[Traditional Research Paper] Integrating Service-Based Learning in Engineering Education: Enhancing Social and Professional Skills through Community Projects

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Abstract

Service-Based Learning (SBL) has proven to be an effective methodology, encouraging the application of academic knowledge in real-world contexts and promoting social engagement. In engineering, balancing technical skills with social competencies is essential for solving complex problems and working in multidisciplinary teams. This study aims to evaluate how SBL projects contribute to the development of social and professional skills in engineering students. It examines which specific skills are enhanced through community projects and how SBL influences students' social responsibility and professional ethics. The research is conducted within the "Capstone Portfolio" course in Construction Engineering as part of an institutional initiative. In this project, students collaborate with women participating in the "Mujeres Jefas de Hogar" program, an initiative led by municipal public entities in Chile that seeks to enhance women's access to personal and professional development opportunities. Over its four iterations, the project has expanded both in scope and impact, incorporating multidisciplinary collaboration with other academic programs to more comprehensively address identified needs. This study specifically focuses on assessing Construction Engineering students' perceptions of the impact of Service-Based Learning on their professional and social development. To assess the project's impact, surveys measure students' perceptions of their development of professional, social, and personal skills and the connection between theory and practice. The study also compares students' views of SBL with traditional courses and evaluates the effects on leadership and community engagement. A descriptive study is conducted using a quantitative approach. Pre- and post-surveys are administered to engineering students from a private university in Chile, and the data is analyzed using descriptive statistics. The results show a significant shift in students' focus from technical skills to increased social awareness, ethical responsibility, and improved interpersonal skills like leadership and teamwork. SBL effectively integrates academic learning with social engagement, contributing to the development of well-rounded engineers. This study provides evidence of the effectiveness of SBL as a comprehensive methodology for developing social and professional skills in engineering education. It also supports the implementation of pedagogical strategies that link academic learning with students' social and ethical responsibilities.

Keywords: service-based learning, social skills, social responsibility, engineering, community engagement, professional development

Introduction

Service-Based Learning (SBL) has become a valuable educational approach, especially within higher education in engineering. By combining academic learning with community service, SBL offers students the chance to apply their theoretical knowledge in real-world situations. This not only helps them acquire technical skills but also fosters the development of the social and personal skills needed to tackle the complex challenges of today's society [1-3]. Recent research highlights that the implementation of SBL projects has proven effective in enhancing academic performance and student retention, especially in fields such

as engineering and computer science, which require comprehensive training encompassing both technical and ethical-social skills [4].

Over the past two decades, SBL has been widely adopted in educational institutions worldwide, promoting experiential learning that connects course content with tangible community needs [5]. This methodology not only contributes to the training of competent professionals but also fosters civic responsibility and social awareness among students— qualities that are increasingly valued in the global job market [6-7]. However, despite advances in research on the impact of SBL, gaps remain in understanding how this methodology specifically influences the development of professional and social skills in engineering students [8-9].

One of the main challenges in engineering education lies in balancing the teaching of technical skills with the development of transversal competencies such as leadership, communication, and teamwork. Various studies have noted that traditional classroom-focused teaching methods are insufficient to prepare students for the complex, multidisciplinary challenges they will encounter in their professional lives [10-11]. Although SBL is recognized as an effective pedagogical strategy to address this issue, questions remain about its ability to systematically foster leadership, social responsibility, and professional ethics in engineering programs. Moreover, the perceived impact of SBL compared to traditional courses remains an underexplored area, particularly from students participating in these projects [12-13].

These observations lead to the research question guiding this study: How does Service-Based Learning impact the development of social and professional skills in engineering students, and how do these students perceive its influence compared to traditional teaching methods? This question underscores the need for a more detailed exploration of the effects of SBL, not only on students' technical competencies but also on key aspects such as leadership, community engagement, and ethical responsibility. Addressing this question could provide valuable insights for more effectively integrating this methodology into educational programs.

Based on this premise, the primary objective of this research is to evaluate the perceived impact of Service-Based Learning projects on the development of social and professional skills in students pursuing a degree in Construction Engineering at a private university in Chile. Specifically, it aims to identify the skills most enhanced through these projects, according to students' perspectives, and how SBL influences their perception of social responsibility and professional ethics. Furthermore, the study seeks to compare students' perceptions of SBL with traditional teaching methods, analyzing its effects on key areas such as leadership and community engagement [12], [14]. This approach will contribute to a deeper understanding of how SBL can be effectively integrated into educational programs, offering both technical and social benefits that strengthen the comprehensive training of future engineers.

Literature Review

Service-Based Learning (SBL) is an educational methodology that integrates academic instruction with community service, allowing students to learn in real-world contexts while making meaningful contributions to their communities [13]. Over the past decades, this methodology has gained relevance in higher education, particularly in disciplines like

engineering, due to its ability to develop both technical skills and transversal competencies, such as communication, leadership, and social awareness [10-11].

Numerous studies support the effectiveness of SBL in connecting academic learning with practical application, promoting students' holistic development. For instance, Duffy et al. [8] and Dukhan and Schumack [9] highlight how SBL projects enable students to actively engage in solving real-world technical problems, such as designing infrastructure or implementing technologies for vulnerable communities. This approach fosters a deeper understanding of theoretical concepts by applying them in meaningful contexts, enhancing students' ability to address complex problems. In a global context where teamwork, problem-solving, and social responsibility are highly valued in the job market, SBL is positioned as an effective pedagogical tool to prepare students for professional challenges [1-2].

Beyond technical benefits, SBL has proven particularly valuable for developing professional and social skills in engineering disciplines. Hill and Hammond [6] conclude that students participating in SBL projects exhibit greater development of interpersonal skills, such as leadership and effective communication, compared to those using traditional teaching methods. Additionally, increased social responsibility and community engagement have been observed. For example, in a study by Duffy et al. [8], students designed solutions for vulnerable communities, including water purification systems and basic infrastructure projects. These experiences not only strengthened their technical skills but also helped them understand the ethical and social impact of their professional decisions.

Similarly, research by Hebert and Hauf [13] underscores that SBL significantly contributes to students' professional identity development. The opportunity to apply technical knowledge in real-world scenarios enhances their confidence in their abilities and fosters a clearer understanding of their roles as future professionals. This aspect is particularly relevant in engineering, where SBL projects often involve addressing complex technical challenges, such as designing sustainable infrastructure or creating innovative technologies for vulnerable communities. For example, González-Cespón et al. [14] found that students engaged in SBL projects demonstrated an improved ability to transfer theoretical concepts to practical contexts, including designing solutions tailored to specific community needs. These students also showed a significant increase in their awareness of the social and environmental issues these communities face, reinforcing their professional ethics and social responsibility.

Despite the well-documented benefits of SBL, its implementation is not without challenges. Harding et al. [15] note that one of the main obstacles is resistance to change among faculty and students, who are often reluctant to move away from traditional teaching methods perceived as more familiar or less demanding. Additionally, the planning and execution of SBL projects require substantial time and resource investment, which can be a barrier for educational institutions with budget constraints [12]. In financially limited contexts, the lack of technical and human resources can significantly diminish the potential impact of SBL projects.

Another significant challenge lies in assessing the learning outcomes associated with SBL. Unlike traditional courses that often rely on standardized tests and exams, SBL requires more complex evaluation tools that measure not only academic performance but also the development of social and ethical skills. Portsmore and Swenson [11] suggest that these evaluations should include mixed methods, such as surveys, interviews, and focus groups, to comprehensively capture the impact of SBL on students' professional and personal development. González-Cespón et al. [14] argue that such approaches can provide deeper

insights into how SBL fosters practical skills and social sensitivity among future professionals.

Current trends in SBL research have evolved toward a more interdisciplinary and global approach, with growing interest in its impact across various disciplines and cultural contexts [7], [16]. Recent studies have explored how SBL contributes to sustainability and the development of resilient communities, particularly in fields like environmental and civil engineering [17]. For instance, some research has linked SBL to the Sustainable Development Goals (SDGs), examining how the methodology promotes the creation of sustainable infrastructure, social equity, and innovative technological solutions for marginalized communities. Watson et al. [16] emphasize that this approach benefits not only the participating communities but also broadens students' global perspectives, preparing them to address the challenges of an increasingly complex and interconnected world.

In this global context, the COVID-19 pandemic accelerated the adoption of digital tools in SBL, leading to the emergence of e-Service Learning. This model leverages digital technologies to ensure pedagogical continuity and community impact in virtual environments [18]. E-Service Learning has simplified project management, improved student progress monitoring, and maintained SBL's relevance as a key educational strategy during crises. Its implementation demonstrated how digital platforms can extend the reach of SBL, facilitating global collaboration and fostering innovative solutions to social challenges, such as sustainability and educational inequality.

As SBL continues to evolve, new areas of research have emerged. One key area is the development of pedagogical models that integrate SBL with digital technologies, such as online learning platforms or virtual simulations, to enhance the accessibility of projects [19]. Additionally, the integration of SBL into hybrid education models, combining in-person interaction with digital tools, is gaining attention. This approach could facilitate SBL adoption in educational contexts with geographical or infrastructure limitations while solidifying its role as a bridge between academia and community, capable of addressing contemporary educational and social challenges.

Finally, analysis of emerging trends suggests that the integration of stakeholders—such as governments, NGOs, and private companies—along with the alignment of SBL with public policies, could enhance its effectiveness in global contexts. These strategic alliances position SBL not only as an educational tool but also as a transformative vehicle for promoting social change and sustainability in an interconnected world.

In conclusion, Service-Based Learning is established as an innovative and effective educational methodology, particularly for training engineers. By combining theory with practice and fostering technical, social, and ethical competencies, SBL prepares students to face professional challenges while enabling them to contribute to community well-being. However, its implementation requires overcoming significant challenges, such as resistance to change and resource limitations. As research advances, SBL's potential to develop engaged citizens and ethical professionals positions it as a cornerstone of higher education.

Methodology

This study examines the impact of Service-Based Learning (SBL) on the perception of the development of social, professional, and academic skills among undergraduate students pursuing a degree in Construction Engineering at a private university in Chile. The research

was conducted within the context of the "Capstone Portfolio" course, which incorporated a structured SBL project to support female heads of households.

The project is developed in collaboration with the government program *"Mujeres Jefas de Hogar"* (Women Heads of Household Program), providing training to women in various technical and social areas through an interdisciplinary approach. Initially, the project began with the exclusive participation of the Construction Engineering program, which offered a workshop on basic home installations. However, over the course of its different iterations, the program has evolved and strengthened with the inclusion of other disciplines within the same institution, expanding its impact and reach.

Currently, as shown in Figure 1, the project involves the participation of four academic programs at the University, each contributing a key area of expertise: Construction Engineering offers a workshop on basic home installations, focusing on providing autonomy in the household through knowledge of plumbing and electricity; Computer Science Engineering conducts a workshop on using ChatGPT to optimize household tasks and search for job opportunities; Automation and Robotics Engineering provides a workshop on home automation, teaching the implementation of smart technologies; finally Social Work leads a women's empowerment workshop, addressing strategies to enhance self-confidence and decision-making skills.

The project's evolution has been guided by a continuous improvement approach based on satisfaction surveys administered to program participants and the government counterpart. This feedback has allowed for adjustments and enhancements to each workshop's content, ensuring that the training effectively addresses the real needs of the women beneficiaries. This growth has transformed the project into a comprehensive, multidisciplinary initiative within the University, impacting student training and empowering the women participating in the program.

The "Capstone Portfolio" course for the Construction Engineering students was structured in stages. During the first weeks, students acquired fundamental knowledge and skills. Subsequently, they planned their interaction with the women within the training course and worked in groups to carry out the activity. For this research study, the first stage will be conducted with the Construction Engineering program, which initiated the project and has consolidated the process over its four iterations.

Construction Engineering students serve as mentors, delivering the course and teaching the women directly. Before this, in class, they developed models and necessary constructions to facilitate the practical teaching of basic home installations, ensuring applied and meaningful learning. The primary objective of strengthening the participants' autonomy is complemented by their participation in the women's empowerment workshop (Module 4) led by female students from the Social Work program. The workshop addresses key aspects to reinforce women's security and decision-making in both domestic and community settings.

It is important to highlight that this study focuses on assessing the perceptions of Construction Engineering students regarding their experience in Service-Based Learning (SBL) projects. In future stages, the evaluation is expected to include the other academic programs involved and measure the project's impact from the perspective of the beneficiary women and the community.
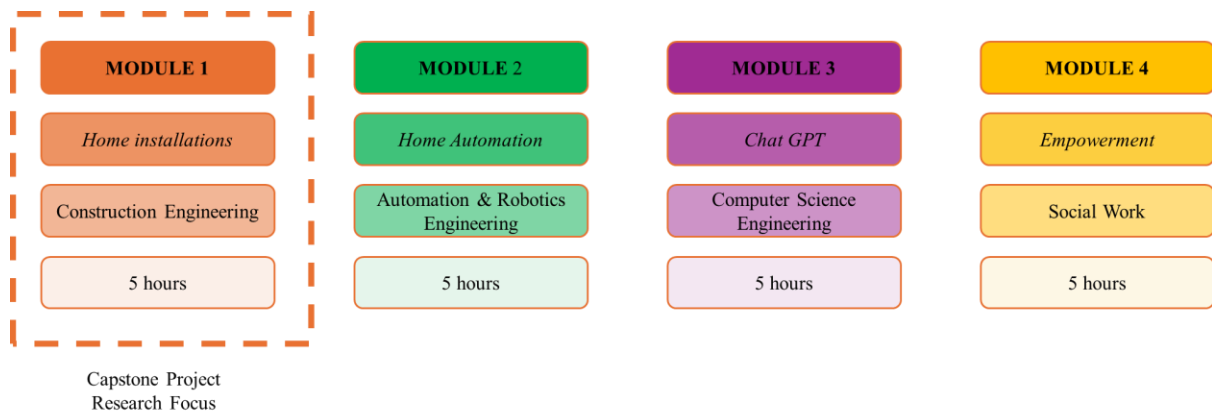
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MODULE 1          MODULE 2          MODULE 3          MODULE 4

Home installations  Home Automation   Chat GPT          Empowerment

Construction        Automation &      Computer Science  Social Work
Engineering         Robotics          Engineering
                    Engineering

5 hours             5 hours           5 hours           5 hours
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Capstone Project
Research Focus

Figure 1. Scheme of the workshop execution process for women in the "Female Heads of Household" program.

The study included 21 participants, all of whom were Construction Engineering students, of which 20 were men and 1 was a woman, with an average age of 24.9 years (SD = 1.76). These students were enrolled in the "Capstone Portfolio" course, a class in which enrollment has traditionally been predominantly male due to the demographic profile of the program. The sample was selected through convenience sampling, and participation was voluntary. All students provided informed consent before taking part in the research.

It is essential to highlight that the survey used to evaluate the perception of the effectiveness of the Service-Based Learning (SBL) intervention was applied exclusively to Construction Engineering students, who were responsible for training the women in basic home installations. In contrast, the women's empowerment module was conducted entirely by students from the Social Work program, who trained with the program participants. It is worth mentioning that, unlike in Construction Engineering, all Social Work students who participated in the training were women, which created a different interaction dynamic in that module.

To assess the perception of Construction Engineering students regarding their development of professional and social skills, community engagement, and perception of the value of SBL, an adapted survey instrument was used, combining validated frameworks from Hébert and Hauf [13] and Drewery and Lollar [20]. The survey included six key dimensions, allowing for an analysis of the perception of the project's impact on students' learning and development:

- *Importance of the Project (QI):* This dimension evaluates the relevance of the project in enhancing class learning, increasing awareness of social needs, fostering empathy, and benefiting the community.
- *Academic Development (QAD):* This dimension assesses students' comprehension of course content, ability to apply knowledge in real-world scenarios, and understanding of the relevance of the course to daily life.
- *Civic Responsibility (QCR):* This dimension measures students' understanding of social needs, their ability to make a difference, and their commitment to helping others.
- *Practical Skills (QPS):* This dimension focuses on students' self-perceived development of technical skills, such as critical thinking, problem-solving, and organizational abilities.

- *Interpersonal Skills (QIS):* This dimension evaluates improvements in teamwork, leadership, communication, and patience.
- *Personal and Professional Development (QPD):* This dimension explores how the project contributes to students' confidence in their career choices, competitiveness in the labor market, and ability to work in diverse environments.

Each dimension was assessed using a 5-point Likert scale, ranging from 1 (Completely Disagree) to 5 (Completely Agree).

The instrument used in this study also included dimensions related to community engagement, perceptions of service-based learning (SBL) compared to traditional courses, and empowerment and leadership. These dimensions captured key aspects of the impact of SBL. The *Community Engagement (QSC)* dimension assessed students' intentions to participate in future service activities, their perception of their ability to make a positive impact in the community, and their valuation of the importance of social contributions. The *Service-Based Learning versus Traditional Courses (QVS)* dimension measured students' perceptions of the effort required for SBL courses, their societal impact, the opportunities for building relationships, and their relevance within the university context. Lastly, the *Empowerment and Leadership (QL)* dimension evaluated students' self-perception of their ability to influence the world, their leadership skills, and the importance of finding a professional career that is meaningful to society. These dimensions enriched the analysis by providing a more comprehensive view of the impact of the SBL methodology on students' personal and professional development.

The study followed a pre-post design. At the start of the semester, students completed a pre-survey to establish baseline measures of their expectations in terms of skills developed and attitudes toward SBL. During the semester, students participated in the SBL project, which combined technical service activities and reflective learning. At the end of the semester, a post-survey was administered to evaluate changes in their perceptions.

The data collected from the surveys were processed and cleaned to ensure completeness and accuracy. Descriptive statistics, including mean scores, standard deviations, and ranges, were calculated for each survey item. To identify significant changes between pre- and post-survey scores, the study employed the Wilcoxon signed-rank test.

This methodology provides a comprehensive framework to assess the impact of SBL on students' perceptions of professional and social development, as well as their community engagement and perceptions of the methodology's value. The findings aim to contribute to the understanding of SBL as an effective pedagogical tool in engineering education.

Results and Data Analysis

This section presents the analysis of the data collected during the study, focusing on changes in five key dimensions before and after the intervention. The Wilcoxon signed-rank test was employed to identify statistically significant differences between pre-test and post-test scores, highlighting the impact of the Service-Based Learning (SBL) methodology on various competencies.

The analysis will be conducted in some cases by dimensions and in others by the individual items that comprise each dimension. This methodological decision is based on how previous authors analyzed the data obtained from these instruments [13], [20].

Descriptive statistics offer initial insights into changes in the dimensions between pre-test and post-test scores. Table 1 presents the means, standard deviations, skewness, and kurtosis for each dimension. Additionally, the results of the Shapiro-Wilk normality test are included to complement the analysis. These findings suggest the appropriateness of using non-parametric statistical methods.

The analysis revealed statistically significant and non-significant changes across the evaluated dimensions. Table 2 summarizes the results of the Wilcoxon signed-rank test.

The *Empowerment and Leadership (QL)* dimension demonstrated a statistically significant improvement ($Z = -2.016$, $p = 0.044$), indicating that the SBL intervention successfully enhanced students' perceptions of leadership and empowerment. This finding aligns with the study's broader goal of fostering social responsibility and professional skills through community engagement.

Table 1. Descriptive Statistics of Pre- and Post-Test Scores and Normality Test

	Pre Test				Post Test				Shapiro-Wilk Test	
	Mean	*SD*	*Skewness*	*Kurtosis*	*Mean*	*SD*	*Skewness*	*Kurtosis*	*W*	*p*
Academic Development (QAD)	4.50	0.44	-0.351	-1.196	4.35	0.70	-0.604	-1.083	0.971	0.761
Civic Responsibility (QCR)	4.54	0.48	-0.463	-1..495	4.49	0.61	-1223	1.771	0.853	0.005
Practical Skills (QPS)	4.71	0.29	-0.889	0.262	4.33	0.76	-1124	0.087	0.865	0.008
Interpersonal Skills (QIS)	4.65	0.36	-0.562	-1.71	4.68	0.49	-1511	1.572	0.925	0.108
Empowerment and Leadership (QL)	4.27	0.83	-1299	1.663	4.59	0.57	-1.68	2.546	0.813	0.001

Table 2. Wilcoxon signed-rank test. Pre-test/Post-test

	Academic Development (QAD)	*Civic Responsibility (QCR)*	*Practical Skills (QPS)*	*Interpersonal Skills (QIS)*	*Empowerment and Leadership (QL)*
Z	-0.961[b]	-0.472[b]	-1.608[b]	-0.495[c]	-2.016[c]
Asymp. Sig. (two-tailed)	0.336	0.637	0.108	0.621	0.044*

*Significant at $p < 0.05$; c Based on negative ranks; b Based on positive ranks.

As mentioned previously, the *Empowerment and Leadership (QL)* dimension showed a statistically significant difference and the most notable improvement, with the mean score increasing from 4.27 (SD = 0.83) to 4.59 (SD = 0.57). This suggests that the SBL methodology effectively promoted the perception of leadership and empowerment among participants, particularly in the context of engaging with community projects that required active problem-solving and decision-making. Importantly, the pre-test means across all dimensions were already high, ranging between 4.27 and 4.71 on a scale where the maximum is 5. The elevated baseline scores indicate the participants' initial perceptions of the SBL's utility, despite not having experienced it yet.

The slight increase in the *Interpersonal Skills (QIS)* mean score (from 4.65 to 4.68) indicates stable or a marginally improved perception about teamwork and communication abilities. Conversely, the decrease in the *Practical Skills (QPS)* mean score from 4.71 to 4.33 suggests potential challenges in maintaining students' perceptions of technical skill development within the SBL framework. The minor reductions observed in *Civic Responsibility (QCR)* and *Academic Development (QAD)* dimensions, though not statistically significant, emphasize the need for a more integrated approach to reinforce these competencies during SBL activities.

Overall, the results underscore the value of SBL as a pedagogical tool for enhancing leadership and empowerment skills while highlighting areas for refinement. The consistently high pre- and post-test means demonstrate that participants entered the program with high expectations about the methodology and the competencies they could develop in the course.

We are going to present additional results focusing on the impact of Service-Based Learning (SBL) across four key students' perceptions: *Importance of the Project (QI)*, *Personal and Professional Development (QPD)*, *Service-Based Learning versus Traditional Courses (QVS)*, and *Community Engagement (QSC)*. The analysis evaluates changes between pre-test and post-test scores to understand the perceived effects of SBL.

The first dimension analyzed is *Importance of the Project (QI)*, which highlights the relevance of SBL projects in reinforcing classroom learning and increasing social awareness. Table 3 summarizes the descriptive statistics and results of the Wilcoxon signed-rank test.

Table 3. Descriptive Statistics and Wilcoxon Signed-Rank Test: Importance of the Project (QI)

	Item	*Pre Test*		*Post Test*		*Wilcoxon Test*		*Shapiro-Wilk Test*	
		Mean	*SD*	*Mean*	*SD*	*Z*	*Asymp. Sig. (two-tailed)*	*W*	*p*
QI_1	Reinforce what I have learned in class	4.52	0.68	4.52	0.68	0.000[d]	1	0.823	0.002
QI_2	Enhance my understanding of the course content	4.38	0.805	4.52	0.68	-1.134[c]	0.257	0.744	< 0.001
QI_3	Accept people with characteristics different from my own	4.76	0.539	4.62	0.59	-0.791[d]	0.429	0.786	< 0.001
QI_4	Increase my awareness of the needs of people from diverse backgrounds	4.81	0.402	4.57	0.676	-1.406[d]	0.16	0.760	< 0.001
QI_5	Step out of my comfort zone	4.33	1.065	4.57	0.598	-1.040[c]	0.298	0.803	< 0.001
QI_6	Be more aware of the needs of others	4.81	0.402	4.57	0.598	-1.508[d]	0.132	0.808	< 0.001
QI_7	Increase my commitment to helping others	4.62	0.59	4.43	0.746	-1.100[d]	0.271	0.799	< 0.001
QI_8	Have a lasting impact on me	4.24	0.944	4.29	0.784	-0.322[c]	0.748	0.881	0.015
QI_9	Benefit the community agency I worked with	4.57	0.676	4.48	0.814	-0.577[d]	0.564	0.837	0.003

*Significant at p < 0.05; c Based on negative ranks; d Based on positive ranks.

The results indicate no statistically significant changes across most items in this dimension. However, the consistently high mean scores, particularly for "Increase my awareness of the needs of people from diverse backgrounds" (Pre: 4.81; Post: 4.57), reflect the strong baseline perceptions of the project's importance.

Next, the analysis turns to *Personal and Professional Development (QPD)*, which explores how SBL contributes to students' career readiness and skill development. Table 4 provides an overview of the results. No statistically significant differences were observed. The high mean scores across items suggest that students perceived strong personal and professional benefits from the intervention, with "Improve my ability to communicate in a 'real-world' environment" consistently rated highly (Pre: 4.57; Post: 4.62).

The third dimension compares perceptions of SBL and traditional courses. Table 5 outlines the findings. While "SBL should be implemented in more courses at our university" (QVS_5) approached statistical significance (p = 0.057), the general trend reflects positive perceptions of SBL compared to traditional courses.

Table 4. Descriptive Statistics and Wilcoxon Signed-Rank Test: *Personal and Professional Development (QPD)*

		Pre Test		Post Test		Wilcoxon Test		Shapiro-Wilk Test	
	Items	*Mean*	*SD*	*Mean*	*SD*	*Z*	*Asymp. Sig. (two-tailed)*	*W*	*p*
QPD_1	...improve my ability to communicate in a "real-world" environment	4.57	0.598	4.62	0.59	-0.277^d	0.782	0.832	0.002
QPD_2	...clarify which professional career I would like to pursue or continue	3.9	1.3	3.76	1.338	-0.178^c	0.859	0.883	0.016
QPD_3	...become more competitive and resilient in the job market within my profession	4.14	1.062	4.1	1.044	-0.226^c	0.821	0.909	0.054
QPD_4	...feel more comfortable working with others from different cultures and diverse backgrounds	4.38	0.865	4.29	0.956	-0.418^c	0.676	0.898	0.032
QPD_5	...empower myself to make decisions	4.57	0.746	4.43	0.811	-0.730^c	0.465	0.851	0.004
QPD_6	...strengthen my critical and abstract thinking skills	4.52	0.68	4.29	0.845	$-1.008c$	0.313	0.911	0.058

*Significant at p < 0.05; c Based on negative ranks; d Based on positive ranks.

Finally, the analysis of *Community Engagement (QSC)* highlights changes in students' intentions and perceptions. Table 6 summarizes the results. A statistically significant increase was observed for "I believe it is important for people to contribute to their community" (QSC_3, Z = -2.333, p = 0.020), reinforcing the role of SBL in fostering civic responsibility.

Table 5. Descriptive Statistics and Wilcoxon Signed-Rank Test: *SBL versus Traditional Courses (QVS)*

	Items	Pre Test		Post Test		Wilcoxon Test		Shapiro-Wilk Test	
		Mean	SD	Mean	SD	Z	Asymp. Sig. (two-tailed)	W	p
QVS_1	SBL courses require more work than traditional courses	3.62	0.74	4	0.949	-1.291b	0.197	0.887	0.020
QVS_2	SBL courses are more time-intensive and cumbersome than traditional courses	3.67	0.856	3.86	0.91	-0.599b	0.549	0.893	0.026
QVS_3	SBL courses have a positive impact on society compared to traditional courses	4.1	0.768	4.29	0.784	-0.708b	0.479	0.923	0.101
QVS_4	SBL courses provide more opportunities to build relationships with peers than traditional courses	3.9	0.831	4.38	0.921	-1.740b	0.082	0.906	0.045
QVS_5	SBL should be implemented in more courses at our university	4	0.894	4.57	0.811	-1.900b	0.057	0.860	0.006

*Significant at $p < 0.05$; b Based on negative ranks.

Table 6. Descriptive Statistics and Wilcoxon Signed-Rank Test: *Community Engagement (QSC)*

	Items	Pre Test		Post Test		Wilcoxon Test		Shapiro-Wilk Test	
		Mean	SD	Mean	SD	Z	Asymp. Sig. (two-tailed)	W	p
QSC_1	I intend to participate in community service next year	3.19	0.981	3.24	1.044	0.000	1.00	0.881	0.015
QSC_2	I believe I can make a difference in my community	4	0.949	4.19	1.25	-1.180c	0.24	0.827	0.002
QSC_3	I believe it is important for people to contribute to their community	4.43	0.676	4.76	0.539	-2.333c	0.02*	0.618	< 0.001

*Significant at $p < 0.05$; c Based on negative ranks

Discussion

The primary objective of this research is to evaluate the perceived impact of Service-Based Learning projects on the development of social and professional skills in students pursuing a degree in Construction Engineering at a private university in Chile.

The analysis of the results of the Service-Based Learning project gains significant depth when considering the context in which it was implemented. The participating students from Construction Engineering, all in their final semester of the program and simultaneously working on their graduation projects, faced a considerable academic and emotional workload. This scenario provides a critical interpretive framework for understanding both the observed patterns in the evaluated dimensions and the overall perceptions of the impact of SBL.

The results of this study provide valuable insights into the impact of SBL on the development of social and professional skills in engineering students. By examining the pre-test and post-test measures, it becomes evident that the SBL experience shapes students' perceptions of their skills and their role in the community. Importantly, the pre-test results reflect students' expectations and aspirations for the SBL experience, while the post-test results capture their self-perceived outcomes after completing the project. This distinction between expectations and actual experiences is critical in interpreting and aligning the findings with the broader literature.

The dimension of *Empowerment and Leadership (QL)* showed a statistically significant improvement, with the mean score increasing from 4.27 to 4.59. This result aligns with studies by González-Cespón et al. [14] and Hebert and Hauf [13], which emphasize the role of SBL in fostering leadership and decision-making skills. The active participation in projects requiring problem-solving and collaboration likely contributed to this improvement, reinforcing the importance of experiential learning in developing these competencies. These findings suggest that SBL may play a role in reducing the gap between technical knowledge and leadership skills, an aspect often highlighted as fundamental in engineering education [6].

While the dimension of *Interpersonal Skills (QIS)* exhibited a slight increase in mean score (from 4.65 to 4.68), the lack of statistical significance suggests stable perceptions of teamwork and communication abilities. This aligns with Duffy et al. [8], who noted that SBL fosters interpersonal skills but often requires longer-term or more intensive interventions to yield significant changes. The high pre-test scores also indicate that students entered the course with a strong baseline, possibly limiting the room for improvement in their perceptions during the project.

The decrease in *Practical Skills (QPS)* from 4.71 to 4.33 warrants attention. While the result is not statistically significant, it suggests a potential gap between students' expectations and their perceived technical skill development within the SBL framework. This finding aligns with Harding et al. [15], who pinpointed challenges in merging technical training with community-oriented projects. It highlights the need for carefully structured projects that balance technical rigor with social engagement, ensuring that both aspects are effectively addressed.

The dimensions of *Academic Development (QAD)* and *Civic Responsibility (QCR)* also showed minor mean-score reductions, reflecting potential discrepancies between initial expectations and perceived outcomes. Although the reductions are not statistically significant, these findings emphasize the importance of managing students' expectations during the design and implementation of SBL projects, as noted by Roy et al. [12]. Additionally, they suggest that SBL programs should include targeted reflections to help students connect their academic and civic learning more explicitly to the project outcomes.

The comparison between SBL and traditional courses revealed generally positive perceptions of SBL, with the item "SBL should be implemented in more courses at our university"

approaching statistical significance ($p = 0.057$). This aligns with Salam et al. [5], who found that students value the real-world applicability and community impact of SBL over traditional methods. The findings suggest that SBL not only enhances students' professional and social skills but also provides a learning experience perceived as more engaging and meaningful.

The significant increase in "I believe it is important for people to contribute to their community" (QSC_3) reinforces the role of SBL in fostering civic responsibility. This result supports previous findings by Hebert and Hauf [13] and Dapena et al. [18], who emphasized the transformative potential of SBL in enhancing students' awareness of their social roles and responsibilities. By engaging in community-oriented projects, students develop a deeper understanding of societal needs and their capacity to contribute meaningfully.

The students' perceptions, shaped by the academic workload and associated stress, underscore the need for adjustments in the planning and implementation of SBL. For instance, rescheduling these projects to earlier semesters could alleviate pressure on students, enabling them to fully take advantage of the learning opportunities provided.

Despite these challenges, the results reaffirm the effectiveness of SBL in promoting the holistic development of students by balancing technical, social, and ethical competencies. The positive trends observed in dimensions such as leadership, interpersonal skills, and community engagement highlight the transformative potential of SBL, particularly in an increasingly demanding and interconnected professional context. This methodological approach, supported by the analyses presented, stands out as a key educational tool for preparing students not only to address technical challenges but also to take on leadership roles and social responsibility within their communities.

Despite its contributions, this study has several limitations. The small sample size and the use of a single institution restrict the generalizability of the findings. Additionally, the reliance on self-reported measures introduces the potential for response bias, as students may overestimate or underestimate their perceptions of skills and experiences. The absence of a control group also makes it difficult to attribute observed changes solely to the SBL intervention. Future research should consider longitudinal designs, larger and more diverse samples, and mixed-method approaches to provide a more comprehensive understanding of the impact of SBL on engineering education. Moreover, future implementations should incorporate data from other students participating in this project, including those from the Automation and Robotics, Computer Science, and Social Work programs. Additionally, the analysis should include the perspectives of female participants in these workshops.

Conclusions

The present study aimed to assess the perceived impact of Service-Based Learning projects on social and professional skills development in students pursuing a degree in Construction Engineering at a private university in Chile. Notably, the dimension of empowerment and leadership showed a statistically significant improvement in students' perceptions before and after the intervention. This finding suggests that projects focused on addressing community issues contribute to strengthening key skills such as decision-making and leadership. These results suggest that SBL can be a valuable pedagogical tool.

However, despite the advances in the dimensions of social and leadership skills, the findings indicate that the perceived development of technical skills was limited. This highlights the importance of designing projects that achieve a more balanced integration of technical and

social aspects, ensuring that both areas receive adequate attention during the implementation of these initiatives.

Furthermore, SBL fosters greater social awareness and civic engagement among students. This effect was reflected in a statistically significant increase in the perception of the importance of contributing to the community, underscoring the transformative role of this methodology in shaping professionals with social sensitivity and ethical responsibility.

Additionally, students expressed positive perceptions of SBL compared to traditional methods, particularly valuing its practical and social impact. This recognition emphasizes the relevance of SBL as a pedagogical strategy that not only enhances academic learning but also enriches the educational experience by connecting students with real-world issues.

Nevertheless, the results also revealed challenges and areas for improvement. The slight decrease observed in the dimensions of civic responsibility and academic development suggests a need to strengthen the mechanisms for reflection and the connection between theoretical learning and practical activities. Implementing this methodology earlier in the curriculum could also alleviate the academic burdens of students in their final semesters, optimizing its overall impact.

In general, SBL can be affirmed as a methodology that facilitates the integration of theory and practice, preparing students to assume leadership roles and social responsibility in complex, multidisciplinary environments. Its implementation stands out as a key strategy for training engineers capable of addressing future professional and societal challenges. This approach may enhance students' professional preparation and encourage them to engage in community well-being and sustainable development

Finally, it is important to acknowledge the limitations of this study, such as the small sample size and the focus on a single institution, which restrict the generalizability of the results. Future studies should consider longitudinal designs with larger and more diverse samples, as well as the use of mixed methods that include qualitative analyses. These approaches would provide a more comprehensive understanding of the impact of SBL on engineering education and expand its applicability in different educational contexts.

Acknowledgment

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