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Women in Construction Engineering: Improving the Students' Experience throughout their Careers

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Women in Construction Engineering: Towards Continuous Improvement in the Student Trajectory

Abstract

Recent retention studies identify factors that exist beyond the academic environment as critical to student dropout. In particular, in the Construction Engineering career, women's participation is similar to that reported in professional life, less than 10%. These figures are alarming. This work seeks to improve female students' accompaniment to complete their degree on time and continue their professional development. This diagnostic study aims to know the perception of female students of the Construction Engineering at Universidad Andres Bello undergraduate course about their interests and academic needs to improve their university careers. The objective is to propose improvements to the students' university experience to increase female students who complete their studies.

This qualitative study will have four sequential phases: session of students with an expert, a survey of perceptions, a survey of female students in the degree, and interviews. The session with the expert seeks to bring closer and broaden female students' vision about the professional environment by knowing her trajectory, uncertainties, experiences, and current work. The survey collects data on the perception and level of satisfaction female students who are active in the career to help them complete their studies successfully. Finally, the researchers conducted three semi-structured interviews with female students of 1st, 3rd, and 5th year delve into the program to better understand female students' expectations from the program. Experts were also be interviewed to find out what motivated them to finish their studies. The talk with an expert offers the students to identify themselves and broaden their vision about the profession. Surveys reveal student interests, needs, and expectations about their academic career. The interviews offer an overview of perceptions about career's different stages: beginning, in the middle, at the end, and as a professional about the perceptions, interests, and expectations, regarding admission, scholarships, academic management, and support

The authors concluded that this study reveals the interests, expectations, and needs of female Construction Engineering students so that the program can visualize initiatives that improve the student career. For example, increasing the inclusion of problematic contexts identified, with social and environmental considerations in a sustained way, allows identifying and broadening the students' vision throughout their career.

Keywords: higher education, gender issues, women in engineering, students' perceptions, educational innovation

Introduction

Participation of women in the engineering industry is meager, and their under-representation in engineering remains despite the industry's efforts. Attracting more women into the field has not yet been achieved, and their participation is still judged as insufficient by several authors [1]. This fact is reflected initially in the low number of women enrolled in careers in the engineering

area. If we specifically analyze the construction sector, it is not effective to push more women to enter these careers since the percentage of women employed in construction is proportional to income. The probability that they will finish the degree and serve the engineering community in the long term must be taken into account [1].

Women are underrepresented in engineering careers, specifically in mining and construction. This situation leads to having a low number of women in the category within the working population. [2]. Women in Chile have had to deal with a two-fold prejudice; the first one is that "University is not for women," and if they hurdle this one, once in university, the next one is "there are university degrees especially for women." This study aims to determine success or failure factors for female students studying Construction Engineering Program and using their student viewpoint to generate proposals to improve student support programs.

Historically, the Construction industry in Chile has shown low participation of women in the workplace. This sector currently has a 7% participation of women (July 2020), according to data published by the Ministry of Women and Gender Equity, a figure directly proportional to the number of female students in the area.

In Chile, the Ministry of Women and Gender Equity promotes initiatives to insert women into the construction industry workforce; it has set up a Technical Working Table called "Women and Construction" and the Chilean Chamber of Construction. Moreover, the Ministry leads an initiative named *Women in Construction*, which - together with private businesses and related entities in the field- aims to identify and reduce gaps, generate more significant participation of women in the sector, and promote female inclusion plans.

Retention studies show that while the academic environment is essential in achieving student retention in a given study program, it is not the only influencing variable. There are personal issues of students that affect them in the interactions they have within the University structure. That is, the decision not to continue with a career is personal and individual. Still, the person is inserted in a society that also affects their choices. "The student's social interactions within the university context can trigger or interrupt the decision to leave [3] – [5].

The present work presents results from a study conducted to determine factors affecting the success of female Construction Engineering students at Universidad Andres Bello, Chile. Given the percentage of female students enrolled in the program and their reasons to drop out, this study aims to understand female students' needs by proposing actions by the program to benefit the student's trajectory.

Context

This diagnostic study seeks to know the perception active female students in Construction Engineering have about their interests and academic needs to improve their university careers. The objective is to propose improvements to the university experience that female students have to increase the percentage of students completing their studies, and therefore, increase the participation of women in said profession.

This study took place in a private university in Chile, Universidad Andres Bello (UNAB). This institution has over 32 years of experience, earned a 5-year accreditation nationwide, and appears ranked internationally by recognized world rankings. Specifically, in the engineering faculty, focusing on female construction engineering students. This is a prestigious program that last year obtained a double 5-year accreditation (up to 2025) by an international and a national agency, Acreditatora de Chile and CONAN, respectively.

The Construction Engineering undergraduate course at this university lasts ten semesters or five years. It includes 50 courses, including Basic Sciences (Physics, Mathematics, and Chemistry), a formation in Economics, General Training on Communication Skills, Information Technologies, Social Responsibility, English Language, and specialization courses designed to meet students' graduation profile. Also, the curriculum includes four integrative courses, whose aim is to incorporate knowledge acquired by students from previous courses and integrate it into activities for current projects and/or for use by companies out in the field. The last integrating course is called Degree Portfolio and culminates with the completion of the study program. This course is based on multidisciplinary projects carried out by teachers of different specialties, finishing in an individual examination before a commission composed of the course lecturers and external evaluators who are invited exclusively for this process.

Around 70% of college courses are specialized and are concentrated in the last 3 years of the degree, while Basic Sciences, English and general training are concentrated in the first 2 years (Table 1). Of the 20 subjects taught in the 4th and 5th year of the career, 95% are specialty subjects.

Table 1. Composition of courses per year for the Construction Engineering program.

Year	Basic Science	Economics	Specialty	General Training	English Language	Total curses per year
1	4		3	2	1	10
2	2	1	5		2	10
3			8	1	1	10
4			10	1		11
5			9			9
Total	6	1	35	4	4	50

Graduated students from this degree had in 2020 as much as 91% employability one year after graduating, ranked among the top three in the country, according to the SIES January 2020.

During the last five years, an average of 48 students entered the program, of which 14% were women. Out of those, 42% of female students did not continue their studies. Currently, there are 21 female students enrolled in the program.

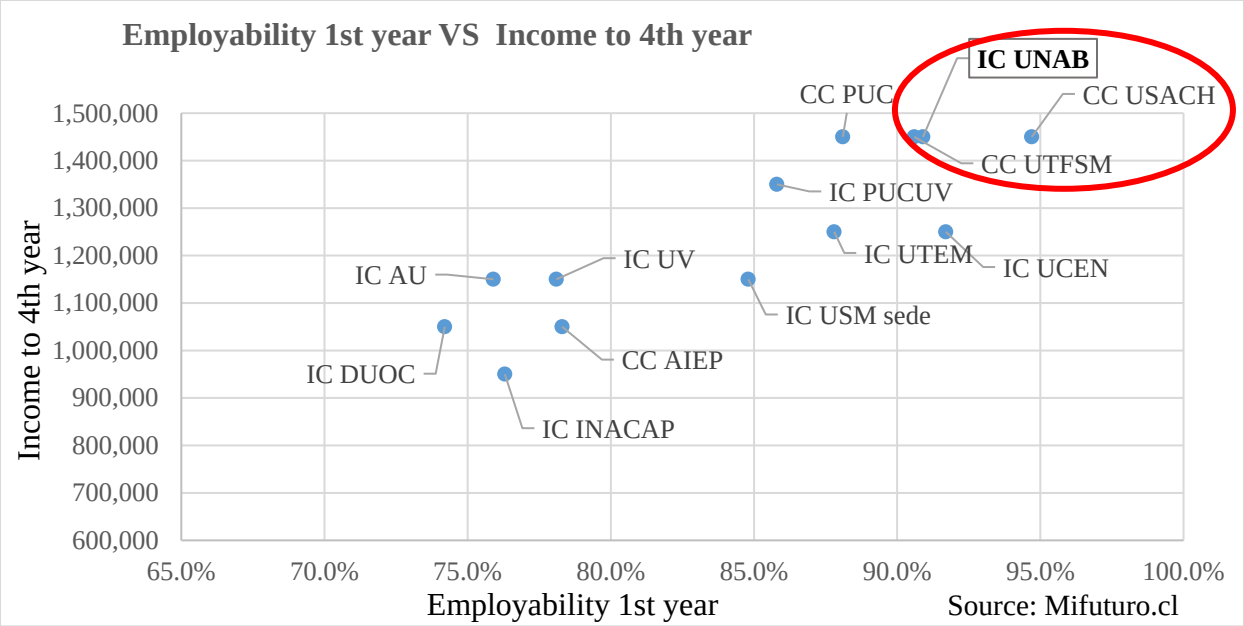

Figure 1. Employability of the 4th vs. the first year. This graph considers day and evening programs.

Students' entry age is between 17 and 23 years old; the average female entry age is 19.08 years, the mode 18 years, and standard deviation 1.628. Table 2 shows that more than half of students who abandoned their studies (either Dropout, Definitive withdrawal, temporary withdrawal) entering university at 17 or 18. Eight out of 15 female students drop out of the program (53%).

Table 2. Relationship between Age and Academic Status for female students.

Entry age	Active	Drop-out / Definite withdrawal	Temporary withdrawal
17	2	2	
18	8	5	1
19	4	2	
20	2	2	
21	3	1	
22	2		1
23		1	
Total	**21**	**13**	**2**

A third (33%) of female students who did not continue their studies have a current debt with the University (Financial Retention), which may hinder their studies if they want to continue in the same institution (Table 3). It is alarming that 87% of the dropouts are definitive. 60% of the female students who drop out do so during the first year. Up to 80% of the first-year courses are science disciplines (mathematics, physics, and chemistry) and 60% during the second semester. It has been documented in the literature this situation. Specialty courses (related to construction engineering) barely represent 30% in the first year. As specialty courses increase, fewer dropout

occurs, there are almost no withdrawals in the fourth and fifth year of the program. No drop out occurs during the last two years of the program, indicating that by then female students decide to stay after that passed the science courses (physics, mathematics) and entered the disciplinary courses. Female student desertion occurs in the first two years of the career, where all introductory science courses appear in that period, and 75% of the English language courses.

Table 3 - Female students who abandoned their studies with and without financial retention

	Without financial retention	**With financial retention**
Dropout / definitive withdrawal	10	3
Temporary withdrawal		2
Total	**10**	**5**

Institutional records (Table 4) indicate that female students dropouts fall in four main reasons: 1) financial issues, 33% of mentions being for economic reasons at the family nucleus, where students or their financial supporter cannot continue paying their studies; 2) work-related issues when students work and have responsibilities outside the academic ones; 3) health issues when students or a family member have a disease that prevents adequate academic progress; and 4) transfer to another educational institution, which is when the student decides to apply to another career or institution. Also, 27% of female students do not state reasons for dropping out (without a described cause).

Table 4 - Reasons for abandoning studies for female students

	Financial	**Labor**	**Other**	**Health**	**No cause given**	**Transfer to other academic institution**
Dropout / definitive withdrawal	3	1	1	1	3	4
Temporary withdrawal	2					
Total	**5**	**1**	**1**	**1**	**3**	**4**

The above information leads us to the following research questions: 1) what are the factors that determine the success or failure of female students studying Construction Engineering Program? and 2) From the students' perspective, what can the program do to improve their success?

Methodology

The study uses qualitative research techniques, whose objective was to know why female students succeed in completing their studies in construction engineering and ascertain - in their own words - how university career direction may provide support to students throughout their studies.

Three instruments were used to these ends (Figure 2), starting with a former undergraduate student's talk where first- and third-year students participated. After the conference, the implementation of the survey occurred. The survey asked about the invited talk, the university experience, and career management support to students. Later, a survey was applied among women in the career regarding their opinion and perception of the university and career management, culminating in an interview with three selected students, one at the beginning, one at the middle, and one at the end of their university training.

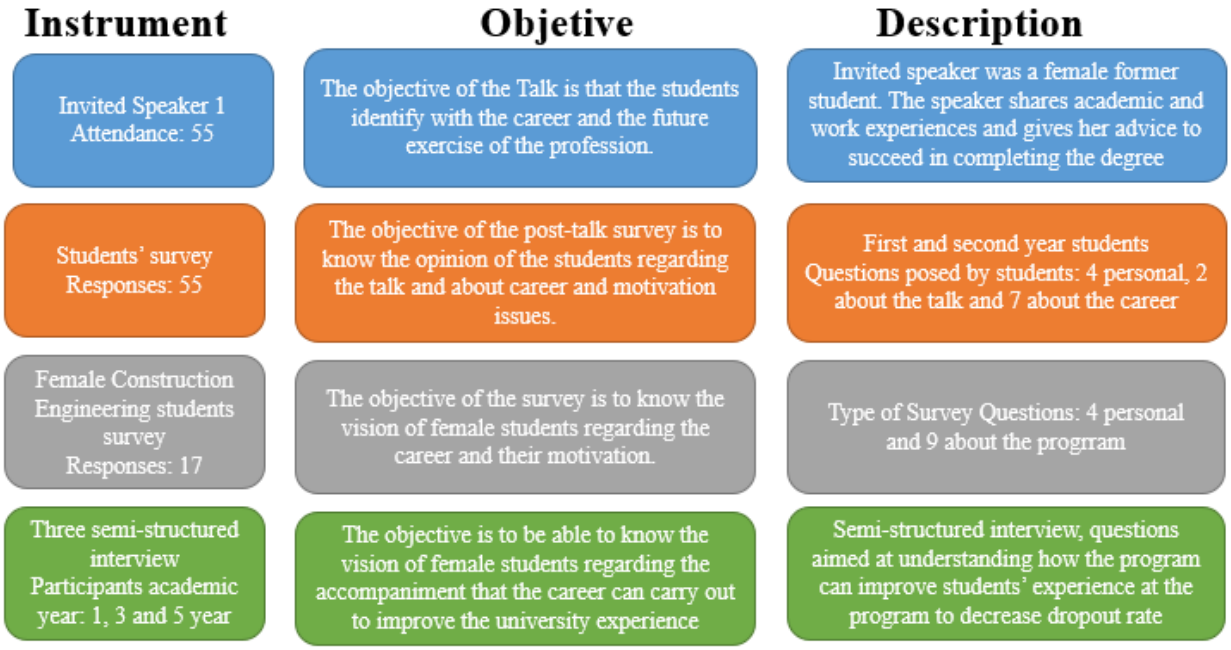

Figure 2. Instrument, objective, and description for each of the four methods of data collection.

Research indicates that pedagogy has a positive impact on the university experience of female students, as well as in their decision to pursue an engineering career" [2]. Through surveys and interviews, we seek to know the perception of female students, particularly their opinion regarding teachers. The authors consider this a relevant issue based on teachers' influence in reducing the dropout rate of women. Teachers become role models to whom students listen and follow and who – through constant interaction and dialogue - create a suitable climate for learning. As teachers, they also monitor students to maintain their interest, motivation, and commitment to the course [4].

Instruments and Participants

Twenty-one active undergraduate students were asked to engage in the study, between August and December 2020. Three sequential phases were implemented, the first was a session with an expert, followed by survey of student perceptions and ending with semi-structured interviews with female students.

The session with the expert was a talk given by a former University student given to an audience of first- and second-year students, where 55 students participated. This session sought both to

bring into sharper focus and broaden students' vision of their professional environment by getting to know the speaker's trajectory, uncertainties, experiences and current work. This activity was evaluated by students through an opinion survey on the talk subject, the guest, and areas of interest for further talks.

The second instrument was a survey on perceptions and level of satisfaction of female students on the career and a probe on what is needed to help them complete their studies successfully. This survey had 13 questions of which 4 were identification questions, 7 were questions regarding their career and the university in particular, and 2 items refer to the talk.

The third instrument is a survey oriented to female students. It focuses on their perception about the support they need from the program or in general that will help them complete their studies. This survey consists of 13 items; four are identification questions, nine questions ask about the program and the university. The 21 female students enrolled in the program were invited to participate, 81% submit their responses.

The survey included socio-demographic general, and career-specific questions. Among the socio-demographic questions, gender, period of admission, and most delayed study area were identified. There were general questions where they were asked about subjects that they would like to probe further in future talks and if they had any family members acting as sources of reference in the field that may have motivated them to join their chosen career, as well as specific questions such as their need to receive support and motivation so they may continue their studies.

Finally, three semi-structured interviews were held with female students in the first, third and fifth years of their studies. Interviews lasted approximately 30 minutes, aiming to delve into program expectations and support that the students consider they require completing their studies successfully. They were also queried on the level of interests held regarding monitoring and accompanying female students, improving program attractiveness and accessibility, improving retention rates, reducing dropouts, and favoring timely graduation.

Interview purpose was to probe aspects of interest that arise from the survey, as well as other interests seen in the program, such as monitoring and accompaniment of female students so they may:

a) Improve program attractiveness and accessibility
b) Improve retention and decrease dropout
c) Promote timely graduation

The semi-structured interview contained fundamental questions which were asked to all respondents with optional questions if it became necessary to expand on certain issues. Interviews were applied to three selected female students in the first, third and fifth year of university, aiming to cover students' needs and perceptions in their initial, intermediate and final stages. Students were invited to participate voluntarily; their selection was made based on their history of participation and motivation in class, in addition to having a curricular progress in accordance to their entry year.

In summary, the session with the expert contributed in generating a space to generate student conversation and motivation, while the survey allows obtaining information regarding student needs and perceptions, particularly for female undergraduate students, and the interview ends the intervention period by looking into specific experiences and needs of female students in the different stages of their career.

Results

The expert talk offered students an opportunity to identify themselves with and broaden their vision on the profession itself, their career and their study program. Surveys revealed students' interests, needs, and expectations regarding their academic path. Interviews provided an overview of career perceptions at different stages of advancement, at the beginning, at the middle and towards the end.

Session with the expert

The session with the expert was a talk prepared by a qualified professional graduated from the university. The invitation was sent to 72 students in their second and forth semester, of which 55 participated (15% women and 85% men). The speaker was extremely generous in giving them first-hand information from her experience, answering all questions. At the end of the session, students thanked her the talk and evaluated the conference positively. Table 5 summarizes the most common comments in the open-ended questions.

Table 5. Comment of students about the talk offered by the invited speaker

Students' comments on the speaker	Students' comments on the talk
- Explained and answered questions very clearly	- Informative, grounded to the real world vision
- Very good disposition seen in answering questions	- An excellent opportunity to know how to deal with the world of work when we finish our studies
- Sincere answers	- An excellent talk, very honest, touching on lots of issues
- Explained very well and answered questions finely	- I thought it was clarifying and quite didactic, information which will be useful when we graduate
- Excellent, with the right level of intimacy so as to generate confidence	- An excellent instance to know how to deal with the world of work when we graduate
- Very good disposition, nice and agreeable	- Interesting as it helped a lot to clarify many doubts about the career work field
- Very good, as she answered students' questions in a clear and honest way	- Very interesting as it showed things that will be coming in our career and future working life
- Spontaneous	- Realistic and very clear to be understood
- Very informative, it was great to know someone like us, our age, telling us about the world of work	- Good, it was an instance for clearing up any doubts on the career and to know what the future holds

The talk allowed the audience to identify and broaden their vision regarding their career and the exercise of their profession, given the experience of the speaker in her university and professional life, this was demonstrated throughout the talk as students constantly intervened to ask questions and delve into specific topics that captured their attention, asking after her professional life with queries on salary, difficulties seen in the industry, differences in working out in the different country regions, as well as asking on her university life, such as her relationship with teachers, degree course, changes to the curricula, course difficulties, among others. Students valued the activity, and actively participated in it, made an extensive round of questions to the speaker in order to clarify their concerns and thanked her, pointed out her sincerity when responding. All attendees gave positive comments regarding the activity, 52% rated it as excellent and 48% found the talk interesting or entertaining.

When asked about what issues they would like to be addressed in future talks, 40% of students mentioned being interested in talks on employability and working life, indicating the relevance of knowing the different areas in which a construction engineer can work in, salaries paid, and work-related problems. In addition, 12% of students stated that talks are especially motivational if the speaker is a graduate of the institution.

Three main areas of interest were identified as mentioned by students,1) Profession, 2) Academic Development, and 3) Personal Development. The item allowed students to select as many options of interest as wanted. Thus, the above three main areas represent a general interest of all the students.

Profession included issues such as "Employability and Work Life", "Innovation in Construction" and "Inviting alumni to give a talk". 64% of students surveyed expressed interest in this area.

Academic Development included "Curricular Program", "Budgeting and APU" (Unit Price Analysis) and "Building". 29% of surveyed students expressed interest in this area.

Personal development included topics such as "Women in construction", "Facing university life" and "Leadership". 7% of surveyed students expressed interest in this area.

Informally, the speaker also valued this activity positively, stating that when she was a student, activities with alumni were not held.

She expressed her willingness to support future activities developed by the career and was interested in returning to give talks in the future and to support any initiative involving graduated alumni.

Her interest was realized on her accepting the invitation to participate as evaluator in the student completion course (degree portfolio) in December 2020, which she accepted, becoming a member of the evaluation commission.

Survey aimed at female undergraduate students

To analyze survey results, student responses were grouped together, the 21 active female students of the career were invited to participate, of which 76% responded the survey. When asked if they had any reference in the field that may have motivated them to enter into the career, 56% of students stated that they had relatives linked to construction that encouraged their interest in the career, while 44% of students did not have family references in the construction area.

Reviewing female student survey data regarding future talks, the breakdown is 47% expressing preferences for professional talks, 16% for Academic talks and 37% for personal development talks. Worthy of note in this last preference is that 21% of mentions were for women's issues in construction versus the 2% interest that this topic generated when all those attending the expert session were consulted, without the gender breakdown.

Female students state that they like their career, in terms of career management, curriculum, and elective courses added in the latest curricular innovation in 2017, and value the high employability rates the career shows. However, they show a genuine interest in adding field visits from the first year onwards and increasing practical activities, teaching assistantships, and field activities that occur throughout their university life. The two main themes that emerged were the curriculum in which they mentioned the importance of elective courses and the support from career direction in a 60%. The second most recurrent topic was the breadth of the labor field and high employability, with 40% mentions.

Regarding those aspects that female students would like to improve in their career, 62.5% proposed field visits and practical activities from the very beginning of their studies, while 18.75% of female students proposed improvements in the online platform used, online classes, and timely feedback from tests and controls. Female students mentioned in 12.5% of cases more guidance for first-year students and 6.25% stated that no improvements are required.

50% of female students mentioned that upon graduating they would be interested in working in the Civil Works or Mining sector, 29% are interested in Sustainable Building and Construction and 21% of students prefer other areas such as working in the Municipal Works Direction, Real Estate or in Management Areas.

First, third- and fifth-year interviews

The instrument used was a semi-structured interview, for which a protocol was followed for each interview, which included fundamental questions which were asked to all respondents and optional questions if it became necessary to expand upon certain issues depending on answers given by interviewees. The aim of the interview was to further probe aspects of interest that arise from the survey, as well as other interests arising from the female student monitoring and support program.

Instrument application was made by selecting three female students and inviting them to participate voluntarily in the interviews, in order to understand the needs and perceptions of women throughout their university life at different stages. A first-year student, a third-year and a

fifth-year student were selected; the selection of the students to interview was made based on their academic situation, participation and motivation seen in class.

From the qualitative analysis of the interviews emerged similar topics of interest by respondents. The salient categories are as follows.

University

- The vision of the Students is that the information provided by Admissions when first entering university, or by talks held prior to enrolment, meet study program expectations.
- Female students stated that if they had to start their studies again they would re-enter Construction Engineering at the same institution, since it is well known in the market and has high employability
- More online access to subject bibliography is needed
- More support and guidance in university processes for new students is needed

Career Management

- Clear procedures are identified in case of academic problems involving academic services directorate, academic secretary and career director
- They stated it would be positive to have clear and defined lunch time hours
- They asked for reinforcement in structural and mathematical courses
- Students are interested in the career having postgraduate programs in online or remote modality.
- The curriculum is generalist; elective subjects give choice to students and bring them up to date on certain matters.
- It is valued that the career directorate is made up of women
- They find the program has an adequate time distribution, except for the 6th semester, which despite having 5 courses, is heavily loaded towards structural courses

Financing

- The students expressed they had little knowledge of scholarships for undergraduate students, even more so now that the career has not had a student center, and hence no students, since 2020.
- Scholarship for admission from technical institute to university, to which they can apply at the institution of origin. The information to apply is not accessible; there is difficulty in finding the bases to apply. In the same way, it is necessary to publicize the validation rules that apply, if possible.
- Female students have applied for teaching assistantships and have summer jobs

Work life

- Female students think that opportunities for men and women in the field are different.

Measures

- A talk program can be generated, with former students, businesses in the field, and successful working women in key courses throughout their career.

- The Program Director will contact those people in charge of scholarships and credits so as to deliver clear information to students via email
- Students will be supported to create a student center and thus have representation in meetings with school directors
- A subject registration tutorial was generated for students
- The school direction, both the school dean and the academic secretary, solve any student academic problems, such as approvals, validations, requests for registration of courses, among others.
- Lecturers were trained during the year in virtual classrooms and in improving methodologies
- For future programming, the possibility of leaving a lunch block per semester will be evaluated.

Given the expert session, a need was identified in generating conversations and the interests that these initiatives generate. An analysis of the surveys revealed areas of particular student interest, while with the interview, it becomes possible to further probe specific student topics according to progress made, and entry situation. It becomes obvious to think that by selecting good students, low dropout rates can be achieved and thus achieve good academic behavior. However, the commitment of the Faculty of Engineering at the university, through its mission, is to incorporate those who aspire to progress [3].

Reflection

Considering students' interests, the Construction Engineering program is developing an elective course based on talks by successful women engineers in working life. The program is interested in coordinating gender and self-esteem workshops focused on career women to learn to face conflicts in predominantly male workspaces. The program supports students to form a new student center, providing facilities to encourage their peers to participate in the elections. It is essential to have a student center so that the students of the degree can apply for internal scholarships. Finally, this study helped to know the students' perception and based on that generate action plans for the career to improve the students' experience during their university life and to face their professional life better. The program plans to offer early extracurricular activities to increase students' identity as future engineering professionals. The idea is to guide students to manage better the science sciences courses (first year) that do not bring the practical connection to the construction engineering profession.

Conclusions

In this section, we answer the two research questions of the study, reflect upon the study results and propose future actions for the program. The two research questions were: 1) what are the factors that determine the success or failure of female students studying Construction Engineering Program? and 2) From the students' perspective, what can the program do to improve their success?

- Failure factor - Female students stated having little specific information on scholarships, reflected in the end in the percentage of students with financial problems who finally end up dropping out.

Program response - The career will send information on the benefits that the university provides to all active students. These are published by the general direction of student development on the university website. In addition, the career direction supports students to form a student center and thus not lose the scholarships given by the faculty since 2016.

- Failure factor - Dropout by female students in the engineering in construction career occurs mainly in the first year, where the curriculum focuses on courses by the departments of mathematics, physics and chemistry mainly. After the third year of studies, there are no dropouts; that is, female students who pass the third-year graduate from the career. Program response – Taking advantage of the Comprehensive Center for Accompaniment and Student Development (CIADE for its acronym in Spanish), the program will promote the support offered by the Center and monitor students' improvement.
- Success factor - A high percentage of female students who entered the career has a family member in the construction area. Having a close reference generates an external accompaniment to the university that contributes to the continuity of female students in the career. This family environment contributes to the students' vision of the profession, and generates additional support for practical and field curricular activities.
- Success factor - Female students of the Construction Engineering career are interested and think that it is very relevant to include talks on gender issues related to their field throughout the career.
  Program response - The faculty, motivated by this interest of female students identified in this study, will create a specific elective course for women in engineering in construction for the second semester of this year, where leading women in the construction industry will be invited to share their experiences.
- Students' perspective - Female students of the Construction Engineering career have a greater interest in developing professionally in the area of civil works, being the item most highly valued by them.
  Program response - The curricular grid considers only one course in this area, so it is proposed to complement it with an elective course or talks to satisfy the students' need for knowledge.
- Students' perspective - Students value that talks given by former students are organized, since they feel identified and close when it is a peer who gives them the information, and this allows them to project themselves for when they finish their degree.
  Program response - It is proposed to consider at least once a year inviting an alumnus to present their university and professional experience.
- Students' perspective - The program is led by women, and this generates confidence in the students, and they also value having female teachers throughout their career.
  Program response - The program reviews teachers every semester to always try to include female teachers in their programming.
- Students' perspective - The program is led by women, and this generates confidence in the students, and they also value having female teachers throughout their career.
  Program response - The program reviews teachers every semester to always try to include female teachers in their programming.
- Students' perspective - Female students value the inclusive courses that have been included in the grid.

Program response - The program has 4 integrative courses, 2 in the classroom and 2 in the field, where the classroom courses are based on real projects and the students play the role of Construction Engineer for the development of the Project. The field courses are internships that students take in companies in the field.

This study brought awareness to the program about students' needs. Also, the program realized that some of the aspects could be easily modified to better suit students' expectations. A general summary of gains is the following.

- This study shortens the connection between the program and their students by attending academic topics and professional expectations, becoming an empathic listener for their concerns and personal situations; in general, it generated a closer and more open interaction and sent the message that the program cares about the students.
- The greatest difficulty and desertion of the students is seen in the first year of their degree, where students are designed to have a large number of departmental courses and fail to identify with the degree itself. The comprehensive center for Student Support and Development was created and together with the career direction, tutorials are scheduled for the department courses with the highest failure rate. The career supports the management and monitoring of the tutorials and the career direction has decided to hold specialty talks in the introductory engineering courses to support the identification of the students with their career from the first year.
  The career can support initial courses with technical talks so that students can identify themselves from the beginning of their studies with the profession and thus avoid early desertion.
- The program plans to offer professional development to the faculty on diversity and inclusion, specifically on learning disabilities, and other issues that will support students learning.
- General Directorate of Student Development (DGDE, for its acronym in Spanish) offers psychological support to students in need. The Construction Engineering Program will continue referring students to the DGDE and to request well-being workshops oriented to students. Moreover, DGDE and the program started an alliance to promote women participation in Construction Engineering program.

This semester, the institution at which this study took place to establish committees by schools to promote women's attraction, access, and retention [6]. In particular, the School of Engineering formed a committee that will aim to sensitize students, academics, and administrators on gender issues. The Construction Engineering program actively participates and embraces this initiative that aligns with its needs and low female student enrollment and retention.

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References

[1] K. Flores Guerrero and M. C. López de la Madrid and M. A. Rodríguez Hernández, "Evaluación de componentes de los cursos en línea desde la perspectiva del estudiante. (Assessment of online courses from a student's perspective)," *Revista Electrónica de Investigación Educativa*, vol. 18, no. 1, pp. 23-38, Jan. 2016. http://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S1607-40412016000100002

[2] S. Sundararajan and T. Heindel and B. Ganapathysubramanian and S. Subramaniam, "Women in Mechanical Engineering: A Departmental Effort to Improve Recruitment, Retention, and Engagement of Women Students," *2012 ASEE Annual Conference & Exposition Proceedings, San Antonio, Texas*. DOI: 10.18260/1-2--22240, 2012, pp. 25.1483.1 - 25.1483.15. https://www.jee.org/22240

[3] E. P. Deess and K. Joshi and V. Briller and R. Calluori, Predicting Engineering Student Retention, *Paper presented at 2004 Annual Conference, Salt Lake City, Utah, June 2004*, pp. 9.1001.1 - 9.1001.10. Doi: 10.18260/1-2--13409. https://peer.asee.org/13409

[4] Y. Zeng and J. R. Duncan, Women: Support Factors and Persistence In Engineering, *Paper presented at 2007 Annual Conference & Exposition, Honolulu, Hawaii, June 2007*, pp. 12.1614.1 - 12.1614.25. Doi: 10.18260/1-2--2771. https://cms.jee.org/2771

[5] S. Chopra, G. Bertoline, and C. Laux, "Finding What Women Want: Developing Strategies to Increase Recruitment and Retention of Women," *2012 ASEE Annual Conference & Exposition Proceedings,* June 2012, pp. 25.637.1 - 25.637.5 Doi: 10.18260/1-2--21394.10. https://peer.asee.org/21394

[6] F. J. García-Peñalvo and A. Bello and A. Dominguez and R. M. Romero Chacón, "Acciones, políticas y estrategias para el balance de género en el ámbito STEM: Resultados de una dinámica World Café," *Education in the Knowledge Society (EKS)*, vol. 20, p. 15, Dec. 2019. e-ISSN:2444-8729, Doi: 10.14201/eks2019_20_a31

Appendix – Students interview protocol

Objectives. To know about general aspects of the program. Specifically, a) to improve attraction and access to the program, b) to improve retention and decrease attrition, and c) to promote timely qualification.

Participants. Female students from the first, middle and last thirds of the program.

A. Greeting and thanking the interviewee

B. Data of the interviewee: Name, graduation year, workplace

C. Introduction

D. Interview questions

- How similar was the admission information about the program compared to that experienced in the program? Why?
- If you could start your studies again, would you study with us again? Why?
- In your recollection, how did the program attend and solve the academic problems that you had during your studies?
- What do you think that students need to improve their academic performance? How can the program support?
- How did you finance your studies?
- What aspects of the academic training you receive in your current career do you like the most?
- Do you think that the curriculum of the major you chose to study meets the needs of today's market?
- Which of the appropriate didactic resources for the development of teaching and learning activities do you use the most, such as: books, thesis, database, among others?
- Do you consider that there is an adequate distribution of the number of subjects per semester, in order to meet the semester academic requirements?
- How have they supported you from the career to receive guidance on the policies, criteria and processes of insertion, permanence and graduation from the career?
- Do you think that men and women have different opportunities about what they can work or study?
- How do you see yourself in 5 more years?

E. Closing the interview and thanking for sharing her perspective.