanical Engineering programs to strengthen the development of soft skills.

INTRODUCTION

High demand for professionals with developed soft skills is a requirement for international companies, as evidenced by a study of more than 5,000 talented professionals from 35 countries (Linkedln, 2019). In addition, at the World Economic Forum, young participants defined that strong development in soft skills such as communication, critical thinking, and resilience (Fore & Moritz, 2020) is needed to face future challenges. Furthermore, the Economic Commission for Latin America and the Caribbean (CEPAL, 2016) defined Latin America as a region with a tremendous gap between skills required by the private sector and those offered by the labor force, and for this reason, they recommend training the young people in both technical and soft skills. A large number of international (Akinbobola, 2020; Botke et al., 2018; Chamorro-Premuzic et al., 2010; Shekhawat, 2020; Singh Dubey et al., 2021; Tsirkas et al., 2020; Wolff & Booth, 2017) and Latin American investigations (Astudillo Yañez & Meléndez Seguel, 2014; Cáceres Francia et al., 2018; Chigó Bustos & Olguín Ramírez, 2006; Tem et al., 2020) warn of the need for workers in the different industrial, commercial, and service sectors to have these skills developed and consider that current university education does not include this type of training (Caeiro-Rodriguez et al., 2021; Cronin et al., 2021; Daley & Baruah, 2020; Neri Torres & Hernández Herrera, 2019; Tang, 2019; Teng et al., 2019; Tholen, 2019; Trevelyan, 2019; Trinidad et al., 2021). Related to the soft skills of the Mechanical Engineer, the exact reflection is made (Cohen & Katz, 2015; Ismail, Hamzah, Fatah, & Muhammad, 2019; Ismail, Hamzah, Fatah, & Zaharim, 2019; Liu, 2017; Magarian & Seering, 2021; Reddy, 2017; Zergout et al., 2019). With such evidence, it is worth analyzing the current soft skills development of graduates of academic programs and the best strategy to develop them.

Higher education institutions address soft skills in their subjects in a reduced way (Almeida & Morais, 2021); being necessary to provide seminars focused on collective intelligence to support teachers. Strategies to develop a soft skills course start with a self-assessment, finding that skill such as strategic thinking is not essential at the beginning of the survey; however, they could significantly improve at the end of the course (Stek, 2022). Soft skills are needed for other areas, such as accounting (Gunarathne et al., 2021), to help form a well-rounded engineer.

Soft Skills

There are different soft skill classifications; they are generally classified into two broad groups, hard and soft ones. Soft skills are social, emotional, socio-emotional, non-cognitive skills, generic, or transversal employability skills (Fomunyam, 2018; Hendarman & Cantner, 2018; Tamara, 2016). They are related to attitudes, personal attributes, personality traits, and practices that allow the creation and development of positive relationships and influence how a person focuses his learning and interacts with the world around him, with his work, environment, and in the positive resolution of conflicts. Currently, these skills are in high demand in organizations because they enhance the efficiency and productivity of workers, improve the work environment, and are necessary to ensure, maintain and scale within an organization (Akinbobola, 2020; Caeiro-

Rodriguez et al., 2021; Ismail, Hamzah, Fatah, & Zaharim, 2019; Itani & Srour, 2016; Neri Torres & Hernández Herrera, 2019; Orwig, 2020; Tamara, 2016; Tem et al., 2020).

In general, soft skills can be considered self-management, communication skills, teamwork skills, interpersonal skills, ability to work under pressure, imagination, creativity, critical thinking, willingness to learn, attention to detail, taking responsibility, planning and organizing, vision, maturity, professionalism, and emotional intelligence (Akinbobola, 2020; Belsches et al., 2016; Chamorro-Premuzic et al., 2010; Fomunyam, 2018; Gang et al., 2020; Teng et al., 2019). Soft skills can be subclassified into two types, intrapersonal and interpersonal. The first ones are internal skills such as abilities, behaviors, or self-awareness that control and manage emotions, assimilate change and open up learning. The second ones, soft interpersonal skills, implicates human relationships covering behaviors, tactics, and social competencies to interact effectively with others.

Purpose Of The Study

This study aims to determine soft skill development in two cases, during undergraduate training and according to a university education degree. In this order of ideas, answer to the following questions were searched for this study.

Q1. What is the quality of softs skills training for ungraduated?
Q2. How does soft skills development level of development of softs skills vary through university education (graduate and postgraduate degree)?

METHODOLOGY

In this quantitative research, the survey tool was selected to recollect information from the participants through their responses to designed questions(Check & Schutt, 2012). This method involves obtaining information relatively quickly from a large sample of individuals (Ponto, 2015).

Population and Sample

Participants were engineering graduates from the Mechanical Engineering program. They lived in different places, so data were collected through an online Google questionnaire in 2019. The voluntary participation was 81 graduates out of 210, yielding an error of 8% and a reliability of 95%. The majority of participants were aged 30-34 (42.5%); the same proportion, 26.3%, were both 35–40 and 25-29, and 2.5% were the pair 41–44 and <25 (Figure 1 Left). Women accounted for 6.3% and men for 93.8% of the participants (Figure 1 Right).

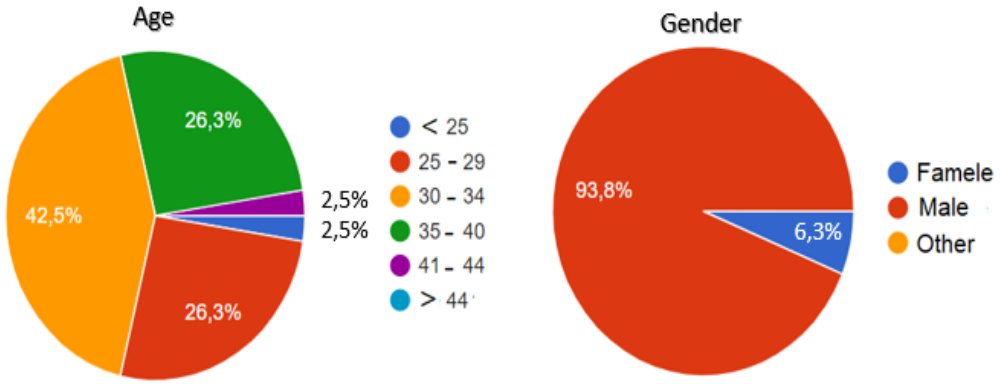

Figure 1. Age and gender of participants

About university degrees (Figure 2-Left), the majority (63%) of participants have a graduate title, a quarter of them were (25%) specialized, and only a minor share (11.3%) had a master's title. Ph.D. title was not accounted. Regarding professional experience (Figure 2 Right), the engineers surveyed are homogeneously distributed among the defined ranges, with the highest proportion (23.5%) being between 9-12 years and the lowest (6.3%) being over 12 years. Data correlate with the ages of participants since a minority is expected in the group over 12 years of experience.

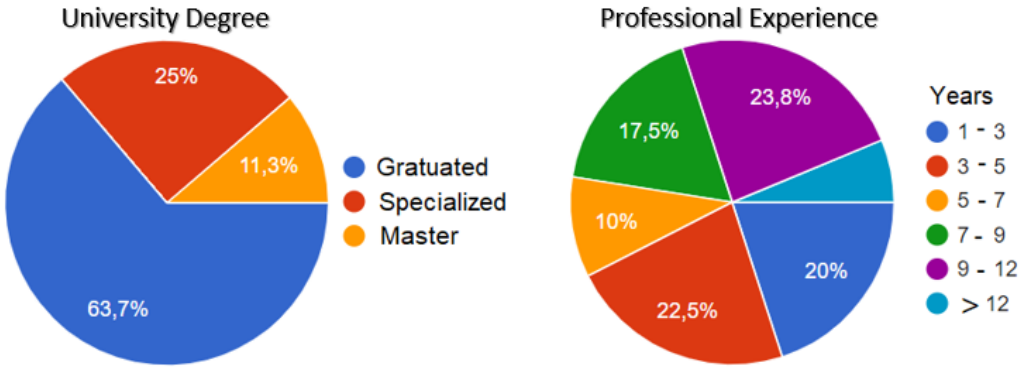

Figure 2. University degree and professional experience

DATA COLLECTION

Thirty publications referred to different soft skills; from all of these, ten soft skills were grouped and defined to apply in this research, listed in Table 1 with their respective bibliographic references.

The first dimension (D1), called soft skill training quality, includes ten categories related to 10 soft skills (Table 3). Each skill was deconstructed between 1 or 4 indicators that question the training quality during the ungraduated process. This dimension includes 18 indicators. The designed questions used the Linkert 5-point scale (1.Very Poor 2.Poor 3. Acceptable 4.Good 5.Excellent) as shown in table 1.

The designed survey included the demographic questions, with results before observed, and two dimensions: the first one named type of university education and the second one, soft skill training quality. The second dimension (D2) was one category (Table 2) and was referred to as academic degree, defined as the type of degree given in a Higher Education Institution (HEI), including graduate, specialization, master's, or doctorate.

Table 1: Soft skill training quality indicators – Dimension 1

Indicators	**Bibliographic references**
Responsibility: R1. Assume responsibility to solve situations (yours or others) that make it challenging to achieve your goals	(Chigó Bustos & Olguín Ramírez, 2006; Kofman, 2018; Marrero Sánchez et al., 2018)
Integrity: I1. Make professional decisions based on integrity and ethics	(Chigó Bustos & Olguín Ramírez, 2006; Ismail, Hamzah, Fatah, & Zaharim, 2019; Zergout et al., 2019), (Kofman, 2018)
Humility: H1. Admit that you don't know or that may be wrong, especially in uncertain or confrontational situations	(Kofman, 2018)
Critical thinking: T1. Make decisions based on facts, data, and reliable information	(Ahern et al., 2019; Ismail, Hamzah, Fatah, & Zaharim, 2019; Tang, 2019; Tem et al., 2020; Zergout et al., 2019)
Communication: C1. Effectively deal with difficult or conflictive conversations; C2. Use non-verbal language (body posture, arms, legs, eye contact, etc.) during a conversation; C3. Effectively expose a topic to an audience of any level of knowledge (Effectively: use of teaching aids and excellent performance); C4. Write management reports and/or technical reports	(Ismail, Hamzah, Fatah, & Zaharim, 2019; Itani & Srour, 2016; Kofman, 2018; Prasad et al., 2015; Selwyn & Renaud-Assemat, 2020; Shekhawat, 2020; Singh Dubey et al., 2021; Tang, 2019; Tem et al., 2020; Zergout et al., 2019)
Negotiation: N1. Carry out effective negotiations (situations with different interests and points of view)	(Chenoy et al., 2019; Kofman, 2018)
Action coordination: A1. Make adequate commitments with your work team (Adequate: Compliance is high, low reprocessing), A2. Supervise the development of tasks without causing rejection; A3. Claim effectively in the event of non-compliance with the commitments acquired; A4. Recognize the achievements of people within a team	(Kofman, 2008, 2018)

Emotional competence: E1. Resolve situations calmly and keep the emotional balance	(Akinbobola, 2020; Belsches et al., 2016; Chamorro-Premuzic et al., 2010; Fomunyam, 2018; Gang et al., 2020; Kofman, 2018; Tang, 2019; Teng et al., 2019)
Leadership: L1. Effectively lead small teams (max. 8 people) oriented to meet specific goals	(Chigó Bustos & Olguín Ramírez, 2006; Ismail, Hamzah, Fatah, & Zaharim, 2019; Itani & Srour, 2016; Shekhawat, 2020; Singh Dubey et al., 2021; Tang, 2019; Tem et al., 2020; Zergout et al., 2019)
Entrepreneurship: B1. Analyze the risk level of possible ways to solve a problem; B2. Analyze business ideas considering technical, marketing, logistics, legal support, organizational structure, and human capital required; B3. Creatively solve problems of different kinds	(Besançon et al., 2013; Chenoy et al., 2019; Chigó Bustos & Olguín Ramírez, 2006; Ismail, Hamzah, Fatah, & Zaharim, 2019; Itani & Srour, 2016; Linkedln, 2019; Singh Dubey et al., 2021; Sousa & Almeida, 2014; Zergout et al., 2019)

Table 2: Academic degree dimension – Dimension 2

Categories	**Indicators**
University degree	1. Graduate 2. Specialization 3. Master 4. Doctorate or Ph.D.

Validation and Reliability

The survey was submitted for evaluation by three experts, a statistic Ph.D., a master's degree in education plus life coach, and a master's degree in administration. The concept of the survey was positive and the changes suggested by the evaluators were made. Cronbach's alpha coefficient evaluated the instrument's reliability in groups of 20 indicators (Oviedo & Arias, 2005), and an average value of $\alpha = 0.95$ to the second dimension (Frias-Navarro, 2020) were obtained, which indicates that a questionnaire to be internally consistent.

Type and Distribution Data

Once the data was collected, to determine its type of parametricity, we applied a bilateral Kolmogorov-Smirnov test for all indicators, resulting significance value in all cases, less than 0.05 (p-value <0.05) (Diego Gutiérrez, 2018), defining data are both non-normal and non-parametric. Those values lead to non-parametric statistical tools for data analysis such as median, mode, range, Kruskall Wallis ANOVA, Spearman correlation, and Game-Howell Post Hoc test.

FINDINGS AND RESULTS

The purpose of this study has been expressed on the following questions:
Q1. What is the quality of softs skills training for ungraduated?
Q2. How does soft skills development level of development of softs skills vary through university education (graduate and postgraduate degree)?

What is the quality of softs skills training for ungraduated?

The opinion of graduates about the quality of soft skills training in undergraduate studies was statistically evaluated by comparing the median and mode of the results given for dimension 2 (Table 3) related to the ten soft skills evaluated. The general result concerning training was acceptable (mean value 3) and tended to be good (mode value 4).

Table 3: Interpersonal soft skill training quality – Dimension 1

Soft skills		**Training quality**		
		Median	**Mode**	**Range**
Responsibility (R1)		4	4	4
Integrity (I1)		4	4	4
Humility (H1)		4	4	4
Critical thinking (T1)		4	4	4
Communication	Diff. Convers (C1)	3	4	4
	No-Verbal Lan. (C2)	3	2	4
	Exposition (C3)	4	4	4
	Writing (C4)	3	3	4
Negotiation (N1)		3	2	4
Action Coordination	Commitment (A1)	3	3	4
	Claim (A2)	3	3	4
	Supervision (A3)	3	3	4
	Recognition (At4)	4	4	4
Emotional Competence (E1)		3	4	4
Leadership (L1)		3	4	4
Entrepreneurship	Risk (B1)	3	4	4
	Methodology (B2)	3	3	4
	Creativity (B3)	3	3	4
Average		3	4	4

1:Very Poor, 2:Poor, 3:Acceptable, 4:Good, 5:Excellent

Additionally, to evaluate these indicators in deep, percentiles were calculated for each one. It can see the percentiles result for intrapersonal relationships (Table 4) as responsibility (R1), integrity (I1), humility (H1), critical thinking

(T1), emotional competence (E1), and entrepreneurship (B1,2,3), highlighting the following aspects:

Table 4: Intrapersonal soft skills quality training – Dimension 1

Percentile	**Median**							
	R1	**I1**	**H1**	**T1**	**E1**	**B1**	**B2**	**B3**
10	2	2	2	2	2	2	1	2
20	3	3	3	3	2	2	2	2
30	3	3	3	3	3	3	2	3
40	3	4	3	3	3	3	2	3
50	4	4	4	4	3	3	3	3
60	4	4	4	4	4	4	3	3
70	4	4	4	4	4	4	4	4
80	4	5	4	5	4	4	4	4
90	5	5	5	5	4	4	4	5

1:Very Poor, 2:Poor, 3:Acceptable, 4:Good, 5:Excellent

- The lowest training soft skill indicator is "B2. Analyze business ideas taking into account technical, marketing, logistics, legal support, organizational structure, human capital required" with a level of 2: Poor for a percentile of 40th.

- Entrepreneurship and emotional competence soft skills are the most deficient degree of quality training in undergraduate education since their level was 3: Acceptable between 50th and 60th percentile.

- All soft skill exhibits good (4) quality training at 70th percentile.

Soft interpersonal skills, communication (C1,2,3,4), negotiation (N1), actions coordination (A1,2,3,4), and leadership (L1), can see in table 5, the following assessment.

Table 5: Interpersonal soft skills quality training – Dimension 1

Percentile	**Median**									
	C1	**C2**	**C3**	**C4**	**N1**	**A1**	**A2**	**A3**	**A4**	**L1**
10	2	1	2	2	1	2	2	2	2	2
20	2	2	3	2	2	2	2	2	3	2
30	3	2	3	3	2	3	3	3	3	2
40	3	2	3	3	2	3	3	3	4	3
50	3	3	4	3	3	3	3	3	4	3
60	4	3	4	3	3	3	3	3	4	3
70	4	4	4	4	3	4	4	4	4	4
80	4	4	4	4	4	4	4	4	4	4
90	4	5	5	4	4	4	4	4	5	4

1:Very Poor, 2:Poor, 3:Acceptable, 4:Good, 5:Excellent

The soft skills indicator with the poorest training are non-verbal communication "C2. Use non-verbal language (body posture, arms, legs, eye contact, etc.) during a conversation" and negotiation "N1. Carry out effective negotiations (situations with different interests and points of view), showing a 2: Poor training level at 40th percentile; that is, 60% of those surveyed consider it this way.

- The skill with the highest training level is "A4. Recognize the achievements of people within a team" since, from the 40th percentile, there is a 4 "good" training.

- At the 80th percentile, the graduates consider that all intrapersonal skills are developed in a "4: Good" way.

How does soft skills development level of development of softs skills vary through university education (graduate and postgraduate degree)?

To determine those indicators which changed according to the type of university degree, a statistically significant difference was calculated using the Kruskall Wallis ANOVA test (Table 6). However, from the 18 indicators, the significant difference (p-value <0.05) was only observed in the emotional skill, and specifically in four of its five indicators (Table 7) related to the following indicators: "E1. Ease of working under pressure, E2. Understanding and emotional management, E4. Accept and find out the emotional causes of each other's, E5. Ability to calm the intense team situations."

Additionally, the Spearman Correlation coefficient determined the type of correlation between these four indicators (E1,2,4,5) and the academic degree. It obtained a moderate and positive Spearman correlation for indicators E1, E2, E4 (Table 6).

Table 6: Kruskal-Wallys ANOVA and spearman's correlation

Indicators	**Kruskall-Wallys**		**Spearman´s correlation**
	χ^2	**p value**	**Rs-value**
E1	10,603	,005	,307*
E2	8,177	,017	,305*
E4	8,533	,014	,323*
E5	7,188	,027	,285**

*Moderate Spearman´s correlation **Weak Spearman´s correlation

Also, to define how the university degree (graduate, specialization, or master's degree) affected the development of those indicators, a Game-Howell Post Hoc analysis was performed. This analysis showed a significant difference (p<0.05) in indicators E1, E2, E4 related to the academic degree (Table 7, Figure 3) if it is compared to graduate with specialization or master level, however, it does not show a difference between specialization and master degree.

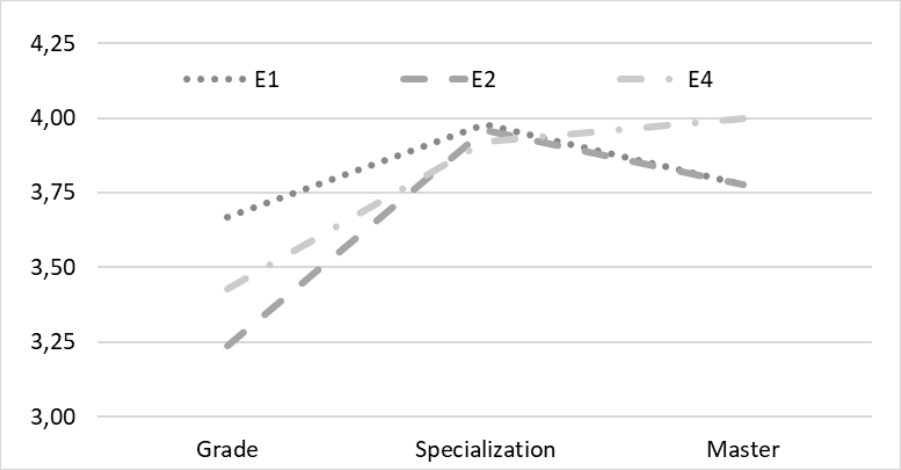

Figure 3. Comparison between indicators of emotional competence and university degree

Table 7: Games-Howell to the comparison of degree and specialization for emotional competence

Indicator	Δmean	Error	p Value
E1	-0,804	0,240	,006
E2	-0,686	0,236	,018
E4	-0,703	0,270	,036

ANALYSIS

A three-dimension survey was designed, validated, and applied to 81 graduates of the Mechanical Engineering program to measure the development in 10 soft skills and university grades (Acero & Suárez Castrillón, Albert M. Bolívar León, 2022). The data shows that soft skills training during undergraduate training is acceptable. The least developed soft skills are entrepreneurship, emotional competence, non-verbal communication, and negotiation; however, intrapersonal soft skill is more developed than interpersonal ones. These soft skills mentioned before are not easily developed in a traditional educational system. Also, the student's negotiation with the teacher is limited due to the system's authority generally confers to him. Non-verbal communication is frequently not relevant because most academic activities do not require interaction between participants that need body reading. Regarding entrepreneurship, there are few spaces where students can analyze business ideas considering technical, marketing, logistics, legal support, organizational structure, human capital required.

The current curriculum of the Mechanical Engineering program does not include any lecture that focuses directly on the development of soft skills, but it does during the professional lectures through workshops, exhibitions, classroom projects, etc. It is important to note that the vast majority of the lecture are focused on building hard skills. For this reason, the observed result denotes that, during the class's progress, the assignments, classroom projects, etc., the students learn or expand these skills thanks to the intuitive training by teachers and their example. Proposing courses focused on developing these skills,

together with methodologies designed to develop these skills and applied to the usual subjects of the engineering cycle, is proposed to increase the value of the result obtained. On the other side, a university degree as a graduate or postgraduate increases emotional competence.

However, no statistical evidence was found that university degrees significantly increase the development of the other nine soft skills investigated. This result reaffirms the previous approaches by several authors about the inadequate training in soft skills at the university programs. This evidence proposes to include two lectures in the Mechanical Engineering curriculum, oriented to develop these soft skills and follow an experiential learning methodology (Collins & Redden, 2021; Kim et al., 2015). This proposal can be extended to other programs that identify with this study. This methodology is based on the fact that students are immersed in specific situations that lead them to paradigm changes, lifelong learning, and personal development; it also promotes organic growth. It is a method where the links between education, work, and personal development are strengthened since it allows the integration of work in the classroom with the real world, and this integration of authentic experiences into their worlds gives the student a personal meaning to plan new actions (Cardona & Palacio, 2013; Gleason Rodríguez & Rubio, 2020).

Some of the main features of this method are:

- They constitute an environment parallel to the real work/social environment, in which the "normal" resistances in these environments are not generated.

- They facilitate obtaining results in a shorter time and more excellent stability over time.

- They favor learning in people with different learning styles.

- They allow serious issues to be worked on with people with whom there has been no previous contact.

- They offer appropriate space for the experimentation of new ideas and approaches, leading to the solution of various problems.

- They stimulate the development of critical thinking and creative thinking; they allow the learning of new information through participatory engagement rather than through memorization.

CONCLUSION

Current training of soft skills in the Mechanical Engineering program has an acceptable level (3 against 5), where soft skills such as creativity, negotiation, and non-verbal communication are the ones that have the most significant shortcomings, and those of exposure, critical thinking, recognition, responsibility, integrity and humility show the greatest development. This training is done intuitively through different methodologies used by teachers in the classroom, such as classroom projects, presentations, debates, etc.

University degree only develops emotional competence; the other soft skills such as responsibility, integrity, humility, critical thinking, communication, negotiation, coordination of actions, leadership, and entrepreneurship remain at the same development level compared to graduated and postgraduate formation.

Two compulsory lectures with experiential learning pedagogical methodology are proposed to include in the curriculum of the Mechanical Engineering program to strengthen the development of soft skills.

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