Characterization of Leadership Skills in Students: A Case Study in a Chilean Engineering School

Vicente Valenzuela-Riquelme, Universidad Andres Bello, Chile

Industrial Civil Engineering, dedicated to data analytics, I have experience in teamwork and leadership. My solid training in information technologies has allowed me to acquire advanced skills in the use of different software. I find myself working closely with databases. I have solid critical thinking and analytical skills, which allows me to interpret large amounts of information and detect opportunities for improvement in business processes. Thanks to my leadership skills and my commitment to excellence, I have achieved outstanding results in projects and work teams. I am an enthusiastic collaborator and committed to continuous improvement, which has allowed me to successfully adapt to new environments and face challenges effectively.

Prof. Maria Elena Truyol, Universidad Andres Bello, Chile

María Elena Truyol, Ph.D., is full professor and researcher of the Universidad Andrés Bello (UNAB). She graduated as physics teacher (for middle and high school), physics (M.Sc.) and Ph.D. in Physics at Universidad Nacional de Córdoba, Argentina. In 2013 she obtained a three-year postdoctoral position at the Universidade de Sao Paulo, Brazil. Her focus is set on educational research, physics education, problem-solving, design of instructional material, teacher training and gender studies. She teaches undergraduate courses related to environmental management, energy and fundamentals of industrial processes at the School of Engineering, UNAB. She currently is coordinating the Educational and Academic Innovation Unit at the School of Engineering (UNAB) that is engaged with the continuing teacher training in active learning methodologies at the three campuses of the School of Engineering (Santiago, Viña del Mar and Concepción, Chile). She authored several manuscripts in the science education area, joined several research projects, participated in international conferences with oral presentations and key note lectures and serves as referee for journals, funding institutions and associations.

Camila Zapata-Casabon, Universidad Andres Bello, Chile

Master in Marketing and Market Research from the University of Barcelona, Spain. Industrial Civil Engineer from the Universidad del Bío-Bío. She has three diplomas in the areas of coaching, digital marketing and equality and empowerment of women. Her professional experience is linked to higher education as a project engineer and university management in the public and private area. Teacher at different universities in matters of entrepreneurship, business plans and marketing. She currently works as a teacher and academic secretary at the Faculty of Engineering of the Andrés Bello University. The areas of research interest are the impact, relationship and integration of the gender perspective within communications and marketing in the various areas of development, digital marketing and content marketing.

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Abstract

Leadership in engineering entails an integration of diverse skills. Engineering leaders employ a full spectrum of abilities and knowledge to develop innovations while seeking to understand, embrace, and address the current and future impact of their work. These leaders must actively foster committed and productive relationships with various stakeholders, including themselves and their teams, users of their technologies, and those affected by their engineering efforts. Developing leadership skills is essential for engineers, enabling them to work effectively in teams, make informed decisions, communicate effectively, solve problems, manage projects, and drive innovation. These skills are crucial for professional success and for the positive impact of engineering on society. Leadership is widely recognized as a key component of business success, with 89% of business leaders considering it fundamental. The engineering student graduation profile emphasizes the need to develop leadership skills, setting the expectation that students acquire these competencies. This study aims to characterize leadership profiles and skills among senior engineering students at a prominent university in Chile. Specifically, it seeks to assess students' self-perception of their leadership skills. The sample comprises 140 students from various engineering disciplines within this school, with the highest enrollment nationally. To achieve these objectives, a quantitative study was conducted by adapting and administering the Developmental Leadership Questionnaire by Larsson to the context of engineering students in Chile. This questionnaire is based on four leadership styles: developmental leadership, conventional positive leadership, conventional negative leadership, and laissez-faire leadership. The results of this study enable the characterization of prevailing leadership profiles among the sampled engineering students. Additionally, significant differences in leadership skills were identified between students who have completed their professional practice and those who have not. These differences also exist based on the ongoing engineering program. The study underscores the importance of equipping engineering students with leadership skills. The results and conclusions from this study provide valuable guidelines for implementing actions that ensure future engineering graduates meet the labor market's expectations for leadership competencies.

Keywords: leadership, engineering education, leadership skills

Introduction

In today's workforce, employers are looking for technically skilled professionals and individuals with strong leadership abilities. Leadership in engineering is the ability to guide, motivate, and influence a team of professionals toward achieving goals and objectives. The Engineering School of a University in Chile needs to understand the self-perceived skills of its students, especially those in the final years of their engineering programs. This will help the faculty prepare future professionals for team management, decision-making, and other essential skills required in their careers. The School can align their graduation standards with the career profiles of the students to ensure they are well-equipped to succeed in their profession.

Numerous studies have suggested that there is a significant gap between the skills possessed by engineering graduates and those required by the industrial workforce [4], [5], [6]. To bridge this gap, academic programs must adopt a comprehensive approach to leadership training. It is recommended that experiential learning opportunities such as internships be incorporated into these programs [7]. However, motivating engineering students to participate in leadership training can be challenging for higher education institutions [8]. This challenge is partly due to the cultural focus on technical aspects and problem-solving in engineering, which often sidelines leadership skills.

This study aims to assess the self-perceived leadership skills of students and provide insights into their educational preparation in this area. First, a literature review of leadership theories presented by various authors will be conducted to achieve this. Subsequently, the social skills necessary in the training of engineers will be discussed, emphasizing leadership ability. This will identify the gaps that various authors note between what is expected of an engineer and their actual training in such social skills. The overall purpose of this study is to identify student similarities and differences based on variables examined with a questionnaire. This pilot study serves as an initial step in validating the instrument used. The questionnaire-based quantitative study may apply to other engineering disciplines or institutions offering similar educational programs.

Literature Review

In the context of academic training in engineering, leadership emerges as a crucial competency, not just in theory but also in professional practice. This literature review highlights the multifaceted dimensions of leadership within the engineering field, exploring various theoretical perspectives and emphasizing the specific competencies and skills demanded in this discipline. It also addresses the gap between the leadership skills acquired during academic training and those effectively required in the job market. This thorough analysis provides a better understanding of how leadership training is incorporated into engineering programs and its importance in preparing future engineers holistically. Moving from theoretical underpinnings to practical applications, the review delves into several fundamental theories that help understand and analyze leadership in different contexts.

Several theories help in understanding and analyzing leadership in different contexts. One of the fundamental theories is the Trait Theory [9], [10], which focuses on personal characteristics and individual traits. According to Northouse [11], traits are considered innate, suggesting that individuals with characteristics such as intelligence, honesty, self-confidence, decision-making ability, and communication skills have a higher potential to be effective and successful leaders. Additionally, the behavior theory, which is based on the specific actions and behaviors of leaders, is integrated to complement this perspective. This theory explores how the actions and behaviors of leaders affect outcomes and follower satisfaction [11].

In this context, the importance of transformational leadership theory is also highlighted, focusing on the impact of leaders on their followers, inspiring and motivating them towards common goals and objectives [12]. This model emphasizes the ability of transformational leaders to foster the personal and professional development of their followers, promoting trust, collaboration, and individual growth. In engineering, applying transformational leadership can enhance the effectiveness of work teams, encourage innovation, and create a collaborative environment where individual contributions are valued [13].

Another relevant theory is situational leadership, developed by Hersey and Blanchard [14]. This approach recognizes the need for leaders to adapt their leadership style based on the maturity or competence of the followers and the specific demands of the situation. In engineering projects and teams characterized by their complexity and diversity, situational leadership theory becomes particularly relevant. Assessing and understanding the technical needs and abilities of team members and their maturity level concerning specific tasks becomes essential for achieving optimal performance [14].

Moreover, transactional leadership theory, based on the exchange between leader and follower, is crucial in efficiently managing engineering projects. This approach establishes agreements and rewards to achieve organizational goals [15]. It is particularly useful when tasks are clear and predictable, and strict adherence to objectives and standards is expected [16]. In contrast, laissez-faire leadership theory, characterized by leader passivity and noninterference [12], can be detrimental in engineering environments where clear direction and rapid decision-making are required. By exploring these various leadership theories, we can discern a fundamental link with the competencies and skills demanded in engineering.

As a professional discipline, engineering requires comprehensive skills and competencies to address industry challenges efficiently. Fundamental technical skills in this field encompass mastery of theoretical and practical foundations and proficiency in using specialized tools and software. These skills are essential for analyzing, problem-solving, and applying specific engineering knowledge, whether in civil, mechanical, electrical, chemical, or industrial engineering [17], [18].

The modern engineer must excel in interpreting and creating blueprints, managing calculations and numerical analysis, and project management with decisive skills [19], [20]. These technical skills form the foundation for successful performance in the engineering workforce. In addition to technical skills, soft and social skills are essential for a successful career in engineering. Communicating effectively, both orally and in writing, is crucial for collaborating in multidisciplinary teams, presenting technical reports, and establishing reliable client relationships [21]. Teamwork and collaboration are skills that foster creativity and innovation when integrated into teams for complex projects [22].

Leadership in engineering is indispensable for managing teams, making informed decisions, and adapting to constant changes [23]. This set of soft and social skills adds to the pyramid of workplace competencies necessary in engineering, which goes beyond technical skills. In this context, problem-solving ability, innovation, project management, and leadership are key competencies that engineers must develop throughout their careers [24], [25], [26].

Figure 1 illustrates a pyramid that was developed to represent continuous growth and development in engineering and constructed based on existing literature in the field. Reflecting the complexity of reaching each skill level, these tiers, derived from the experience and judgment of the researcher, support the foundation of each job competency. In summary, the engineering field demands a unique combination of technical skills and workplace competencies, emphasizing the importance of a comprehensive approach to meet the challenges and opportunities in this highly dynamic industry.

Furthermore, the development of leadership as a skill and the behavior of leaders are gender-dependent [27], [28]. In [28], significant differences in leadership behavior between genders and work environments were found. Women in work environments dominated by women and mixed genders exhibited greater developmental and positive conventional leadership, while men tended towards negative conventional and destructive leadership. This suggests that female leaders adapt flexibly to different contexts, challenging gender stereotypes in leadership. In agreement, but in an educational setting, the study [27] showed that although transformational or interactive leadership is associated with a feminine style and transactional with a masculine one, the surveyed women scored higher on authoritarian and dictatorial styles, possibly adapting to dominant male leadership models. However, the predominant style among participants was consultative. This work also found a greater correlation between consultative and dictatorial styles in women, suggesting an adaptation to male-dominated environments and pursuing male leadership models.

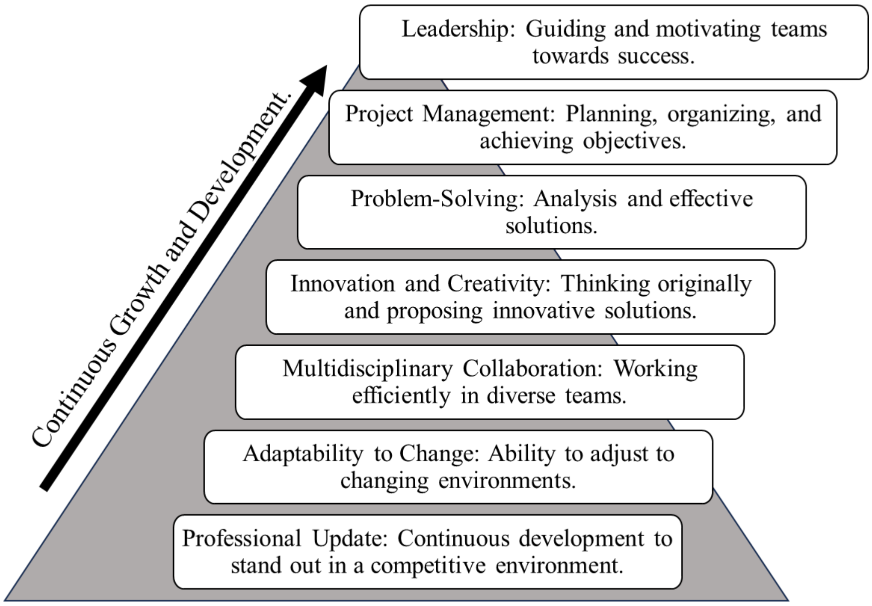

Figure 1. Critical engineering skills for facing challenges and seizing opportunities.

Significant disparities become apparent when discussing gaps between industry demands and the skills possessed by engineering graduates. Previous studies have identified critical deficiencies in areas such as effective communication, teamwork, management and decision-making, ethical leadership, and social responsibility within the engineering field. Engineers often encounter challenges applying these soft skills in dynamic work environments, underscoring the pressing need to address these discrepancies during academic training.

The ability to communicate effectively and collaborate in multidisciplinary teams is essential for leading projects and establishing solid relationships in the workplace. However, various studies [4], [5] reveal that engineering graduates often lack effective communication skills and find it challenging to work efficiently in teams. Moreover, management and decision-making, fundamental aspects of leadership in engineering, exhibit gaps identified by previous studies [6], [29], suggesting that graduates may not have the necessary skills to face challenges optimally.

Similarly, ethical leadership skills and social responsibility gaps are also notable [30], [31]. Engineering leaders must consider the social and environmental impacts of their decisions in a globalized world geared towards sustainability. However, some engineering graduates may have limited awareness of social responsibility and lack the skills to adequately address these dimensions in their leadership.

Addressing these skill gaps requires a comprehensive approach to leadership training in engineering education. Numerous studies have highlighted the crucial need to incorporate leadership skills into engineering education. This ensures that graduates are well-equipped to tackle the various challenges of the job market and society. For instance, in the study [32], the authors developed a tool to measure leadership, adaptability to change, and synthesis. This emphasizes the necessity of these skills in engineers. The study [33] also identified key generic skills essential for employability in the built environment, including leadership and critical thinking. A study [34] proposed a precise definition of engineering leadership, focusing on integrating technical and leadership competencies. Furthermore, the study [35] addressed the significance of soft skills, such as leadership, in software engineering education.

Regarding incorporating leadership training into engineering programs, [8] analyzed the integration of leadership skills into engineering programs in the United Kingdom, highlighting challenges in their implementation. It was found that there is a lack of commitment from course designers to address the leadership skills gap in engineering education. This may be due to insufficient recognition of the importance of leadership skills. Additionally, there are structural and conceptual difficulties in integrating leadership teachings with existing modules, which suggests barriers to the effective combination of leadership with technical content. The saturation of technical content in curricula also limits the possibility of offering leadership as a standalone module. Lastly, some aspects of leadership are not emphasized enough in curricula, indicating areas that require greater integration to strengthen leadership competencies in future engineers. Similarly, [36] reviewed leadership development programs for youth, noting the need for more research to determine their effectiveness. Finally, [37] evaluated leadership competence in mining engineering students, promoting participative leadership styles.

Effective integration of leadership skills into engineering education emerges as a key imperative in training capable and versatile professionals. These studies reveal a clear trend towards the valuation and development of leadership as an essential competency, not only for engineers' professional success but also for their significant contribution to society and technological progress.

Therefore, this study focuses on characterizing leadership profiles and styles among engineering students, recognizing the importance of understanding their self-perception of leadership abilities. This characterization, conducted using the adapted leadership questionnaire by [38], will identify specific gaps present in the students and provide valuable guidelines for implementing actions that ensure engineering graduates meet the job market's expectations regarding leadership competencies.

Methodology

Survey

The instrument used in this study was specifically selected to assess students' perceptions of leadership competencies in engineering students from a prominent private Chilean university. This survey is based on the "Developmental Leadership Questionnaire" (DLQ) [38], adapted for use in the context of Chilean engineering students. To detect ambiguities and achieve statements that were clear to the student sample, cognitive validation (interpretation of the item's meaning in relation to what is intended to be investigated) and structural validation (grammatical, typographical, or formatting errors) of the first version of the survey were carried out. This was done through interviews with students, thereby generating the version of the instrument used in this pilot study.

At this stage of the validation process, the instrument's reliability presents a Cronbach's alpha of 0.860, reflecting high item consistency. However, the reliability calculated for the different theoretical dimensions of the instrument shows some Cronbach's alpha values that are not satisfactory (Table 1). Therefore, as the validation work on the instrument continues, results will only be reported for the "Developmental leadership," "Conventional-positive leadership," and "Conventional-negative leadership" dimensions, which are also the most relevant according to the objectives set for the current study.

Table 1. Instrument Dimensions - Cronbach's Reliability Analysis.

	Dimensions	*Number of items*	*Scale*
Developmental Leadership Questionnaire (α=0.860)	*Developmental leadership (α=0.879)*	19	1: "Never" 2: "Rarely" 3: "Occasionally" 4: "Frequently" 5: "Very Frequently"
	Conventional-positive leadership (α=0.766)	8	
	Conventional-negative leadership (α=0.570)	6	
	Laissez-Faire leadership (α=0.481)	3	

Descriptive statistics were used to analyze the results and characterize the sample. The Kolmogorov-Smirnov test was used to examine the sample, and it found that the items analyzed did not follow a normal distribution for the students. Therefore, non-parametric statistics were chosen to analyze the results. The data analysis included the use of statistical methods such as the Kruskal-Wallis test, the Mann-Whitney test, and Spearman correlations. These analyses were performed using the SPSS software to determine significant differences and correlations between variables. These insights were crucial in evaluating the leadership competencies of the participants.

Participants

This research was conducted using an online self-administered questionnaire distributed to undergraduate senior students from the School of Engineering at a prominent private Chilean university. Out of the 140 valid responses collected, 70% were from men, 28.6% were from female participants, and 1.4% did not identify with biological sex. Regarding age range, 52.1% were between 19 and 21 years old, 31.4% were between 22 and 24 years old, and 16.4% were 25 years or older. Regarding the distribution by major, 42.9% were enrolled in Industrial Engineering, 25.7% in Geology, 17.1% in Computer Engineering and Informatics, and 14.3% in Automation and Robotics Engineering.

It is important to note that out of all the questionnaire participants, only 23.6% were employed, while the remaining 76.4% were not. Almost half of the respondents, 45%, had already completed an internship or work placement in a company or organization. Additionally, 32.9% of the participants had participated in extracurricular activities related to leadership or teamwork. It is worth mentioning that 93.6% of the students who took the survey considered it essential to participate in leadership activities as a part of their academic training.

Results

Table 2 displays the descriptive analysis of each sub-dimension of the four dimensions that make up this model: “Developmental Leadership” (M= 4.02, SD=0.477), “Conventional Positive Leadership” (M=4.25, SD=0.472), and “Conventional Negative Leadership” (M=2.88, SD=0.609). These values provide detailed insight into the distribution and variability of the leadership competencies evaluated in the student sample.

Table 2. Descriptive Analysis Results for Each Subdimension.

Sub dimension	*Min.*	*Max.*	*Mean*	*Dev. Std.*
Developmental leadership - Support	2,5	5	4,3071	0,5955
Developmental leadership - Responsibility	2,6	5	4,24	0,50903
Developmental leadership - Value base	2,3	5	4,1524	0,52036
Developmental leadership - Promote participation	2	5	3,8905	0,70563
Developmental leadership - Promote creativity	1,3	5	3,7548	0,8544
Developmental leadership - Confrontation	2,3	5	3,7286	0,67095
Conventional positive leadership - Take necessary measures	2,3	5	4,2643	0,56333
Conventional positive leadership - Seek agreements	2	4,2	3,5405	0,42356
Conventional negative leadership - If, and only if, reward	1,3	5	3,1833	0,7256
Conventional negative leadership - Overcontrol	1	5	2,5857	0,7648
Dimension				
Developmental Leadership	2,63	5	4,0207	0,47663
Conventional Positive Leadership	2,75	5	4,2545	0,47235
Conventional Negative Leadership	1,33	4,67	2,8845	0,60866

In the analysis of the relationships between the dimensions of interest, correlations among the four dimensions of the model were explored, identifying one that was statistically significant. A strong positive correlation was observed between the "Developmental Leadership" and "Conventional Positive Leadership" dimensions ($\rho = 0.727$, $p < 0.001$). In Table 3, we have presented the results of Spearman's rho correlation analysis among various subdimensions.

The data exploration showed moderate positive correlations between the subdimensions "Promote Participation" and "Promote Creativity" ($\rho = 0.640$, $p < 0.001$). Similarly, a moderate positive correlation was found between "Seek Agreements" and "Take Necessary Measures" ($\rho = 0.597$, $p < 0.001$), among others, as listed in the table. These findings offer a comprehensive understanding of the interrelationships within the leadership competencies model, shedding light on the competencies of the participants.

These correlations reveal significant relationships between leadership dimensions, potentially indicating possible synergies and tensions between specific styles. For example, the strong positive correlation between "Developmental Leadership" and "Conventional Positive Leadership" suggests a complementarity between these approaches. These observations lay the groundwork for future detailed analyses of the interaction of these styles and their impact on the leadership competencies of students.

Table 3. Spearman Correlation Analysis Results by Subdimensions

		CNL - If. and only if. reward	*CNL - Overcontrol*	*DL- Promote creativity*	*DL - Promote participation*	*DL - Responsibility*	*CPL - Seek agreements*	*DL - Support*	*CPL - Take necessary measures*	*DL - Value base*
Developmental leadership (DL) - Confrontation	CC	.287**	0.053	.522**	.433**	.426**	.390**	.358**	.478**	.391**
	Sig.*	<.001	0.533	<.001	<.001	<.001	<.001	<.001	<.001	<.001
	N	140	140	140	140	140	140	140	140	140
Conventional negative leadership (CNL)- If. and only if. reward	CC	1	.299**	.317**	.288**	.257**	0.144	0.123	.383**	0.142
	Sig.*	.	<.001	<.001	<.001	0.002	0.09	0.148	<.001	0.093
	N	140	140	140	140	140	140	140	140	140
Conventional negative leadership (CNL) - Overcontrol	CC		1	0.163	.183*	0.131	0.134	0.006	0.166	0.038
	Sig.*		.	0.055	0.03	0.122	0.115	0.944	0.05	0.656
	N		140	140	140	140	140	140	140	140
Developmental leadership (DL) - Promote creativity	CC			1	.640**	.493**	.495**	.400**	.578**	.456**
	Sig.*			.	<.001	<.001	<.001	<.001	<.001	<.001
	N			140	140	140	140	140	140	140
Developmental leadership (DL) - Promote participation	CC				1	.581**	.534**	.258**	.495**	.466**
	Sig.*				.	<.001	<.001	0.002	<.001	<.001
	N				140	140	140	140	140	140
Developmental leadership (DL) - Responsibility	CC					1	.508**	.374**	.581**	.446**
	Sig.*					.	<.001	<.001	<.001	<.001
	N					140	140	140	140	140
Conventional positive leadership (CPL) - Seek agreements	CC						1	.569**	.597**	.404**
	Sig.*						.	<.001	<.001	<.001
	N						140	140	140	140
Developmental leadership (DL)- Support	CC							1	.349**	.338**
	Sig.*							.	<.001	<.001
	N							140	140	140
Conventional positive leadership (CPL) - Take necessary measures	CC								1	.395**
	Sig.*								.	<.001
	N								140	140

** The correlation is significant at the 0.01 level (two-tailed). * Two-tailed

A Mann-Whitney U test examined potential differences in leadership perceptions between men and women. The results showed no significant differences ($p > 0.05$). This suggests that both men and women have a similar perception of leadership, indicating homogeneity across both groups.

The same test was used to identify differences between employed students (G1) and unemployed students (G2). Significant differences were found in the "Responsibility" subdimension ($M_{G1}=4.41$, $M_{G2}=4.19$, $Z=-2.192$, $p=0.028$). Furthermore, significant differences were identified between students who have completed internships or practicums (G1) and those who have not (G2) in three subdimensions: "Confrontation" ($M_{G1}=3.92$, MG2=3.57, Z=-2.973, p=0.003), "Take Necessary Measures" (MG1=4.37, MG2=4.18, Z=2.497, p=0.013), and "Promote Participation" (MG1=4.01, MG2=3.80, Z=-2.213, p=0.027). Similarly, significant differences were found between students who participated in extracurricular activities related to leadership (G1) and those who did not (G2). The differences were observed in the subdimensions "Overcontrol" (MG1=2.80, MG2=2.48, Z=2.213, p=0.027) and "Promote Creativity" (MG1=3.94, MG2=3.66, Z=-2.043, p=0.041).

The Kruskal-Wallis test was also applied to contrast leadership perceptions among students from different majors, highlighting significant differences, mainly in the group of Industrial Engineering students compared to other disciplines. The first considerable discrepancy was evident when comparing Industrial Engineering students (G1) with Geology students (G2), specifically in the "Developmental Leadership" dimension (MG1=4.18, MG2=3.92, Z=2.417, p=0.016). Additionally, significant differences were identified between Industrial Engineering students (G1) and those in Computer Engineering and Informatics (G3) and Automation and Robotics Engineering (G4). Specifically, disparities were observed in the subdimensions of "Promote Participation" (MG1=4.10, MG3=3.67, MG4=3.55), "Confrontation" (MG1=3.99, MG3=3.47, MG4=3.81), and "Value Base" (MG1=4.29, MG3=4.04, MG4=4.00). These findings highlight the importance of considering the diversity in leadership perceptions across different majors, providing a more comprehensive understanding of student competencies in specific academic contexts.

Finally, when comparing groups from different age ranges (G1: 19-21 years, G2: 22-24 years, G3: 25 years or more), significant differences were found in the subdimensions "Overcontrol" (MG1=2.74, MG2=2.37, MG3=2.48) and "Support" (MG1=4.32, MG2=4.42, MG3=4.04).

These results offer detailed insights into advanced students' perceptions of leadership within different academic and work settings.

Discussion of Results

In the descriptive analysis of the dimensions, the highest mean (4.25) corresponds to “Conventional Positive Leadership,” followed by “Developmental Leadership,” with a 4.02, indicating that students from the School of Engineering perceive themselves as active and effective leaders. This aligns with the expectations for future professionals in the field of engineering, where part of their graduation profile is to be capable of leading teams [24], [25], [26]. There is also a strong positive correlation between both dimensions, indicating a direct relationship in what each of these dimensions involves.

Despite these positive self-perceptions, it is essential to investigate whether the students' perceptions accurately reflect their true leadership capabilities. While students may perceive themselves as effective leaders, it is crucial to recognize that self-perception does not always align with reality. This raises questions about the discrepancy between the leadership skills students perceive and the actual competencies demanded by the industry. Complementing this study with an external assessment in the future to compare results can provide a more comprehensive and accurate perspective on the leadership skills of engineering students, thus ensuring they are adequately prepared for the professional world.

In addition to the above, regarding correlations, there are subdimensions with positive correlations, such as "Promote Participation" and "Promote Creativity." This can be associated with the notion that students who perceive themselves as promoters of participation (of the team) also consider that they promote creativity. Authors like [21] and [22] suggest that creativity is fostered when working in teams due to the complementary contributions each member can make while simultaneously developing other soft skills.

For this research, it was evaluated whether there were differences in self-perception between men and women. The results obtained indicate that there are no significant differences between the men and women in the sample. This contrasts with the findings of the study [27], where leadership styles were evaluated, and differences were found between men and women, with the group of women scoring higher in relation to men in authoritarian and dictatorial styles.

Significant differences were found between employed students (M=4.41) and unemployed students (M=4.19) in the subdimension of responsibility. Also, between those who have completed internships and those who have not, in the subdimensions: “Confrontation,” “Take Necessary Measures,” and “Promote Participation,” where the highest means were from the group that completed internships. The sub-dimension "Confrontation" refers to the students' ability to confront and resolve challenging situations constructively and professionally within a workplace setting. This allows us to deduce that students who have been in a work context, whether working or interning, can better develop characteristics associated with an active and effective leadership style sought by organizations. As indicated by [7], experiential learning contributes directly to professional development.

In line with the above, there were statistically significant differences between those students who participated in some activity outside the formal training of their program related to leadership and those who did not. The former group scored higher in the subdimensions of “Overcontrol” and “Promote Creativity.” In line with other studies that promote leadership training [36], [37], it would be advisable for the School of Engineering to encourage its students to participate in such activities, allowing them to complement their formal education through extracurricular activities, and thus better develop skills associated with “Developmental Leadership.”

Lastly, when analyzing differences between academic programs, significant differences were found between the Industrial Engineering program (G1) and others such as Geology (G2), Computer Engineering and Informatics (G3), and Automation and Robotics Engineering (G4). With G2, it was in relation to the Developmental Leadership dimension. In the case of G3 and G4, it was associated with the subdimensions "Promote Participation," "Confrontation," "Value Base." While every engineering professional should know how to lead teams, this skill is context-dependent [28]. There is more demand for industrial engineering professionals; therefore, the results make sense, whereas, in students of this program, leadership skills associated with developmental leadership are more greatly fostered.

This analysis presents interesting and significant patterns in leadership self-perception among students at the School of Engineering. The findings highlight the students' inclination towards positive and developmental conventional leadership and emphasize the importance of hands-on experience, such as employment or internships, in developing effective leadership skills. These insights suggest an educational approach that integrates both theory and practice, preparing future engineers to lead effectively in dynamic professional environments.

Conclusions and Future Directions

This study focuses on characterizing leadership profiles and styles among engineering students, recognizing the importance of understanding their self-perception of leadership abilities. After conducting a thorough analysis, this study reveals that students studying engineering in a private Chilean university positively perceive their leadership skills. This perception is found to be directly aligned with the competencies that the industry demands. The students excel in various dimensions related to leadership, especially in "Conventional Positive Leadership" and "Developmental Leadership." This is a positive sign as it highlights their potential to take up active and effective leadership roles, which aligns with the professional expectations of the engineering field. The primary objective of this research is to provide valuable insights into the preparedness of the students in the area of leadership during their formative development.

The correlations that were identified show how “Developmental Leadership” and “Conventional Positive Leadership” complement each other and how “Promote Participation” and “Promote Creativity” are positively related. This highlights the importance of teamwork in driving innovation. Although gender differences were expected, the results do not reveal significant variations in self-perception of leadership skills. This suggests a possible trend towards equality in leadership perception across genders in the studied context.

However, it is crucial to address the validation of the instrument used. Measures were taken to enhance validity and reliability, significantly impacting the results' interpretation. Future studies should provide a clear and direct discussion of the validation process, including item review and additional steps taken to refine the instrument. This includes expanding the student sample for greater representativeness and considering the utilization of a questionnaire to assess students' actual skills to mitigate potential biases. Additionally, exploring the possibility of implementing a 360-degree evaluation or alternative methods that allow for the elimination or supplementation of self-perception is suggested.

Long-term tracking is advisable to assess the evolution of students' leadership perceptions in their professional careers. Furthermore, addressing the integration of leadership skills into the curriculum, overcoming barriers, and incorporating diversity into leadership expectations across various engineering contexts are essential considerations. An international comparison is recommended to gain insights into global and contextual patterns in engineering leadership development. Lastly, exploring the specific impact of extracurricular activities on leadership skill development will provide further guidance for implementing extracurricular initiatives in engineering education.

This study lays the foundation for understanding leadership skills in engineering students, aiming for more effective and contextualized training for their future professional development. Considering these findings, developing an improvement plan in leadership training is suggested, specifically addressing the identified areas for optimization and adapting it to the changing needs of the academic and professional engineering environment.

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