Senior-year internships impact assessment in engineering programs at UCSC

Marcia Muñoz, Claudia Martínez-Araneda

Computer Science Department, Universidad Católica de la Santísima Concepción, Chile.

Matilde Basso, Claudio Oyarzo

Civil Engineering Department, Universidad Católica de la Santísima Concepción, Chile.

Patricio Cea, Michelle Bizama, Helga González

Industrial Engineering Department, Universidad Católica de la Santísima Concepción, Chile.

ABSTRACT

In this work, we aim to evaluate the impact of internships on recent graduates entering the workforce for four UCSC School of Engineering programs. Civil Engineering and Geological Engineering students take a 400-hour internship, generally during the summer months preceding their senior year. Computer Science and Industrial Engineering students optionally take a semester-long senior-year internship. These professional internships are integrated learning experiences in an organization (CDIO standard 7) which foster student disciplinary knowledge (CDIO 1), analytic reasoning and problem solving (CDIO 2.1), perseverance and flexibility (CDIO 2.4.2), critical thinking (CDIO 2.4.4), teamwork (CDIO 3.1), communication skills (CDIO 3.2), and conceiving, designing, implementing and operating systems in a real context (CDIO 4). This study considers data gathered through an online perception survey applied to all those program graduates that signed up for an internship from 2016 onwards, and have graduated at least a semester ago. It also shows that graduates from all programs state that the internships strengthened their technical knowledge, personal and interpersonal skills. Regarding product, process, and system building skills, these numbers increase to over 90%, except for their ability to operate them (CDIO 4.6), which is closer to 75% for Civil and Geological Engineering. Our results also show that about 70% of graduates who did a semester-long internship feel the internship helped them find a job within six months of graduating, whereas less than a third of students doing the shorter internship felt so. Around 40% of graduates entered into a contractual relationship with their internship company, except for graduates of the Industrial Engineering program, where this number doubles. Students were also asked to identify those strengths and weaknesses that helped and hindered them during their internship. Among their strengths, they identified their teamwork and leadership skills, and among their weaknesses, they identified their lack of self-confidence and experience.

KEYWORDS

Experiential learning, internship impact, recent graduates follow-up, Standards: 7, 11, 12.

INTRODUCTION

In 2011, the School of Engineering of the Universidad Católica de la Santísima Concepción (UCSC) underwent a curricular reform process based on the CDIO Initiative (Crawley et al., 2007; Loyer et al., 2011). As a result of this reform process, program learning outcomes were reformulated based on the CDIO Syllabus (Crawley et al., 2011). Recognizing the importance of providing students with learning opportunities for them to experience professional practice and activities, all programs incorporated mandatory internships. Since 2016, as a result of our continuous improvement process, the School of Engineering lets students choose to spend their last semester working on a research project, an applied engineering project or in a semester-long senior-year internship. The Computer Science and Industrial Engineering programs have implemented all three options, being a semester-long senior-year internship the most popular by far, while the Civil Engineering and Geological Engineering programs have only implemented the first two options.

In all internships, students' performances are assessed regarding their professional, personal and interpersonal CDIO skills by a supervisor in the company and by a faculty member (CDIO Standard 11). As evidence of the achievement of the programs' learning objectives (CDIO Standard 12), the School of Engineering analyzed the senior-year internship supervisors' evaluations and comments about student performance for the Computer Science and Industrial Engineering programs from 2016 up to the first semester of 2018 (Muñoz et al., 2018). These supervisors' evaluations and comments, which offer an external view of student performance during their professional internships, show that, while student skills at the beginning of the internships are adequate for the assigned tasks, they improve throughout the internship, reaching high achievement levels in most cases. Moreover, they also state that there are opportunities for improvement in student communication skills. In this work, we complement this study by gathering program graduates' perceptions of the impact of these internships once they have graduated, and on their usefulness for later employment.

INTERNSHIP GOALS

The major goal of an internship, a short-term practical work experience, is to offer students a smooth transition from academia to industry, as it is a natural bridge between universities and the labour market. Internships are win-win investments for all major stakeholders: students, industry and academia. The benefits of internships are many: they improve students' chances of employment, enhance students' job and social skills, and help students decide their career paths. Likewise, employers benefit from having access to a source of inexpensive and qualified labour, from saving on recruiting costs, and from having stronger bonds with academia. Lastly, universities benefit from enhanced visibility and reputation, from a natural showcase to attract potential students, and from increased collaboration opportunities with industry (Haag, Guilbeau & Goble, 2006; Sanahuja & Ribes, 2015).

Internships

The Civil Engineering and Geological Engineering programs include an internship, lasting at least 400 hours and generally done during the summer months preceding the senior year. This internship gives students the chance to put their knowledge, abilities, and skills into practice in a

professional environment, either in a public or private organization. A company supervisor assesses student performance regarding technical knowledge (CDIO 1.3), personal and professional skills (CDIO 2.4), ethics (CDIO 2.5.1) and interpersonal skills such as teamwork (CDIO 3.1) and effective communication (CDIO 3.2). Also, a faculty member assesses a technical report written by the student about the internship work. In the case of Geological Engineering, a student self-evaluation report is additionally considered.

Senior-year Internships

In the case of the Computer Science and Industrial Engineering programs, students who choose to do a senior-year internship must do 700 hours of training in a company or organization. These senior-year internships are integrated learning experiences in a real context (CDIO standard 7) which foster student disciplinary knowledge (CDIO 1), analytic reasoning and problem solving (CDIO 2.1), perseverance and flexibility (CDIO 2.4.2), teamwork (CDIO 3.1), communication skills (CDIO 3.2), and product, process, and system building skills (CDIO 4). Each student is supervised by a company professional. In the case of the Computer Science program, a faculty member also mentors the whole process. Students' performances are assessed regarding their professional, personal and interpersonal CDIO skills by the company supervisor through intermediate and final evaluations, and by a faculty member via a final technical report written by the student about the internship work.

METHODS

In order to assess the impact of these internships on the programs' graduates, a Google Forms survey delivered by electronic mail was designed to gather graduates' perceptions of these effects. Survey responses were confidential and anonymous. In particular, the online survey covered the internship impact on those program learning objectives related to disciplinary knowledge, personal and professional skills and attributes (CDIO 2.1, 2.4.2, 2.4.4, 2.5.1, 2.5.2 and 2.5.5), interpersonal skills (3.1 and 3.2), CDIO in context (4.3, 4.4, 4.5 and 4.6) . Additionally, graduates were asked about the usefulness of the experiential learning activities they had during their studies (e.g. project-based learning, service-learning, internships, among others) for their job placement. Finally, the survey included open questions asking graduates to identify the top two weaknesses that affected their internship performance, and the top two skills they improved during the internship.

Data collection

This survey was sent to all those graduates of the four programs that signed up for an internship from 2016 onwards, and that have graduated at least a semester ago. Table 1 shows the number of surveys sent for each program, and the number of responses received, separated according to the semester in which the respondent did the internship.

Table 1. Survey coverage

Engineering program	Surveys sent	Responses received						
		2016-I	2016-II	2017-I	2017-II	2018-I	Total	Response rate
Civil Engineering	59	10	7	7	3	3	30	51%
Geological Engineering	36	1	3	8	2	1	15	42%

Industrial Engineering	111	1	16	8	31	17	73	66%
Computer Science	35			1	4	11	16	46%

RESULTS AND DISCUSSION

Figure 1 shows survey results for each program, regarding the program graduates' perception of whether their internship strengthened specific CDIO personal and professional skills and attitudes, such as: analytical reasoning and problem solving (CDIO 2.1), perseverance and flexibility (CDIO 2.4.2), critical thinking (CDIO 2.4.4), ethics, integrity and social responsibility (CDIO 2.5.1), professional behaviour (CDIO 2.5.2) and equity and diversity (CDIO 2.5.5). As can be seen in the figure, graduates from all four programs perceive internships as having a bolstering effect on the above mentioned CDIO skills. Worthy of note are analytical reasoning and problem solving for the Computer Science and Geological Engineering programs, and perseverance and flexibility, for all program graduates. On the other hand, fewer students perceived an improvement in the ethics, integrity and social responsibility item due to their internships.

Figure 2 shows survey results for each program, regarding the program graduates' perception of whether their internship strengthened particular CDIO interpersonal skills: teamwork (CDIO 3.1) and communications (CDIO 3.2). All results are high, over 75%.

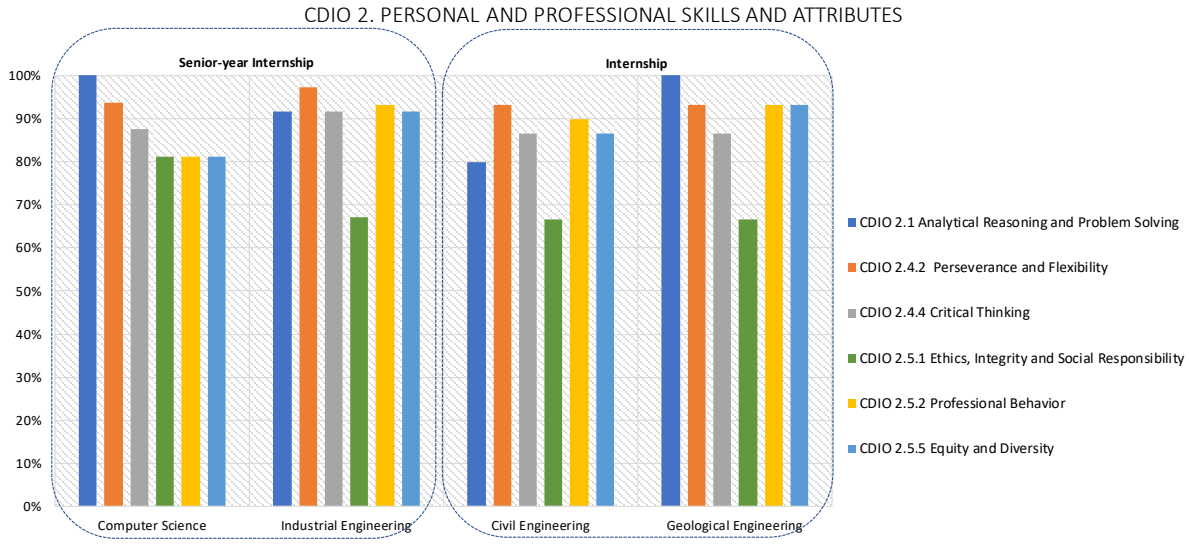

Figure 1. Program graduates' perception of strengthening of personal and professional skills

Figure 3 shows survey results for each program, regarding the program graduates' perception of whether their internship strengthened specific CDIO skills related to conceiving, designing, implementing and operating systems in the enterprise, societal and environmental context, in particular: conceiving, system engineering and management (CDIO 4.3), designing (CDIO 4.4), implementing (CDIO 4.5) and operating (CDIO 4.6). Results show that graduates from all programs regard their internships as very helpful in developing the first three skills, but slightly less so for the last skill. In particular, this value is lower for graduates from the Civil Engineering and Geological Engineering programs, which had a shorter internship.

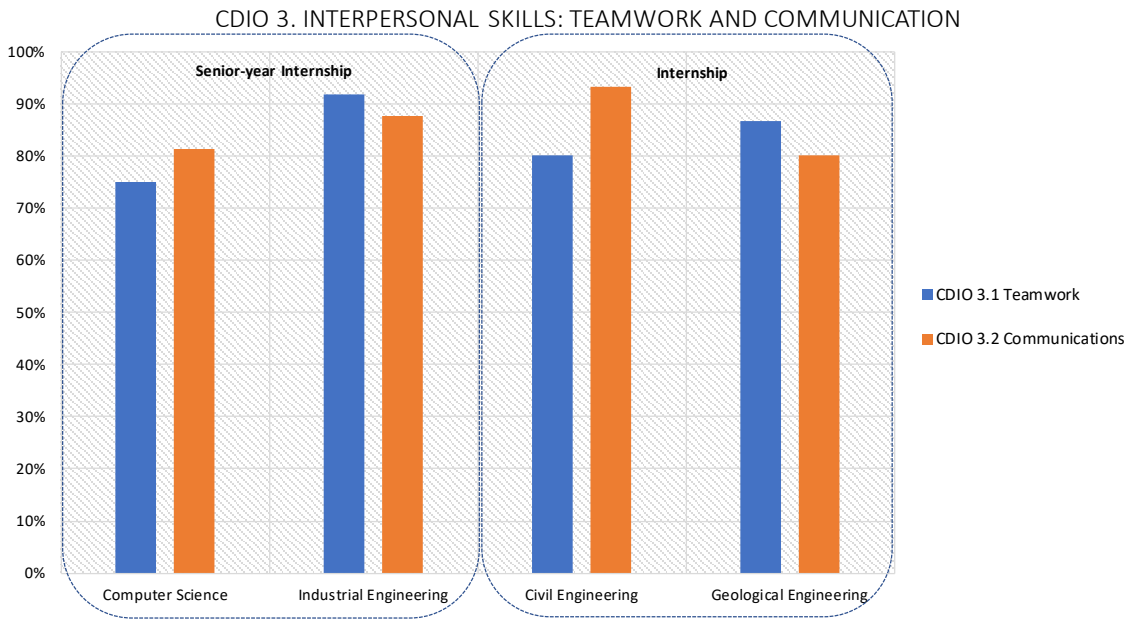

Figure 2. Program graduates' perception of strengthening of interpersonal skills

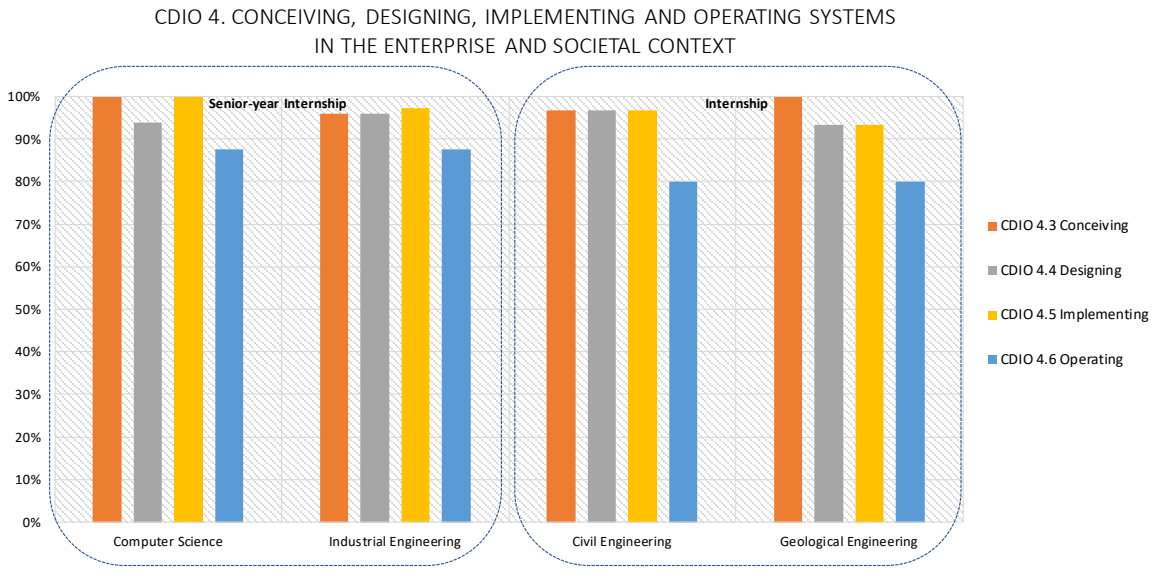

Figure 3. Program graduates' perception of strengthening of CDIO skills

Figure 4 shows that about 70% of graduates of the two programs that have a senior-year internship, Computer Science and Industrial Engineering, state that their senior-year internship helped them get a job within 6 months of graduating. Graduates from the Civil Engineering and Geological Engineering programs, which have a shorter internship a year before graduating, report lower numbers. Graduates from all programs state that the internship helped boost their self-esteem, results being slightly higher for the Industrial Engineering program (75%). Graduates from all programs may take an employability skills workshop, which is given in an online manner to all programs except for Computer Science. Graduates from this last program highly rated the usefulness of this workshop for job placement.

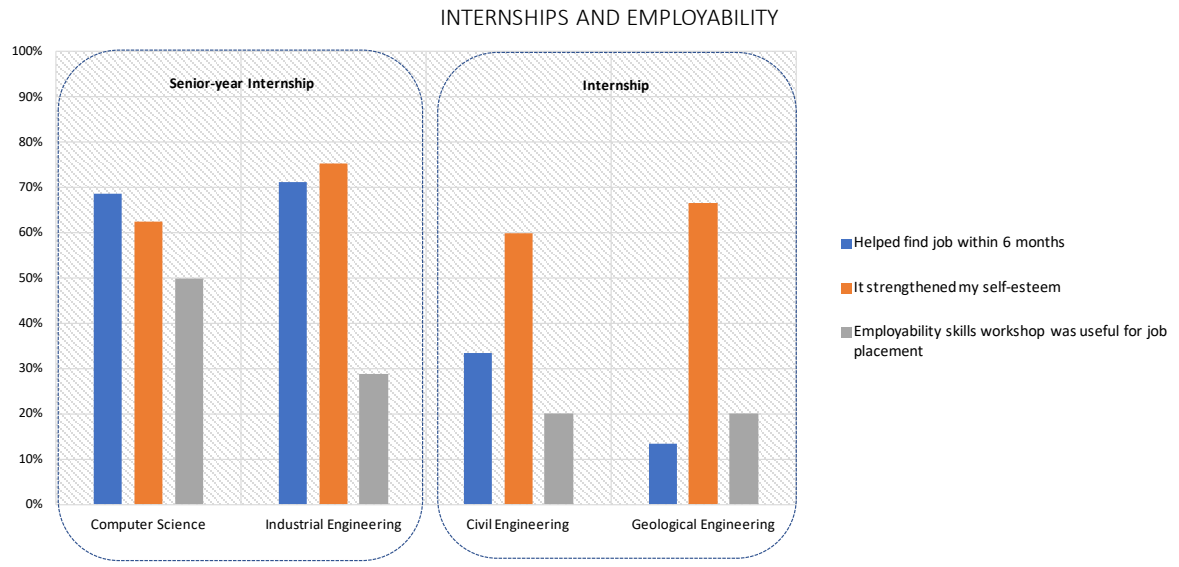

Figure 4. Impact of internships on employability

Table 2 presents survey results regarding the perceived usefulness of experiential learning activities such as project-based learning, service-learning, internships, among others, to the program graduates' job placement. Graduates from the Computer Science and Industrial Engineering rate this usefulness slightly higher (75%) than graduates from the Civil Engineering and Geological Engineering programs (above 60%). Most graduates highly rate their internship experiences regarding the strengthening of their technical skills, above 82% in all cases. Finally, as shown in Table 2, over a third of all graduates entered into a contractual relationship with the company that hosted them during their internships. This number is particularly noteworthy for graduates of the Industrial Engineering program, where 60% of graduates continued working for their internship company after graduating.

Table 2. Graduates' opinions about the usefulness of experiential learning

Statements	Computer Science	Industrial Engineering	Civil Engineering	Geological Engineering
The active learning activities in a real context I had during my studies (project-based learning, service-learning, among others) helped my job placement	75%	75%	60%	67%
My internship strengthened my technical skills	94%	82%	83%	87%
After my internship, I had a contractual relationship with the company	44%	60%	40%	33%

Figures 5 to 8 show the results for the survey's open questions, where program graduates were asked to identify the top two weaknesses that hampered their internship performance, and the top two skills they improved during their internship. All comments were classified, sorted by frequency, and associated to particular knowledge, skill or attitude of the CDIO Syllabus (Crawley et al., 2011). These figures show the resulting comment mappings, classified as either strengths or weaknesses and their frequencies.

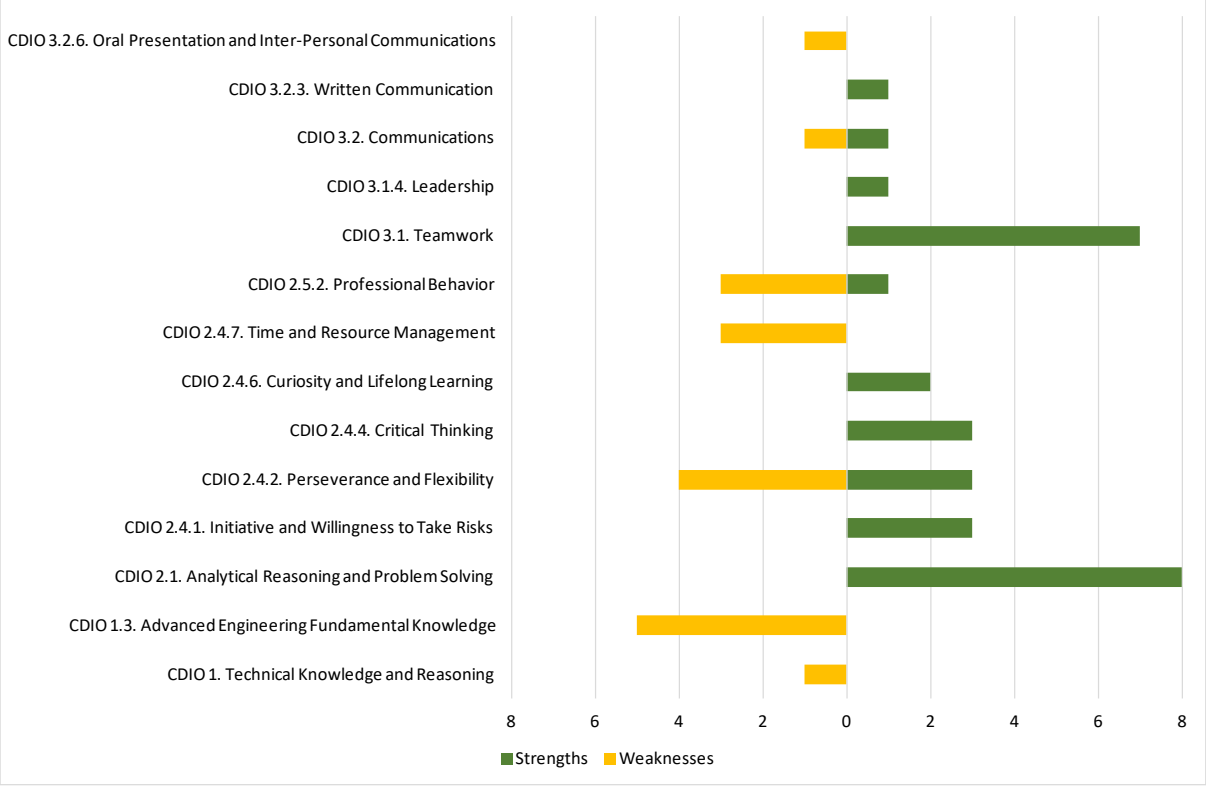

Figure 5. Computer Science (16 program graduates surveyed)

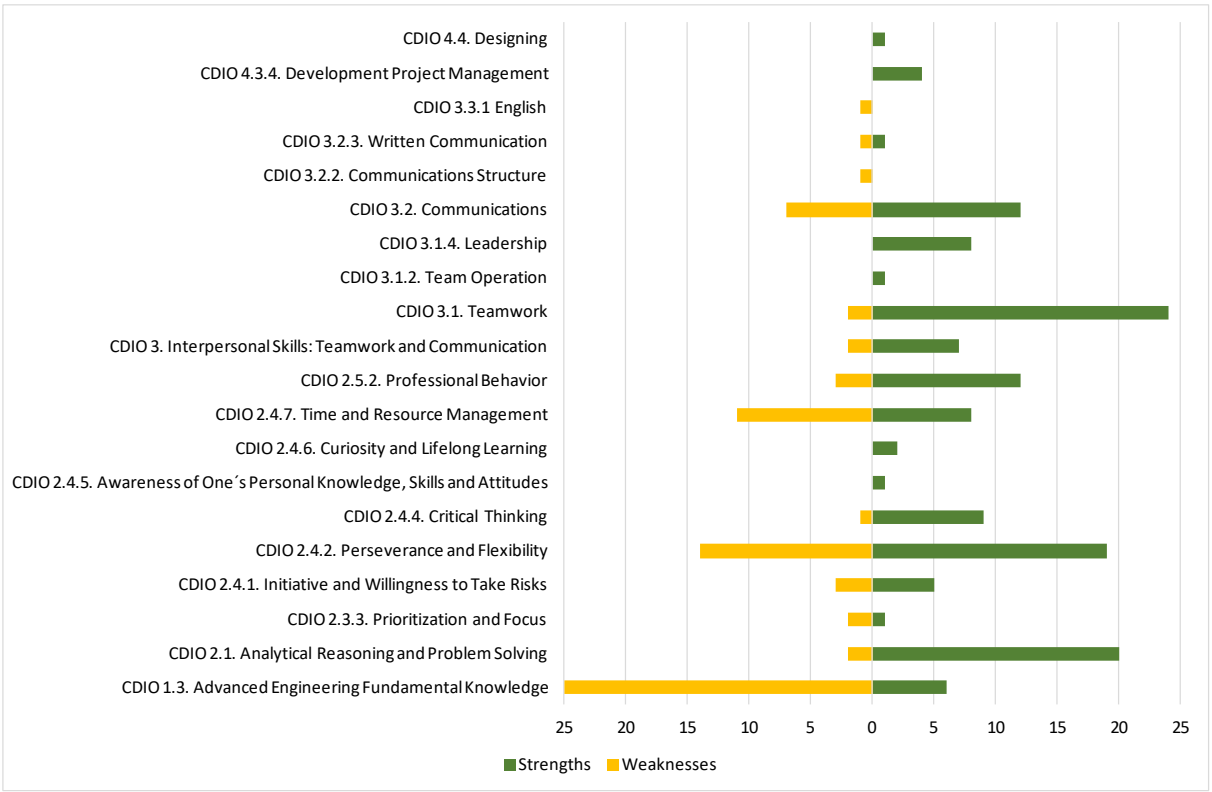

Figure 6 Industrial Engineering (73 program graduates surveyed)

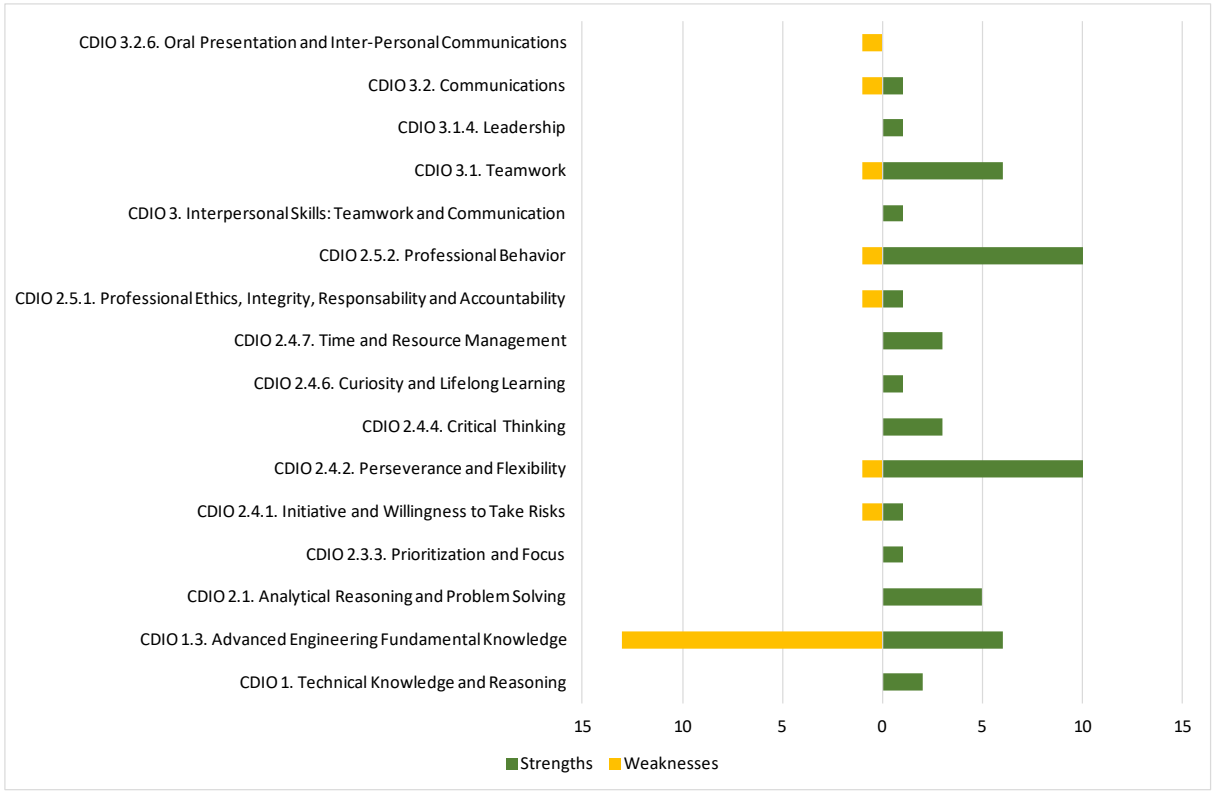

Figure 7 Civil Engineering (30 program graduates surveyed)

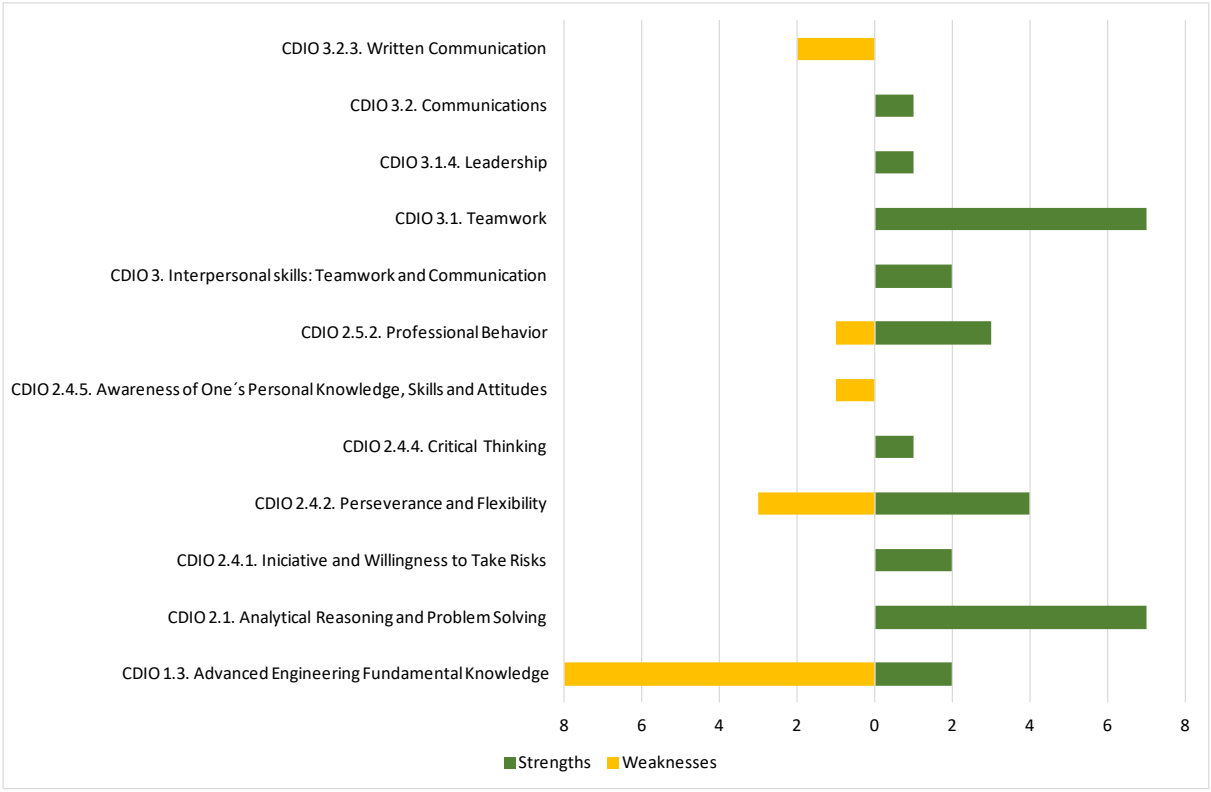

Figure 8 Geological Engineering (15 program graduates surveyed)

Figures 5 to 8 show that graduates from the Computer Science, Industrial Engineering and Geological Engineering programs mention teamwork (CDIO 3.1) and analytical reasoning and problem solving (CDIO 2.1) as the top two skills they improved during the internship, while Civil Engineering graduates mention perseverance and flexibility (CDIO 2.4.2) and professional behaviour (CDIO 2.5.2) with the two highest frequencies. Regarding the weaknesses that affected their internship performance, graduates from all programs mention with the two highest frequencies their advanced engineering fundamental knowledge, methods and tools (CDIO 1.3), and perseverance and flexibility (CDIO 2.4.2) with the exception of Civil Engineering that has this last one as a strength. It is worth noting that, in general, students do not frequently mention their communication skills as one of their top two weaknesses. However, the study of Muñoz et al. (2018) shows that supervisors find that there is some room for improvement in that skill.

Regarding the online survey's response rates, several possible reasons for a low response rate have been reported in the literature (Saleh & Bista, 2017) that may apply to our case, such as: having an obsolete and/or inaccurate email address list, the email checking habits of people with more than one email address, etc. In our case, program graduates were contacted mainly through their university email address. However, given that they have been graduates for at least a semester, they may not check this address as frequently as was expected.

CONCLUSIONS

Internships, as educational and professional experiences, have been shown to yield many benefits. From our results, graduates' perceptions of the internship's impact are the improvement of their skills and competencies, the rise of their self-esteem and the increase in their employment opportunities, results which agree with the literature. These effects are further emphasized in the case of the longer senior-year internships. Graduates feel that having had a senior-year internship as their last curricular activity helped them decrease job search time and find a job within six months of graduating. As future work, we intend to leverage these positive internships experiences into stronger and tighter collaboration bonds between academia and industry.

REFERENCES

Crawley, E., Malmqvist, J., Ostlund, S., & Brodeur, D. (2007). *Rethinking Engineering Education: The CDIO Approach*. New York: Springer.

Crawley, E., Malmqvist, J., Lucas, W., & Brodeur, D (2011). The CDIO Syllabus v2.0. An Updated Statement of Goals for Engineering Education. In *Proceedings of the 7th International CDIO Conference*, Technical University of Denmark, Copenhagen, Denmark.

Haag, S., Guilbeau, E. & Goble, W. (2006) Assessing Engineering Internship Efficacy: Industry's Perception of Student Performance. *International Journal of Engineering Education, 22*(2), 257-263.

Loyer, S., Muñoz, M., Cárdenas, C., Martínez, C., Cepeda, M., & Faúndez, V. (2011). CDIO Approach to Curriculum Design of Five Engineering Programs at UCSC. *Proceedings of the 7th International CDIO Conference*, Technical University of Denmark, Copenhagen, Denmark.

Muñoz, M., Cea, P., Martínez, C., Bizama, M., & González, H. (2018). Evaluación del logro del perfil de egreso: Ingeniería Civil Informática e Ingeniería Civil Industrial, UCSC. *Proceedings of XXXI Congreso de la Sociedad Chilena de Educación en Ingeniería (SOCHEDI 2018)*. Universidad Técnica Federico Santa María, Viña del Mar, Chile.

Saleh, A. & Bista, K. (2017). Examining Factors Impacting online survey response rates in educational research: Perceptions of graduate students. *Journal of MultiDisciplinary Evaluation*, *13(*29).

Sanahuja, G., & Ribes, G. (2015). Effects of business internships on students, employers, and higher education institutions: a systematic review. *Journal of Employment Consulting*, *52*, 121-130.

BIOGRAPHICAL INFORMATION

Claudia Martínez-Araneda studied Computer Science at the University of Concepción, Chile, and obtained her Master in Educational Informatics at the Universidad de la Frontera, Chile. Currently she is the School of Engineering head and a faculty member in the Computer Science Department at UCSC, Chile. Her research and interest areas are Information retrieval and engineering education.

Marcia Muñoz studied Computer Science at the University of Concepción, Chile, and obtained her M.C.S. at the University of Illinois at Urbana-Champaign, USA. Currently she is a faculty member in the Computer Science Department at UCSC, Chile, where she also serves as undergraduate program director. Her research areas are machine learning and engineering education.

Matilde Basso studied Geology at the University of Concepción, Chile. Currently she is a faculty member in the Civil Engineering Department at UCSC, Chile, where she also serves as undergraduate program director. Her research areas are geology and engineering education.

Claudio Oyarzo studied Civil Engineering at Universidad Técnica Federico Santa María, Chile, and obtained his PhD in Civil Engineering at the University of Auckland, New Zealand. He is a faculty member in the Civil Engineering Department at UCSC, Chile, and he has served as Civil Engineering program director and School of Engineering head. His research areas are earthquake engineering, structural health monitoring and engineering education.

Patricio Cea studied Port Engineering at Universidad Católica de la Santísima Concepción, Chile and obtained his Master of Transport and Maritime Economics at ITMMA University of Antwerp, Belgium. He is a faculty member in the Industrial Engineering department at UCSC, where he serves as undergraduate program director. He is also the Service-learning Center's Academic coordinator. His research interests are transport economy, logistics and service-learning.

Michelle Bizama studied Industrial Engineering at Universidad Católica de la Santísima Concepción, Chile. Currently she is an assistant at the School of Engineering at UCSC, Chile. Her interest areas are statistic analysis and engineering education.

Helga González studied Industrial Engineering at Universidad Católica de la Santísima Concepción, Chile. Currently she is responsible for coordinating internship and first-year Industrial Engineering courses. Her interest areas are economics and engineering education.

Corresponding author

Marcia Muñoz
Universidad Católica de la Santísima Concepción
Department of Computer Science
Alonso de Ribera 2850, Concepción, Chile
56-41-2345326
marciam@ucsc.cl