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Exploring Leadership Development in Engineering: How GPA and Professional Experience Shape Student Leadership Skills

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Abstract

Leadership is a critical competency in the engineering field, requiring technical expertise and the ability to lead teams, make informed decisions, and adapt to changing environments. Recently, there has been increasing demand to integrate leadership skill development into engineering education, as many graduates face difficulties when assuming leadership roles in professional settings. Previous research highlights the influence of factors such as professional experience, extracurricular activities, and demographic variables on individuals' self-perception of leadership abilities. However, it is also interesting to study the relationship between academic performance and the leadership skills developed by students. Studying the link between GPA and leadership skills is essential, as GPA is often seen as an indicator of academic performance and may be associated with key leadership qualities such as organization and responsibility. This analysis seeks to determine whether high academic achievement correlates with the development of soft skills, which are critical for effective team management and communication. Furthermore, it examines whether the current educational system of an engineering school successfully balances technical knowledge and leadership development, providing a comprehensive understanding of a student's profile and suggesting areas for improvement in engineering leadership training. This study aims to analyze the leadership characteristics of final-year engineering students by examining the relationship between various sociodemographic factors, including GPA, academic program, work experience, professional internship, gender, and participation in extracurricular activities. The Developmental Leadership Questionnaire (DLQ), customized for the academic context and based on transformational leadership theory, assessed leadership characteristics. A path analysis was conducted to explore the direct and indirect relationships between GPA, work experience, professional internships, extracurricular activities, and leadership skills. This model allowed us to examine how these factors influence students' self-perception of leadership skills, particularly in relation to their assessment of the importance of leadership training. The analysis sheds light on how various academic and experiential factors contribute to the development of leadership skills, highlighting the complex interactions between these variables. The results revealed the direct and indirect effects of GPA, leadership skills, and the role of professional experience in leadership skills. These findings suggest that other factors, such as professional internships or extracurricular activities, may substantially bridge the gap between academic performance and leadership competence. These findings offer valuable insights into the impact of academic performance and practical experience on leadership development among engineering students. The study underscores the need to foster both technical and leadership skills within engineering curricula, offering guidance for more holistic educational approaches that better prepare graduates for leadership roles in the engineering profession.

Keywords: leadership, higher education, professional development, leadership profile, leadership in engineering

Introduction

Leadership has become an essential competency for 21st-century engineers, who must solve technical problems and lead multidisciplinary teams, make strategic decisions, and adapt to a constantly changing global environment. The increasing complexity of social, economic, and technological challenges highlights the need to train leaders who combine technical and professional skills [1]. In this context, higher education institutions are called to play a fundamental role in developing these capabilities, transforming engineering education to better prepare students for effective leadership roles [2].

Despite its importance, significant gaps still need to be filled in understanding the factors that contribute to leadership development in engineering students. Previous research has emphasized the influence of practical experiences, such as project-based learning and internships, in strengthening students' leadership skills and self-confidence [3]. However, aspects such as the impact of academic performance, measured by grade point average (GPA), on leadership perception still need to be explored. This metric, commonly used to assess educational achievement, may be associated with crucial leadership qualities such as organization, responsibility, and team management [4].

Furthermore, integrating leadership competencies into engineering curricula remains a challenge. While some educational programs have made significant progress, such as developing global competencies and focusing on intercultural collaboration, there is still a lack of a systematic and uniform strategy to implement these skills in academic curricula [5]. Similarly, some innovative models highlight the need for contextual and adaptive approaches to fostering inclusive and sustainable leadership [6].

This study aims to analyze the relationship between leadership characteristics in senior engineering students and measures of professional experience and academic achievement, such as grade point average (GPA) and academic progression. One recognized methodology in leadership studies is the Multifactor Leadership Questionnaire (MLQ), available in both its extended and shortened versions and adapted to various contexts. However, the MLQ is primarily used to identify leadership styles: Transformational, Transactional, and Laissez-Faire [7]. This research focuses on studying the skills of a leader. The study employs the Developmental Leadership Questionnaire (DLQ) [8], based on transformational leadership theory to achieve this. It applies statistical tests and path analysis to explore these variables' direct and indirect relationships. The study's findings can serve as a foundation for the Engineering School to implement concrete actions that integrate technical and leadership skills into engineering education programs, fostering a more holistic development of students.

Literature Review

Leadership has emerged as a crucial element in engineering and higher education, shaping the ability of professionals to navigate complex, multidisciplinary, and globalized environments. Beyond technical expertise, engineers and students are increasingly required to demonstrate leadership qualities such as adaptability, strategic vision, and collaboration, which are critical for success in both academic and professional contexts. Evidence

suggests that leadership development in engineering students is integral to long-term academic and professional success, enhancing decision-making, resilience, and teamwork [9],[10].

Leadership is considered a cornerstone of engineering education. Leadership skills are essential for the employability of these professionals [11]. Therefore, combining technical skills with interpersonal abilities is necessary to meet modern professional demands. Engineers lead multidisciplinary teams, manage complex projects, and adapt to global challenges [1], [2]. Beyond project management, leadership in engineering demands strategic foresight, ethical decision-making, and the ability to integrate technical and social dimensions in complex systems [12]. This underscores the need for leadership training in engineering education to equip graduates with both technical and managerial skills.

Leadership is a skill that involves communication, teamwork, and problem-solving, which drive innovation and help achieve goals. Many institutions adopt transformational leadership models, which have been shown to improve outcomes in resource-limited settings [13], [14]. These models prepare graduates for dynamic, interconnected workplaces. Engineers with well-developed leadership abilities can mobilize resources and promote innovation within organizations [11]. Empirical evidence indicates that students who develop leadership skills early in their academic trajectory not only excel in team-based projects but also achieve greater professional integration post-graduation [15]. Employers value leadership as a key skill for engineering graduates. Students with leadership training have better career prospects [16]. In response, institutions are increasingly aligning curricula with industry demands by incorporating leadership development programs [17]. Furthermore, decision-making under uncertainty is a critical leadership competency in high-stakes engineering sectors such as aerospace, energy, and infrastructure development [10]. These efforts emphasize the importance of leadership in preparing graduates for a dynamic global workforce.

Engineering education must balance technical and leadership skills. Adaptability, strategic vision, and inclusivity are crucial for diverse organizational cultures. Tools like the Developmental Leadership Questionnaire (DLQ) assess and develop leadership behaviors in academic and professional contexts [18], [19], [20].

Developmental Leadership [18], [19], [21] is a model based on the person-by-situation interaction paradigm, highlighting the importance of context in leadership effectiveness. It highlights the interplay between leaders' personal characteristics, such as intelligence, creativity, and resilience, and environmental conditions in shaping leadership actions. The model underscores behaviors like serving as an exemplary role model, providing individualized consideration, and inspiring and motivating followers. Drawing from transformational leadership, it adapts concepts like "charisma," replacing it with "inspiration" to better fit specific organizational cultures. This approach fosters desirable leadership competencies and positively influences teams and organizations through ethical and adaptive leadership practices. According to this theory, the Developmental Leadership Questionnaire (DLQ) is a crucial tool for assessing and evaluating students' self-perception of their leadership competencies [22], offering a practical method for assessing leadership competencies and guiding targeted development.

Academic performance and leadership skills are closely linked. Riutta and Teodorescu [23] report that students in leadership roles tend to have higher GPAs. Similarly, Sánchez-Anguita highlights that leadership fosters self-efficacy and resilience, improving academic outcomes [24]. Additionally, structured leadership programs, such as peer-assisted learning models, enhance student retention and career readiness, especially in STEM fields [12]. Empirical research links leadership directly to GPA, while others highlight self-efficacy as a mediator. Gannouni and Lalao [25] argue that leadership primarily affects academic performance by enhancing self-efficacy. Ting found leadership experiences and community engagement correlate with first-year GPA, reinforcing motivation and persistence [9]. Predictive models suggest leadership, motivation, and self-efficacy strongly predict student retention and long-term academic success in engineering [10].

Leadership fosters confidence, motivation, and adaptability, key factors for academic success. Uaikhanova et al. [26] found that structured leadership programs enhance problem-solving and reduce anxiety, creating a supportive learning environment. Similarly, Shamsi demonstrated that leadership and emotional intelligence improve students' ability to navigate academic challenges [15]. Additionally, teamwork competencies, often tied to leadership, correlate with higher GPA. The relationship between leadership and GPA is complex. Shamsi et al. found that lower assertiveness correlates with higher GPAs, indicating that traditional leadership traits may not always align with academic success. However, structured leadership initiatives foster self-efficacy, belonging, and retention, contributing to long-term academic achievement [12].

This research aims to analyze the direct and indirect effects of leadership skills among a group of senior engineering students, using measures of professional experience and academic success, such as GPA and academic progress. To achieve this, data was collected through the administration of the DLQ and the academic records of the surveyed students to obtain the aforementioned academic indicators. It is important to consider that senior students, the group studied in this research, have had the opportunity to develop leadership skills through two main pathways. First, through course content included in the innovation and entrepreneurship curriculum. Second, by developing transversal skills that contribute to the graduate profile of their respective degree programs. Although there is no specific training pathway for leadership development, the university and the faculty offer some non-mandatory extracurricular activities to foster leadership skills.

Methodology

This study utilizes a quantitative cross-sectional survey design. This section details the research design, data collection instrument, sample selection, and statistical methods used for data analysis. The subsequent section will present the results.

The sample consisted of 130 undergraduate engineering students from a private university in Chile, specifically those in their final two years of study, selected using a non-probability sampling method. The average age of the students was 22.59 years, with a standard deviation of 1.63. The gender distribution was 73.1% male and 26.9% female.

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 33-item survey is based on the "Developmental Leadership Questionnaire" (DLQ) [8], adapted for use with Chilean engineering students [22].

The dimensions examined in this instrument are based on the Developmental Leadership Model proposed by Larsson and colleagues [18], [19], [21]. In particular, the model addresses skills related to inspiration and individual consideration, as well as conventional styles that include demand, reward, and control. Additionally, it includes a dimension of non-leadership, known as "laissez-faire," which is not included in this study.

According to Larsson, the main dimensions of the model include:

- *Developmental Leadership*. This dimension focuses on behaviors that promote the personal and professional development of team members through role modeling, inspiration, and individual consideration. The subdimensions within this category are:
    - *DL - Support*: Providing emotional and practical support to team members.
    - *DL - Responsibility*: Fostering a sense of individual and group responsibility.
    - *DL - Value Base*: Acting and making decisions guided by ethical and moral values.
    - *DL - Promote Participation*: Encouraging active participation and engagement among group members.
    - *DL - Promote Creativity*: Stimulating innovative ideas and creative solutions.
    - *DL - Confrontation Management*: Addressing conflicts and issues directly and constructively.
- *Conventional Leadership.* This dimension encompasses behaviors oriented toward achieving group objectives through structured and task-focused approaches. Includes both conventional positive and conventional negative approaches, divided into the following subdimensions:
    - *CPL - Take Necessary Measures*: Taking necessary actions to achieve tasks and objectives.
    - *CPL - Seek Agreements*: Seeking consensus and agreements within the group.
    - *CNL - If Reward*: Regulating behavior exclusively through conditional rewards.
    - *CNL - Overcontrol*: Maintaining excessive control over details and processes.

In the context of the present study, these dimensions were adapted to explore behaviors self-perceived by university students during collaborative activities such as projects, forums, and group assessments. Data were collected using a Likert scale that measured the frequency with which students self-reported engaging in specific behaviors during group

interactions. This approach enables an analysis of individual perceptions regarding collaboration style and responsibility management within the academic context.

Faculty members distributed the questionnaire and allocated class time for students to complete it. The process began with obtaining informed consent, providing assurances of confidentiality, and sharing contact information for the research group. The questionnaire was created and administered using Microsoft Forms, ensuring that the collected data was anonymized and securely backed up.

The results were analyzed using JASP version 0.19.0. This analysis included assessing the normality of the data, calculating descriptive statistics, and conducting a path analysis to test the underlying hypotheses. A mediation model analysis was performed to estimate both direct and indirect effects. The Maximum Likelihood (ML) estimator with robust standard errors was utilized, and 95% confidence intervals were calculated. Finally, the model's explanatory power was assessed using the coefficient of determination (R^2).

Results

The main objective of this study is to analyze both the direct and indirect effects among the constructs related to leadership, as well as the influence of work experience and internship experience on leadership dimensions, and two measures of academic success: Grade Point Average (GPA) and Academic Progression (AcProg). The AcProg variable is constructed based on students' academic behavior, incorporating factors such as the number of courses enrolled (those required for enrollment after data collection), registration for the final degree project (if applicable), and timely completion of the degree (when relevant). Our approach begins with the presentation of descriptive statistics and normality results, followed by an analysis of the effects of work experience and internship experience on leadership dimensions. Finally, we conduct a path analysis, with gender and age as controlled variables.

Table 1 shows the descriptive data for the scales assessed. These data reveal that the standard deviations for all the variables measured were relatively low, suggesting consistent responses and moderate variability among participants. Among the dimensions, *DL - Support* has the highest mean (4.385), indicating that it is the most strongly endorsed dimension, while *CNL - Overcontrol* exhibits the lowest mean (2.436). The skewness and kurtosis values for all scales fall within acceptable ranges (±2 for skewness and ±7 for kurtosis), indicating that the distributions of the variables are approximately symmetric and exhibit no extreme deviations from normality. These findings provide a foundation for further statistical analyses by confirming that the scales are generally well-distributed.

As mentioned before, one of the objectives of this study is to analyze the relationship between students' professional experience and leadership. To this end, two measures of professional experience were considered: students' work experience and participation in professional internships. The results of this analysis are presented in Table 2.

Table 1. Descriptive Statistics of the Scales.

Scales	*Mean*	*Std. Deviation*	*Skewness*	*Kurtosis*
DL - Confrontation Management	3.626	0.691	0.014	-0.254
DL - Promote creativity	3.751	0.775	-0.230	-0.547
DL - Promote participation	3.833	0.744	-0.462	0.311
DL - Responsibility	4.294	0.462	-0.336	-0.526
DL - Support	4.385	0.586	-0.714	-0.104
DL - Value Base	4.195	0.465	-0.448	0.723
CPL - Seek Agreements	3.570	0.380	-0.456	0.199
CPL - Take necessary measures	4.190	0.525	-0.356	-0.093
CNL - If reward	2.951	0.571	0.204	0.090
CNL – Overcontrol	2.436	0.696	-0.033	-0.739

The results of the independent samples t-test revealed statistically significant differences between students with prior or current work experience (Group 1, N1 = 32) and those without work experience (Group 2, N2 = 98) in two dimensions: DL - Promote Participation ($t = 2.028$, $p = 0.045$) and DL - Promote Creativity ($t = 2.220$, $p = 0.028$). Specifically, students in Group 1 (M1 = 3.990, SD1 = 0.741) reported a higher perception of creativity promotion compared to students in Group 2 (M2 = 3.673, SD2 = 0.774). Similarly, in the participation promotion dimension, students with work experience (M1 = 4.083, SD1 = 0.817) scored significantly higher than those without work experience (M2 = 3.752, SD2 = 0.704), suggesting that having worked or currently being employed may be associated with a perception of higher opportunities for creativity and participation. No significant differences were found in the other analyzed variables ($p > 0.05$).

Table 2. Independent Samples t-Test for Work Experience and Internship Experience.

	Work Experience			***Internship Experience***		
Scales	***t***	***df***	***p***	***t***	***df***	***p***
DL - Confrontation Management	-0.697	128	0.487	-0.332	128	0.740
DL - Promote creativity	2.028	128	0.045	0.935	128	0.352
DL - Promote participation	2.220	128	0.028	0.860	128	0.391
DL - Responsibility	1.414	128	0.160	2.335	128	0.061
DL - Support	-0.107	128	0.915	0.959	128	0.340
DL - Value Base	1.791	128	0.086	0.178	128	0.859
CPL - Seek Agreements	-0.136	128	0.892	0.792	128	0.430
CPL - Take necessary measures	1.016	128	0.312	1.841	128	0.068
CNL - If and only if reward	-0.272	128	0.786	1.625	128	0.107
CNL - Overcontrol	-0.374	128	0.709	0.827	128	0.410

Another measure of potential professional experience considered was students' participation in professional internships that are part of the curriculum. As can be consulted

in Table 2, in this case, no significant differences were found between students who completed these internships (N1 = 83) and those who did not (N2 = 47). This may suggest that current internship structures prioritize technical skills over leadership development.

The mediation analysis reveals interesting relationships between the leadership dimensions evaluated and students' academic progression, with distinct results observed for direct, indirect, and total effects. Among all the dimensions analyzed, the only ones showing statistically significant indirect and total effects were *CNL - If Reward* (Conventional Negative Leadership - If Reward), *CNL - Overcontrol* (Conventional Negative Leadership - Overcontrol), *DL - Responsibility* (Developmental Leadership - Responsibility), and *DL - Confrontation Management* (Developmental Leadership - Confrontation Management). Accordingly, the path analysis corresponds to the one presented in Figure 1, which examines the effects of the four variables related to leadership on *Academic Progression* **(**AcProg**)**, mediated by the Grade Point Average (GPA), using standardized coefficients controlled by gender and age (Figure 1). The model encompasses both direct and indirect effects, and the analysis accounts for 38% of the variance in Academic Progression (R^2 = 0.381), offering insights into the relationships between leadership and academic performance.

The indirect effects mediated by *GPA* provide a more nuanced perspective on how these dimensions influence academic progression through academic performance (*GPA*). These effects are detailed in Table 3. The *CNL - If Reward* dimension exhibits a marginally significant positive effect (β = 0.115, p = 0.058), indicating that a conditional rewards-based approach could enhance academic performance, thereby improving academic progression. Conversely, the *CNL - Overcontrol* dimension shows a statistically significant negative indirect effect (β = -0.119, p = 0.020, 95% CI [-0.220, -0.019]), suggesting that a controlling approach may negatively impact *GPA*, reducing the likelihood of students progressing as expected. The *DL - Responsibility* dimension demonstrates a significant positive indirect effect (β = 0.207, p = 0.013, 95% CI [0.043, 0.371]), highlighting the importance of commitment and responsibility in enhancing *GPA*, improving academic progression. Lastly, the *DL - Confrontation Management* dimension shows a significant negative indirect effect (β = -0.130, p = 0.010, 95% CI [-0.229, -0.031]), indicating that a propensity for conflict management may have negative repercussions on academic performance and, consequently, on academic progression.

Finally, the total effects combine the direct and indirect influences of each dimension, offering a comprehensive view of their impact on academic progression (Table 3). The *CNL - If Reward* dimension has a positive and statistically significant total effect (β = 0.231, p = 0.008, 95% CI [0.060, 0.401]). In contrast, the *CNL - Overcontrol* dimension presents a significant negative total effect (β = -0.129, p = 0.011, 95% CI [-0.284, -0.025]). On the other hand, the *DL - Responsibility* dimension shows a significant positive total effect (β = 0.260, p = 0.040, 95% CI [0.012, 0.507]). Lastly, the *DL - Confrontation Management* dimension exhibits a significant negative total effect (β = -0.189, p = 0.037, 95% CI [-0.366, -0.011]).

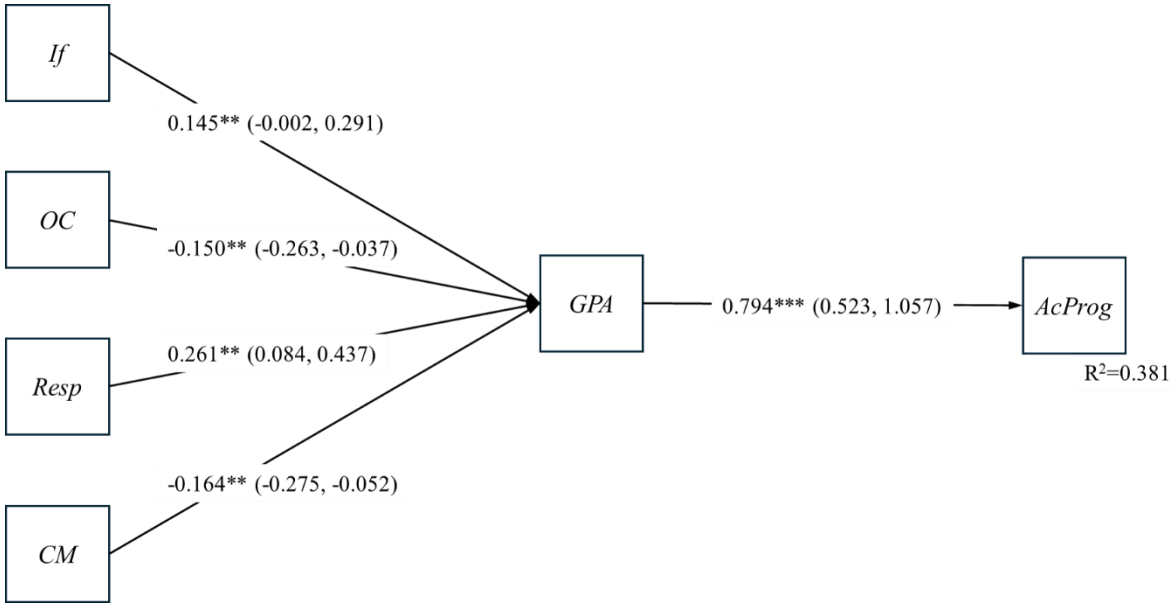

Figure 1. Path Analysis. Effects of *CNL - If Reward* (If), *CNL - Overcontrol* (OC), *DL - Responsibility* (Resp), *DL - Confrontation Management* (CM), and *Grade Point Average* (GPA) on *Academic Progression* (AcProg), with standardized coefficients controlled by gender and age, 95% confident interval, explained variance of the dependent variable (AC), and statistical significance (**p <0.05; *** p < 0.001)

Table 3. Parameter Estimates

						95% Confidence Interval	
	Effect	***Estimate***	***Std. Error***	***z-value***	***p***	***Lower***	***Upper***
If → AcProg	Direct	0.116	0.091	1.270	0.204	-0.063	0.294
OC → AcProg	Direct	-0.010	0.072	-0.139	0.889	-0.150	0.130
Resp → AcProg	Direct	0.053	0.103	0.511	0.609	-0.150	0.255
CM → AcProg	Direct	-0.059	0.073	-0.807	0.419	-0.201	0.084
If → GPA → AcProg	Indirect	0.115	0.061	1894	0.058	-0.004	0.234
OC → GPA → AcProg	Indirect	-0.119	0.051	-2326	0.020	-0.220	-0.019
Resp → GPA → AcProg	Indirect	0.207	0.083	2481	0.013	0.043	0.371
CM → GPA → AcProg	Indirect	-0.130	0.050	-2582	0.010	-0.229	-0.031
If → AcProg	Total	0.231	0.087	2655	0.008	0.060	0.401
OC → AcProg	Total	-0.129	0.079	-1642	0.011	-0.284	0.025
Resp → AcProg	Total	0.260	0.126	2058	0.040	0.012	0.507
CM → AcProg	Total	-0.189	0.091	-2082	0.037	-0.366	-0.011

Discussion

The results of this study offer new insights into leadership development in higher education, particularly in its application to engineering education.

One of the key findings of this study is the positive association between work experience and two leadership dimensions: Promoting Creativity and Promoting Participation ($p < 0.05$). This result suggests that students with work experience tend to develop stronger skills in fostering innovative ideas and motivating their peers to engage in teamwork actively. This finding aligns with previous studies emphasizing the importance of practical experiences in developing leadership competencies [3]. Similarly, the literature indicates that effective leadership in technical environments requires not only disciplinary knowledge but also communication, creativity, and teamwork skills [4]. Additionally, research suggests that teamwork and leadership skills positively correlate with academic performance, reinforcing their relevance in engineering education [9], [10].

However, the lack of significant differences in other leadership dimensions, such as conflict management or team support, suggests that work experience alone is not sufficient to develop a comprehensive leadership profile. This conclusion is consistent with research that highlights the need for specific educational programs to complement practical experience with structured leadership training [17]. Additionally, structured peer-assisted leadership programs have been shown to enhance student leadership development [12].

In contrast to work experience, participation in curricular professional internships did not show significant effects on any of the evaluated leadership dimensions. Several factors may explain this lack of impact. First, professional internships may be primarily designed to strengthen technical competencies rather than interpersonal and leadership skills. This aligns with previous studies that have identified that engineering internship programs often prioritize acquiring technical skills over team management and strategic decision-making [2]. Additionally, the duration and structure of professional internships may be insufficient to produce noticeable changes in leadership development. Previous research has indicated that leadership requires an ongoing development process and that short or loosely structured experiences may not be sufficient to generate a substantial impact [20]. In this regard, internship programs could benefit from more structured strategies that incorporate explicit opportunities for decision-making and team management.

On the other hand, a positive relationship between responsibility, as a dimension of leadership, and academic progress is confirmed, supported by literature highlighting self-efficacy as a key mediator [25]. Responsibility-based leadership fosters students' confidence in their abilities, intrinsic motivation, and essential skills for decision-making and problem-solving. This approach, aligned with transformational leadership, promotes environments of trust and mutual respect, elements that enhance collaborative and meaningful learning [27]. Furthermore, the association between leadership responsibility and academic success is consistent with previous studies, which indicate that self-efficacy and leadership skills contribute to student performance [24].

From an educational perspective, responsibility emerges as a critical skill that can be developed through practical strategies such as project-based learning and assigning leadership roles within teams. In engineering education, this is particularly relevant as it links personal skills with professional demands, preparing future engineers to lead with integrity and adapt to complex organizational environments.

The study also identifies a negative association between conflict management and academic performance, highlighting the challenges of transferring professional competencies to the educational context. While conflict management is essential in professional settings [19], its inadequate implementation in the classroom can create interpersonal tensions that disrupt group dynamics and learning. This underscores the need for adaptive approaches, such as structured mediation and assertive communication, which not only minimize conflicts but also strengthen group cohesion and performance [27]. Additionally, research suggests that structured peer leadership training can help students develop conflict resolution skills while improving teamwork effectiveness [12]. These strategies are crucial for developing leaders capable of managing collaborative challenges in both educational and professional environments.

The results also show a positive direct effect between the leadership dimension associated with rewards and academic progress. In terms of transactional leadership, the use of conditional rewards demonstrates a positive impact in structured contexts, ensuring clarity in expectations and outcomes [28]. However, its limited capacity to foster innovation and critical thinking highlights the need to integrate it with transformational leadership, which promotes creativity, strategic vision, and collaboration [27]. This balance is particularly important in engineering education, where students must combine technical skills with proactive leadership capabilities. Designing programs that integrate both styles can maximize learning and prepare students to lead in a rapidly evolving professional world.

On the other hand, the leadership dimension associated with excessive control has a negative effect on academic progression. This could be due to the inhibition of autonomy and the limitation of creative collaboration, elements essential for learning and leadership development [19]. The findings suggest that authoritarian styles affect both the perception of leadership and academic performance as mediated by GPA. Conversely, participative leadership that fosters trust and motivation improves the learning experience and the development of key competencies such as problem-solving and collaborative decision-making [27]. This is particularly relevant in engineering, where teamwork and innovation are fundamental.

Finally, the findings reinforce the idea proposed in the literature that leadership programs must be inclusive and adaptive. Studies such as those by Larsson and Hyllengren [21] emphasize that a contextual approach sensitive to demographic and cultural differences is essential to prepare students to lead in a globalized and diverse environment. In this sense, the implications of this study transcend the specific context of engineering, offering valuable insights for designing leadership training programs across disciplines.

In conclusion, the results corroborate previous findings and present new challenges and opportunities to improve leadership training. By linking to the literature, this study provides

a solid foundation for redesigning educational programs that balance technical and leadership skills, promoting a more holistic development aligned with the demands of today's professional world.

Conclusions

The research allowed for identifying and analyzing the direct and indirect effects of leadership skills on academic performance, measured through academic progress and GPA. "Responsibility" demonstrates a significant positive total effect, as does "If reward," which is supported by the literature. On the other hand, within the strategies for a leadership training plan in the School, special attention must be given to dimensions related to "Confrontation Management" and "Overcontrol," which showed a negative total effect in the results. Excessively controlling leadership negatively impacts performance, and a review of how conflicts are managed within workgroups is also necessary. Conflict management strategies should be adapted to prioritize team cohesion and, consequently, improve performance.

One of the key findings of this research evaluates the impact of professional experience on the development of leadership skills. This experience can be related to either prior work experience or participation in professional internships. In the first group, there are significant differences between those who have prior work experience and those who do not. Individuals with previous work experience demonstrate a greater ability to promote creativity and participation. Notably, this prior work experience is not necessarily aligned with their field of study; therefore, the observed differences may be associated with their involvement in areas beyond their academic discipline. For the second group, participation in professional internships does not show significant differences in the development of leadership skills. This may be because internships primarily contribute to the technical development of the profession. If professional internships are to have a more significant impact on leadership development, these programs should be reconsidered or redesigned, incorporating a specific training itinerary focused on cultivating leadership skills.

Incorporating teaching strategies that foster leadership and teamwork is essential for practically applying these skills. To ensure their effective development, it is critical to implement a structured plan early in the academic program. This proactive approach will better prepare engineering professionals to lead teams through a participatory leadership style, positively impacting both individual performance and overall outcomes. The Engineering School faces the challenge of designing a training plan that promotes leadership development and aligns with the growing demands of the job market. Leadership encompasses multiple dimensions, all of which must be addressed in the curriculum to provide a well-rounded education. Moreover, leadership training should extend beyond theoretical instruction to include practical applications that demonstrate its relevance in real-world contexts. As highlighted in the literature, integrating structured leadership development programs into the curriculum can significantly enhance the comprehensive education of engineering professionals, particularly by strengthening their leadership skills.

References

[1] D. Magrane, P. S. Morahan, S. Ambrose, and S. A. Dannels, "Competencies and Practices in Academic Engineering Leadership Development: Lessons From a National Survey," *Social Sciences*, vol. 7, no. 10, p. 171, Sept. 2018, doi: 10.3390/socsci7100171.

[2] S. J. Perry, E. M. Hunter, S. C. Currall, and E. Frauenheim, "Developing Engineering Leaders: An Organized Innovation Approach to Engineering Education," *Engineering Management Journal*, vol. 29, no. 2, pp. 99-107, Apr. 2017, doi: 10.1080/10429247.2017.1298189.

[3] J. Sonnenberg-Klein and E. J. Coyle, "Leadership Growth Over Multiple Semesters in Project-Based Student Teams Embedded in Faculty Research (Vertically Integrated Projects)," *IEEE Transactions on Education*, vol. 67, no. 3, pp. 443-452, June 2024, doi: 10.1109/TE.2023.3344314.

[4] G. Coluccio Piñones and M. Muñoz-Pareja, "Study on the Performance and Leadership of Industrial Engineering Students Using Social Network Analysis," *Ingeniare. Revista Chilena de Ingeniería*, vol. 29, no. 4, pp. 735-742, Dec. 2021, doi: 10.4067/S0718-33052021000400735.

[5] T. Richter and B. Kjellgren, "Global Competence Development Around the World: A Systematic Review of Practical Initiatives in Engineering Education," *Cogent Education*, vol. 11, no. 1, p. 2396190, Dec. 2024, doi: 10.1080/2331186X.2024.2396190.

[6] A. Zabaniotou, "Learning Outcomes of Leader and Leadership Development: Method of Soft and Female Leadership (SFL) Empirical Framework for Driving the Gender Equality Change in Mediterranean Engineering Education," *Open Research Europe*, vol. 1, p. 63, Oct. 2021, doi: 10.12688/openreseurope.13340.2.

[7] H. Moreno-Casado, F. M. Leo, M. A. López-Gajardo, T. García-Calvo, R. Cuevas, and D. Sánchez-Oliva, "Adaptation and validation of the MLQ-5X leadership scale to the Spanish educational context," *Anales de Psicología*, vol. 37, no. 2, pp. 367–375, May 2021, doi: 10.6018/analesps.37.2.425351.

[8] G. Larsson, "The Developmental Leadership Questionnaire (DLQ): Some Psychometric Properties," *Scandinavian Journal of Psychology*, vol. 47, no. 4, pp. 253-262, Aug. 2006, doi: 10.1111/j.1467-9450.2006.00515.x.

[9] S. M. R. Ting, "Predicting Asian Americans' Academic Performance in the First Year of College: An Approach Combining SAT Scores and Noncognitive Variables," *Journal of College Student Development*, vol. 41, no. 4, pp. 442-448, 2000.

[10] Q. Jin, P. K. Imbrie, J. J. Lin, and X. Chen, "A Multi-Outcome Hybrid Model for Predicting Student Success in Engineering," in *Proceedings of the 2011 ASEE Annual Conference & Exposition*, Vancouver, BC, Canada, 2011.

[11] S. R. Cabana, M. I. Aguilera, A. F. Chiang, and E. I. Hurtado, "Sustainable Leadership Analysis of Engineering Students in a Higher Education Center: Management Challenges," *Formación Universitaria*, vol. 15, no. 5, pp. 75-86, Oct. 2022, doi: 10.4067/S0718-50062022000500075.

[12] J. Fogarty, R. Altman, and J. Lundmark, "Impact of Peer-Assisted Learning and Leadership Development on Undergraduate Students," in *Proceedings of the 2022 ASEE Annual Conference & Exposition*, Minneapolis, MN, USA, Aug. 2022, doi: 10.18260/1-2--41968.

[13] B. Altynbassov, A. Bayanbayeva, M. Tolegen, and M. Zhamankarin, "A Comprehensive Bibliometric Analysis of Trends in Higher Education Leadership in the Global South, 2013-2023: Contemporary Perspectives and Developments," *International Journal of Educational Research*, vol. 127, p. 102421, 2024, doi: 10.1016/j.ijer.2024.102421.
[14] P. Arsenis, M. Flores, and D. Petropoulou, "Enhancing Graduate Employability Skills and Student Engagement Through Group Video Assessment," *Assessment & Evaluation in Higher Education*, vol. 47, no. 2, pp. 245-258, Feb. 2022, doi: 10.1080/02602938.2021.1897086.
[15] A. Shamsi, T. Varisco, A. De La Cruz, R. El-Desoky, M. Wanat, and E. Coyle, "Association of Emotional Intelligence With Pharmacy Students' Leadership and Academic Performance," *American Journal of Pharmaceutical Education*, vol. 88, 2024, doi: 10.1016/j.ajpe.2024.101335.
[16] S. Cui, Q. Wu, and B. Erdemir, "Being a College Student Leader Boosts Career Prospects: A Panel Survey in China," *Education & Training*, vol. 64, no. 5, pp. 700-715, Sept. 2022, doi: 10.1108/ET-04-2021-0153.
[17] G. Oproiu and M. G. Ianoș, "A Study on Employability Skills of Engineering Graduates," in *The European Proceedings of Social & Behavioural Sciences*, Aug. 2019, pp. 605-614, doi: 10.15405/epsbs.2019.08.03.72.
[18] G. Larsson, "The Developmental Leadership Model: Conceptual Framework and Practical Applications," *Leadership & Organization Development Journal*, vol. 27, no. 3, pp. 190–202, 2006.
[19] G. Larsson and J. Eid, "An Idea Paper on Leadership Theory Integration," *Management Research Review*, vol. 35, no. 3/4, pp. 177-191, Mar. 2012, doi: 10.1108/01409171211210109.
[20] G. Larsson and J. Eid, "An Interactional Approach to Leadership in High-Stakes Environments," *International Journal of Organizational Analysis*, vol. 20, no. 4, pp. 292–304, 2012.
[21] G. Larsson and P. Hyllengren, "Contextual Influences on Leadership in Emergency Type Organisations: Theoretical Modelling and Empirical Tests," *International Journal of Organizational Analysis*, vol. 21, no. 1, pp. 19–37, 2013.
[22] V. Valenzuela-Riquelme, M. E. Truyol, and C. Zapata-Casabon, "Characterization of Leadership Skills in Students: A Case Study in a Chilean Engineering School," in *2024 ASEE Annual Conference & Exposition Proceedings*, Portland, Oregon: ASEE Conferences, Jun. 2024, p. 48451. doi: 10.18260/1-2--48451.
[23] S. Riutta and D. Teodorescu, "Leadership Development on a Diverse Campus," *Journal of College Student Development*, vol. 55, no. 8, pp. 830–836, 2014, doi: 10.1353/csd.2014.0082.
[24] Á. Sánchez-Anguita Muñoz and M. F. Pulido López, "Leadership and self-efficacy as predictors of academic performance," *INFAD Journal of Psychology*, vol. 1, pp. 453-462, 2022, doi: 10.17060/ijodaep.2022.n1.v1.2403.
[25] K. Gannouni and L. R. Lalao, "Leadership and Students' Academic Success: Mediating Effects of Self-Efficacy and Self-Determination," *International Journal of Leadership in Education*, vol. 21, no. 1, pp. 66–79, 2018, doi: 10.1080/13603124.2015.1123300.

[26] M. Uaikhanova, A. Zeinulina, M. Pshembayev, and A. Anesova, "Developing Leadership Skills in University Students," *Cogent Education*, vol. 9, no. 1, pp. 2143035, 2022, doi: 10.1080/2331186X.2022.2143035.
[27] B. M. Bass and R. E. Riggio, *Transformational Leadership*, Psychology Press, 2006, doi: 10.4324/9781410617095.
[28] B. M. Bass, *Leadership and Performance Beyond Expectations*, New York, NY, USA: Free Press; London, UK: Collier Macmillan, 1985.

Appendix

Dimensions	Subdimensions	Item
Developmental leadership	Value Base	I demonstrate an ethical and moral attitude.
	Value Base	I express values based on a humanistic perspective.
	Value Base	I act consistently with the opinions I share.
	Responsibility	I represent my group to third parties in an exemplary manner.
	Responsibility	I acknowledge my own mistakes without trying to make excuses.
	Responsibility	I take responsibility for tasks, even when they are challenging.
	Responsibility	I perform my leadership role in an exemplary manner.
	Responsibility	I accept the commitment to ensure that initiated tasks are completed.
	Support	I understand the needs of the people around me.
	Support	I take the time to listen to my teammates.
	Confrontation Management	I treat those who have not performed their tasks well appropriately.
	Confrontation Management	I address conflict situations among the people in my group.
	Confrontation Management	I know how to manage teammates with problematic behaviors.
	Promote participation	I generate enthusiasm for tasks.
	Promote participation	I contribute to enjoyment at work, encouraging my teammates to strive harder.
	Promote participation	I create a shared sense of responsibility in the group's development.
	Promote creativity	I motivate others to develop their skills.
	Promote creativity	I stimulate creative thinking in others.
	Promote creativity	I inspire others to experiment with new work methods.
Conventional-positive leadership	Seek Agreements	I discuss important values before making decisions.
	Seek Agreements	I consider my teammates' opinions.
	Seek Agreements	I seek agreements with my teammates on how to carry out tasks.
	Seek Agreements	I talk with my teammates about what to expect when a goal or objective is achieved.
	Seek Agreements	I collaborate with teammates to plan tasks.
	Take necessary measures	I act when measures need to be taken.
	Take necessary measures	I intervene if things start to go wrong.
	Take necessary measures	I maintain a good understanding of what is happening.

Conventional-negative leadership	If, and only if, reward	I only recognize and congratulate teammates who complete the agreed tasks.
	If, and only if, reward	I respectfully confront teammates who have not completed the agreed tasks.
	If, and only if, reward	I use a system of rewards and punishments to influence the work of others.
	Overcontrol	I take note of other people's mistakes.
	Overcontrol	I look for mistakes in my teammates' work.
	Overcontrol	I rarely praise when something is positive but immediately point out mistakes.