COLLABORATING FOR GREATER GENDER DIVERSITY IN UNIVERSITY ENGINEERING PROGRAMS

Recruitment, retention and academic support practices for women students in Quebec, exploration of the literature and recommendations

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COLLABORATING FOR GREATER GENDER DIVERSITY IN UNIVERSITY ENGINEERING PROGRAMS

Recruitment, retention and academic support practices for women students in Quebec: Exploration of the literature and recommendations

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INTRODUCTION

In Quebec, as in Canada and most Western countries, a movement toward greater representation of women in science and engineering has been underway for some 30 years, and continues to grow today. Since the Fourth United Nations World Conference on Women in 1995, followed by the World Conference on Science organized by UNESCO and the International Council of Scientific Unions (ICSU) in 1999, a global consensus on women's essential contribution to science and the need to give them more equitable access to this field has given rise to numerous initiatives (Deschênes, 2002). In Canada, for example, in 1996, the Natural Sciences and Engineering Research Council (NSERC) expanded the Chairs for Women in Science and Engineering program, initially launched in 1989, to allocate five Canada Chairs to major regions of the country, one of which is the province of Quebec. More specifically in Quebec, a report by the Secrétariat à la condition féminine identified a dozen initiatives to promote science and engineering to girls by the Government of Quebec and partners since the early 2000s, such as *Les Scientifines, Les filles et les sciences, un duo électrisant!*, *Hats Off to You!* and its *Excellence in Science* segment, *Femmessor*, etc. (Vincent, 2012).

Yet in spite of all these efforts, women's representation in science and engineering is slow in changing. According to the statistical report *Inscriptions des femmes en sciences et en génie au collégial et à l'université au Québec entre 2005 et 2019*, women were in the majority in all undergraduate disciplines in 2018, with the exception of pure and applied sciences and engineering, which showed 43% and 22% female enrolment, respectively (Belletête & al., 2019). The engineering field has also been found to be the one with the lowest representation of women among all the fields covered by Quebec universities, and at all education levels (bachelor's degree: 22%; master's degree: 28%; and doctorate: 27%). This data is very similar to the data for the rest of Canada. As a result, since 2011, Engineers Canada has set a national target of 30% women newly admitted to provincial orders by 2030, since, according to the organization, "thirty per cent is universally held as the tipping point for sustainable change" (Engineers Canada, n.d.-a, n.d.-b). Engineers Canada relies on the collaboration of many organizations to achieve this ambitious goal. In Quebec, there are four organizations, among others, that support this initiative and are committed to achieving this target: the Ordre des ingénieurs du Québec (OIQ), McGill University, Concordia University, and Université de Sherbrooke (Engineers Canada, n.d.-b).

Engineers Canada's 30 by 30 initiative illustrates the scope of the movement to increase women's representation in science and engineering, and shows the need to take concrete action in our universities. Indeed, the focus on increasing the number of women in engineering mainly concerns Canadian universities that are mandated with graduating more women students in these fields. To this end, the Chair for Women in Science and Engineering (CWSE) in Quebec has developed a project to identify recruitment, retention and academic support practices for women students in engineering faculties, schools and

departments in Quebec. The four stages of the project are 1) collecting practices in order to draw up an inventory; 2) drafting a report and recommendations based on a literature review; 3) disseminating the report nationally; and 4) assisting engineering faculties, schools and departments in making decisions and implementing actions to achieve the target set by Engineers Canada.

Although the project as a whole was conducted for the engineering field at the university level, it could be transposed to science programs and college programs in science and engineering. Moreover, this report sets forth findings and information that could inspire the field of science. The report *Collaborating for Greater Gender Diversity in University Engineering Programs* is a tool that decision-makers in the Canadian university community can use to devise an action plan. It is divided into three parts. The first presents the design of the inventory, the practices collected in the areas of recruitment, retention and academic support for women engineering students, and key findings. The second features a discussion of the measures proposed in the inventory, supported by a literature review, and gives examples of promising or proven practices in Western countries. The third part concludes with 14 recommendations for the university community in order to effectively guide efforts to improve women's representation in engineering.

PART ONE
PRACTICE INVENTORY

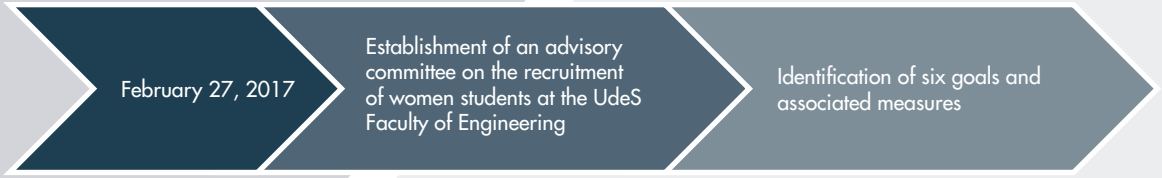
In part one of this report, we will begin by discussing the methodology used to inventory recruitment, retention and academic support practices for women students in engineering faculties, schools and departments in Quebec. This will be followed by the results, presented in the form of summary tables and findings.

1. METHODOLOGY

The project of inventorying engineering student recruitment, retention and academic support practices began in early 2017 and matured through several consultations with various stakeholders up through 2020. What began as an exploratory analysis grew into a Quebec-wide project. The pages that follow describe the different stages of the project, from the first launch meeting to the creation of the data collection tool, and from data analysis to the exploration of the literature.

1.1 Launch of the project

In 2017, a committee made up of women undergraduate students, graduate (master's and doctoral) students, professors and professionals working at the Université de Sherbrooke Faculty of Engineering met to come up with ideas to improve the recruitment of women students.



Following this meeting, led by the Chair for Women in Science and Engineering, suggested actions were compiled into three main orientations based on issues already well documented in the literature, and six objectives were devised. With the exception of the first objective, the other five are not presented in order of importance or priority. Each institution will have to determine its own priorities according to its own context, needs and resources.

ORIENTATIONS	Guidelines based on current issues that guide reflections and the project.
OBJECTIVES	Targets that engineering faculties, schools and departments should strive toward in order to align with the suggested orientations.

Objective 1.
Identify the current situation

This objective comes before all the others, given that it is useful to all of them. The idea is to create a portrait of the current state of play and to measure the impact of actions taken in order to know where to focus efforts. It also helps verify whether the actions applied are structural or individual.[1]

Objective 2.
Increase the interest of girls at all levels of education in bachelor's and graduate engineering programs

This objective, more geared toward recruitment, is about generating greater interest in engineering programs among high school and college-age girls, and greater interest in graduate studies among women students.

Objective 3.
Create an inclusive, attractive and respectful environment for women students

Women students' well-being is conducive to their retention and success. This objective has to do with the quality of women students' welcome and integration into their environment.

Objective 4.
Prepare women students and their employers for positive internship experiences

This objective aims, first, to equip women students to work in a predominantly male environment and, second, to help employers make their workplaces more inclusive in order to facilitate the integration of women students.

1 Section "2.2.5 Objective 5: Improve the graduation rates of women students" will discuss the nature of the actions in place according to institutions' understanding of the problem of women engineering students' under-representation. Actions that alter the existing structure of programs and institutions, although more difficult to carry out, are believed to be more successful than individual actions. For this reason, part two of this document will set forth a measure associated with analyzing actions.

Objective 5.
Improve graduation rates for women students

This objective concerns women students' progress and success, and involves determining the difficulties that these women encounter and the quality of support available to help them grow and develop.

Objective 6.
Prepare women students for the labour market or graduate studies

This objective aims to help women in engineering to succeed, either via a transition to the labour market or graduate studies, first, by equipping them to integrate into a new environment and, second, by equipping employers and supervisors to welcome young women graduates onto their teams.

This structure was inspired by a similar approach adopted by the Commission de la construction du Québec published in 2015 under the title *Agir pour une mixité réel en chantier : une responsabilité partagée*.

1.2 Inter-university collaboration

Following the meeting and the data compilation, the CWSE team found that the work to be done in order to improve the recruitment of women engineering students was considerable. The CWSE, which has a Quebec-wide mandate, naturally saw the potential benefits of collaboration between academic institutions offering engineering programs, given that the challenge of women students' under-representation is not unique to the Faculty of Engineering at Université de Sherbrooke.

The idea of making an inventory of all current practices for recruiting, retaining and supporting the success of women students was thus established as a starting point. An inventory would enable the institutions to share information on the approaches that have been successful, but also those that have not.

To this end, the CWSE met with the Conseil des doyens d'ingénierie du Québec (CODIQ) to present the practice inventory project. Seven institutions subsequently agreed to participate out of a total of 11 schools, departments or faculties of engineering:

// Department of Mathematics, Computer Science and Engineering, Université du Québec à Rimouski;
// École de technologie supérieure;
// School of Engineering, Université du Québec à Trois-Rivières;
// Faculty of Engineering, Université de Sherbrooke;
// Faculty of Science and Engineering, Université Laval;
// Faculty of Engineering, McGill University; and
// Engineering Division, Université du Québec à Chicoutimi.

This group consists of institutions with different geographical, financial and even social contexts. As a result, the magnitude of practices inventoried under certain inventory measures may vary. Although the names of the participating institutions were disclosed, they asked, in a brief survey, to remain anonymous in terms of the actions taken at the various institutions. The practices will therefore not be associated with any particular institution, out of respect for this wish and these contextual differences.

1.3 Development of the data collection tool

The grid used to inventory the various recruitment, retention and academic support practices for women students was developed according to the objectives targeted following the first consultation at the Faculty of Engineering of Université de Sherbrooke. It is divided into six sections, one for each of the previously mentioned objectives. Each objective is broken down into several measures proposed by the CWSE. While some measures could have appeared under multiple objectives (e.g., the measure pertaining to women role models could be found in objectives 2, 3, 4, 5 and 6), they were assigned to a single objective each in order to avoid repetition (objective 3 in this case). The measures guided the institutions in classifying their concrete actions. If one of the actions could not be classified among the proposed measures, it was possible to add a measure under the appropriate objective.

MEASURES	The means suggested in the inventory to achieve the objectives.
CONCRETE ACTIONS	Set of current activities and initiatives for applying the measures.

For illustrative purposes, Table 1 shows the first part of the data collection tool. It contains the first objective, the associated measures, and a few initial examples to help the individuals concerned to properly fill out the tool.

Table 1
Data collection tool

OBJECTIVE 1: IDENTIFY THE CURRENT SITUATION				
MEASURES	WHAT ARE THE CONCRETE ACTIONS (ACTIVITIES OR INITIATIVES) AT THE FACULTY, SCHOOL OR DEPARTMENT? (e.g., description of an event, survey, report, analysis)	FREQUENCY? (e.g., once a month; once a semester; once a year; etc.)	WHAT PARTNERS OR RESOURCES ARE INVOLVED? (e.g., university, school, community or other partners)	COMMENTS ON IMPACT (e.g., perceived usefulness, positive or negative outcomes, areas for improvement, etc.)
1.1 Assessing the internal portrait of women students' situation	E.g., Report on undergraduate enrolment, dropout and graduation by discipline.	Yearly	// Registrar // Secretariat of the Faculty of Engineering	Useful for monitoring the situation
1.2 Assessing faculty, school or department positioning with respect to other Quebec and Canadian Universities	E.g., Comparison of the rate of women's enrolment by discipline at the faculty compared to other Quebec universities.	Yearly	// Bureau de coopération interuniversitaire (BCI) // Chair for Women in Science and Engineering in Quebec (CWSE)	Useful for understanding the local vs. provincial situation
1.3 Monitoring the integration of women students from the faculty, school or department into the labour market or higher educations				
Other measures? (please add any here). Add rows as needed…				

For each section corresponding to the different objectives, questions were asked in order to assess the implementation of current practices. The first column to be completed was for collecting activities or initiatives at the different institutions (e.g., description of an event, survey, report, analysis). Next, to get a better idea of the scope of each, a column of the grid was devoted to the frequency of these activities or initiatives (e.g., once/month; once/semester; once/year). Another column of the tool was used to identify the partners or resources involved in the activity/initiative (e.g., university, school or community partners).

The purpose of this information was to observe the importance given to an action. Finally, the last column of the grid was created to collect feedback on the impact of these various activities or initiatives (e.g., perceived usefulness, positive or negative outcomes, areas for improvement, etc.). Knowing the impact of actions generally helps to tell the practices that work well from those that do not in various contexts.

1.4 Procedure for collecting and analyzing practices

For each faculty, school or department participating in the inventory of recruitment, retention and academic support practices pertaining to women engineering students, a designated person was required to read over and complete the grid. The designated persons were appointed by the leadership of each institution. These individuals were members of the faculty, program administration, deanship or leadership of the engineering faculty or school.

The completed grid was then emailed back to the CWSE, which compiled all current practices in the summary tables presented in the "Practice inventory and findings" section of this report (see p. 16). Information that would have identified institutions has been removed or explained in such a way as to ensure data confidentiality.

Similar concrete actions, sometimes classified under different measures by the institutions, were grouped together. Some were shifted over to more appropriate measures based on the researchers' understanding of the information received, while others had to be withdrawn because of a lack of information.

Table 2 shows that, where actions were comparable, they were grouped together in a single item.[2] The examples following the items briefly list the activities included within the same statement. Next, actions addressed to all girls and boys were separated from those addressed to girls only, or that were particularly focused on girls. The words in bold therefore indicate the targeted groups for each activity, and a note in italics indicates whether particular focus is placed on girls in elementary or high school, or on women university students. This mention is necessary, since few of the inventoried activities are addressed only to girls or women students.

2 NB The tables do not show the total number of actions implemented by all the participating institutions. Rather, they show the different actions that the institutions put in place, i.e., an action can be implemented by a single institution or by several.

Table 2
Example from a summary table

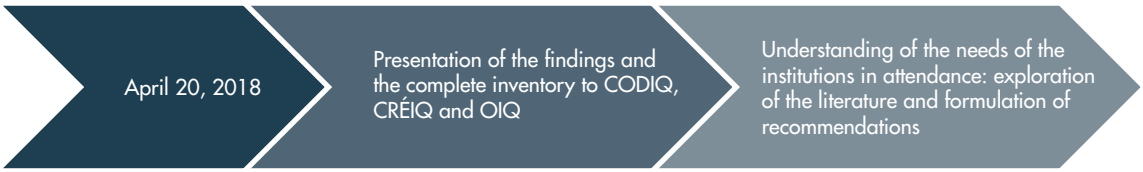
MEASURE IMPLEMENTED	WHAT ARE THE CONCRETE ACTIONS (ACTIVITIES OR INITIATIVES) AT THE FACULTY, SCHOOL OR DEPARTMENT? (e.g., description of an event, survey, report, analysis)	LEGEND
2.4 Conveying a welcoming image of the faculty, school or department for high school and college girls in the region	Production or revision of promotional tools targeting…	General item
	… girls and boys…	Targeted group
	… (e.g., videos and articles on student projects)…	List of actions
	* Special focus placed on girls (e.g., including materials related to events produced by and for women students, featuring women students in photographs, etc.)	Note designating mixed actions focused on girls

1.5 Development of the report

Collaborating for Greater Gender Diversity in University Engineering Programs

Following this analysis, the CWSE team met with CODIQ a second time to present the main findings. The Confédération pour le rayonnement étudiant en génie au Québec (CRÉIQ) and the OIQ were also present. During this session, a few questions were raised. Some had to do with ways of improving existing practices, for example when they are not appropriate for girls or women students. Others concerned some of the measures proposed in the grid that were less well known or understood, such as equitable education.

These questions gave rise to the project of writing this report, *Collaborating for Greater Gender Diversity in University Engineering Programs*. Indeed, although the practice inventory is useful in order to find out what is being done in other Quebec academic institutions and to find inspiration therein, the report responds to an even greater need: to understand what must be done and why. The aim of this report is therefore to provide ways forward, in the form of solutions and reflections.



To this end, the CWSE team first held a workshop in June 2018 at the Canadian Coalition of Women in Engineering, Science, Trades and Technologies (CCWESTT) conference in Edmonton, Alberta to collect the practices of other Canadian universities. The event brought together stakeholders from across Canada who encourage the advancement of women in science and engineering. Some of the practices collected will be mentioned in the second part of the report as examples that may inspire the creation of new practices or adaptations to existing ones.

Next, an exploration of the literature provided the opportunity to draw on research to support and explain the measures proposed in the practice inventory. This exploration was also an occasion to learn about practices established at other universities elsewhere in the world. Avenues for reflection and potential solution to facilitate recruitment, retention and academic support for women students in engineering faculties, schools and departments were thus included in this document. The second part of the report is the culmination of the exploration of the literature.

Finally, this review of the research on recruitment, retention and academic support for women students led to formulating recommendations. In December 2019, a third meeting with CODIQ was held to share preliminary recommendations. The recommendations were positively received, thereby validating the direction in which the practice inventory project had evolved in the last few years.

1.6 In summary

During the period 2017 to 2020, the CWSE team called upon multiple stakeholders in academia in order to draw up an inventory of current practices that would reflect the reality as closely as possible. However, this inventory cannot be considered exhaustive, since it is based on data provided to the best of the knowledge of the designated persons working in the participating academic institutions. As a result, some actions may not be inventoried. In addition, during this period, new circumstances, such as the updating of Canada Research Chairs (CRC) program requirements or the launch of the Government of Canada's Dimensions program and charter, prompted universities to put in place concrete action plans to improve the situation of women in science and engineering. Today's practices have therefore evolved since 2017. Nevertheless, this synthesis and exploration of the literature is all the more relevant in the current context with a view to meeting the challenges in the academic world.

CANADA RESEARCH CHAIRS PROGRAM

In 2017, the program published an equity, diversity and inclusion action plan to correct the under-representation of designated group members in the allocation of Chair positions and the selection of chairholders (Government of Canada, n.d.-a).

DIMENSIONS PROGRAM AND CHARTER

Launched in 2019, the Dimensions program and charter is aimed at transforming the culture in post-secondary institutions and research by fostering the values of equity, diversity and inclusion (Government of Canada, n.d.-b).

2. PRACTICE INVENTORY AND FINDINGS

The following pages present the results of the inventory of practices project carried out in collaboration with seven engineering faculties, schools and departments in Quebec in 2018. First, the general findings that emerged in the course of data analysis will be presented. Next, the specific findings and the summary tables for each of the six objectives will paint a portrait of the practices put in place to promote the recruitment, retention and success of women students.

2.1 General findings emerging from analysis of the practice inventory

When analyzing the data, it was observed that, in 2018, all participating institutions implemented at least one practice to improve recruitment, retention or academic support for women engineering students. This indicates a degree of awareness of the problem.

However, while the original intent was to collect actions designed for girls and women students (e.g., the *Les filles et le code* awareness campaign or the *Hats Off to You!* competition) as well as actions aimed at a mixed group with special focus on girls and women (e.g., selecting an ambassador of the faculty as a role model of women's success in engineering), it was found that the participating institutions added many mixed actions not geared toward any particular gender (e.g., career days). They were left in the inventory like the others, because generally speaking, little information was provided about the impact on the recruitment, retention or academic support of women engineering students.

Indeed, it was observed that, in the grids received from the participating institutions, the boxes related to frequency, involved partners and comments on impact were filled in only partially, or left empty. The purpose of these boxes was to identify the actions that were the most likely to bring about change according to each institution. However, they required data that might not have been available. This lack of information makes it difficult to assess the quality or relevance of the inventoried practices. For this reason, the summary tables presented in this report do not contain any information on frequency, partners and impacts, which was too incomplete to include. Moreover, this situation suggests that, in general, engineering faculties, schools and departments know little about or perhaps do not measure the impact of their actions, which prevents them from obtaining an overall picture of the situation.

Finally, a last observation that must be made about the practice inventory is that certain measures established by the CWSE were not associated with concrete actions. Some boxes of the grid therefore remain empty. The second part of this report will therefore explain, among other things, the relevance of giving importance to these measures in engineering institutions and of providing ways forward to remedy the situation.

2.2 Findings specific to each objective and summary tables

2.2.1 Objective 1: Identify the current situation

Two specific findings arise from analysis of the summary table (see Table 3) for this first objective. The first is that the actions listed under Measure 1.1 "Assessing the internal portrait" are mainly based on quantitative assessments of enrolment, recruitment, dropout and graduation. While this is an important basis, it is not sufficient to provide a complete internal portrait. Qualitative data, for example on the well-being, needs or difficulties of women students, would help better target the problems to be solved in order to improve their recruitment, retention and success in engineering. Qualitative research techniques, such as survey analysis and individual or group interviews (i.e., focus groups), would be relevant with a view to changing institutional practices (Da Silva, 2001).

The second finding is that only one type of action has been established in order to monitor women graduates' integration into the labour market or higher education (Measure 1.3) and it is focused only on the placement of women graduates. However, studies show that, even if the situation is gradually improving, it remains difficult for women in engineering to feel included in this predominantly male field, particularly on construction sites and in academic careers, according to Brière (2016). Leveraging a qualitative approach to monitor women students' integration would therefore shed light on whether tools, courses and continuing education, among other things, have properly prepared women students for the labour market or for higher education. It would also provide an opportunity to examine what needs to be done to improve the situation.

Table 3
Summary of practices for Objective 1: Identify the current situation

MEASURES IMPLEMENTED	WHAT ACTIONS (ACTIVITIES OR INITIATIVES) AT THE FACULTY, SCHOOL OR DEPARTMENT?
1.1 Assessing the internal portrait of women students' situation[3]	Diversity survey (sex, origin, language, degrees, etc.)
	Report on men and women's undergraduate enrolment by discipline.
	Report on the recruitment of women undergraduate students
	Compilation of data on women's undergraduate and graduate enrolment
	Report on undergraduate men and women's enrolment, dropout and graduation by academic discipline
	Report on men's and women's enrolment and graduation provided to Engineers Canada for the Engineering Enrolment and Degrees Awarded Report
1.2 Assessing faculty, school or department positioning with respect to other Quebec and Canadian universities	Involvement in provincial and national committees (e.g., Engineers Canada's 30 by 30)
	Participation in the National Council of Deans of Engineering and Applied Science (NCDEAS) annual resource survey
	Comparison of the rate of women's enrolment by discipline at the faculty, school or department compared to other Quebec universities
1.3 Monitoring the integration of women students from the faculty, school or department into the labour market or higher education	Survey on women and men students' placement * Special focus placed on women students (e.g., part of the survey devoted to following up on their graduate studies)

3 For this measure, the various reports and surveys have not been grouped into a single item, because according to the researchers' understanding of the information received about them, they all target different issues or groups of people.

2.2.2 Objective 2: Increase the interest of girls at all levels of education in bachelor's and graduate engineering programs

For this objective, two observations can be made. First, generally speaking, the table contains many elements, and concrete actions are associated with all the measures. This suggests that the issue of recruitment is taken seriously by the engineering institutions that participated in the inventory. However, out of a total of 24 different actions listed for this goal, 9 appear to target girls only and 4 seem to focus more particularly on girls (see Table 4). However, it is possible to adapt the actions already in place in order to reach more girls. According to a synthesis of 228 academic publications by Potvin and Hasni (2014), although boys' and girls' general level of interest in science and technology (ST) is similar in elementary and high school, there are notable differences when looking at different contents, subjects or disciplines. Human biology and health, for example, are recognized from the secondary level onwards as attracting more interest among girls than other fields such as engineering and computer science. Yet it is possible to spark the interest of girls in all knowledge areas of ST. A judicious selection of the contexts in which content is taught appears to have an important influence on girls' perceptions of scientific and technological concepts (Haussler & Hoffmann, 2002). Such a selection can be made without fear of losing the interest of boys, since the topics that are more interesting to girls are equally interesting to boys, if not more so, while the reverse is not necessarily true (Bruyère & Allaire-Duquette, 2013).

Next, the analysis reveals that measure 2.4 "Conveying a welcoming image of the faculty, school or department for high school and college girls in the region" shows the fewest actions for the 2nd objective. This is in spite of the fact that a greater variety of actions could improve girls' image of engineering. Indeed, the image projected by higher education institutions has been a strategic element for many years. A positive image of an institution can affect many facets including student enrolment, the recruitment of qualified personnel, and the financial resources provided to universities (Belanger & al., 2002). Importantly, universities evolve over time and their image must keep up with this evolution in order to reflect the features and fundamental values that put them on the map in an increasingly competitive market (Stensaker, 2007). Engineering institutions wish to accommodate more women students, but the images projected in websites, communications, scholarship criteria and photos, for example, do not always reflect this. The practice of including women in the projected image of an engineering program, department, faculty or school, so that girls perceive a more positive and welcoming image for them in engineering, would be deserving of greater consideration in order to improve recruitment.

Table 4
Summary of practices for Objective 2: Increase the interest of girls at all levels of education in undergraduate and graduate engineering programs

MEASURES IMPLEMENTED	WHAT ACTIONS (ACTIVITIES OR INITIATIVES) AT THE FACULTY, SCHOOL OR DEPARTMENT?
2.1 Supporting elementary and high school teachers with science and technology instruction	Supporting a faculty, school or department program or committee developing popularization tools for technology education at the elementary or high school level (e.g., Engineering Projects in Community Service - EPICS)
	Partnering with an external association or organization that supports teachers with course preparation (e.g., Association québécoise des jeux mathématiques - AQJM)
	Participating in a mentoring program for students and teachers (e.g., Robotique FIRST)
2.2 Demystifying engineering careers for girls in elementary school, high school and college within the region	Participating in one or more activities to demystify engineering and related careers with girls and boys (e.g., *Attraction chimique, École des protéines, Jeux photoniques, Montréal Relève – Mentor d'un jour, Classe techno, Projet découverte*, etc.) * Special attention placed on girls (e.g., pairing a girl with a woman university student or teacher during the mentoring activity)
	Participating in one or more Réseau Technoscience programs for girls and boys (*Les Innovateurs à l'école, Défi apprenti génie, Défi génie inventif ÉTS, Expo-sciences Hydro-Québec, Génitrucs*, etc.) * Special attention placed on girls (e.g., theme on women scientists)
	Participating in one or more activities to demystify engineering and related careers with girls and boys (e.g., *Les filles et les sciences, un duo électrisant!, Les Scientifines*, etc.)
	Partnering with a movement or campaign to demystify technology with girls (e.g., *Les filles et le code*)
	Creating and organizing one or more activities for girls (e.g., *Fan de sciences* immersion day camp)
	Visiting elementary schools, high schools and CEGEPs to demystify engineering and related careers (e.g., workshops, career days) among girls and boys
2.3 Promoting the faculty, school or department to high school and college girls in the region	Organizing a welcome day for high school girls (e.g., annual conference hosted by engineering students)
	Participating in a university tour of CEGEPs to promote the faculty, school or department to girls and boys
	Home university participating in open houses for girls and boys
	Scholarship awards for girls and boys in high schools or colleges or in certain engineering promotion activities or programmes * Special attention placed on girls (e.g., entry scholarships for applicants)
	Highlighting groups of women students in promotional materials to leverage them for recruitment purposes (e.g., supporting a women's mentoring program through *INGénieuses* for high school and CEGEP students)
2.4 Conveying a welcoming image of the faculty, school or department for high school and college girls in the region	Producing or revising promotional tools targeting girls and boys (e.g., videos and articles on student projects) * Special focus placed on girls (e.g., including materials related to events produced by and for women students, featuring women students in photographs, etc.)
	Showcasing graduates (women and men) in engineering program promotion tools (e.g., information cards distributed to high schools, written features, etc.)

2.5 Specifically targeting women students in promotion and recruitment	Putting together a dedicated website for the recruitment of women in engineering
	Awarding scholarships for girls in certain engineering promotion activities or programs (e.g., *FIRST, Défi génie inventif*, etc.)
	Promoting the role of women in engineering at various events (e.g., women ambassadors representing the faculty)
2.6 Promoting graduate studies to women undergraduate students	Making visits to final year bachelor's classes to introduce graduate programs to women students
	Providing materials on graduate studies through a dedicated website for the recruitment of women in engineering
	Organizing events for women students which highlight faculty research (e.g., Soirées des cycles supérieurs [graduate evenings]) * Special focus placed on women students (e.g., emphasizing the research of women professors as much as on that of men professors)
	Establishing a science popularization and innovation platform for women students (e.g., the Substance platform) *Special focus placed on women students (e.g., highlighting articles about technological advances made by women)
	Developing a communication strategy and a recruitment strategy to create positivity among women students (e.g., rebranding, institutional communications specifically for women, specific targeting of women in international pools where they are present in large numbers in engineering, etc.)

2.2.3 Objective 3: Create an inclusive, attractive and respectful environment for women students

This third part of the inventory includes the most measures. During the first consultation on February 27, 2017, most of the suggestions provided by the participants concerned women students' sense of inclusion and general well-being. These suggestions are the basis for the measures proposed in the summary table for this objective (see Table 5). It can therefore be concluded that this objective was especially important to the participants at the consultation. Two findings can be pointed out in light of the summary table.

First, no practices were classified for measures 3.2 "Fostering women university students' sense of belonging to their engineering program, faculty, school or department, as well as to the profession" or 3.7 "Promoting equitable education among management and faculty." Regarding measure 3.2, it may be tempting to assume that it is up to women university students to develop a sense of belonging to engineering, and simply, for example, encourage them to get involved in student life, committees or technical groups. However, why would they commit if they do not identify with these things, or felt uncomfortable or even unwelcome? Lewis & al. (2016) suggest that a sense of belonging in the fields of science, technology, engineering and mathematics (STEM) has a greater impact on women than on men. Women with a low sense of belonging appear to have a lower intention to persevere and a low retention rate even if they meet course objectives. Thus, since it is difficult to influence the sense of belonging in student activities, perhaps more should be done to reinforce it in the classroom, for example, identifying clues that perpetuate male culture stereotypes in certain discourse or openly approving of work and effort rather than attributing success to brilliance[4] (Lewis & al., 2016).

In addition, Measure 3.7 could help to improve women students' sense of belonging. According to the Ontario government definition, set out in its Policy 119 "Developing and implementing equity and inclusive education policies in Ontario schools" (2013), inclusive education can be summarized as follows:

4 Regarding brilliance, Leslie & al. (2015) found a correlation between gender distribution in certain academic fields and the skills that are said to be needed to study in these fields. For example, physics and philosophy, predominantly male fields, tend to be perceived as requiring innate abilities such as brilliance and genius. Other fields, such as molecular biology and psychology, which are generally more feminine, seem to be more strongly considered as requiring a lot of work and skills such as empathy. According to these authors, women are under-represented in areas where brilliance is perceived to be necessary, since the stereotype that women do not have this innate talent is still well entrenched.

> Board policies on equity and inclusive education are designed to foster a positive school climate that is free from discriminatory or harassing behaviour. A positive and inclusive school climate is one where all members of the school community feel safe, included, welcomed, and accepted.

Equitable education is believed to reduce barriers to students' learning and development and to their full potential to contribute to society (Government of Ontario, 2014). Some gender-based barriers can be identified and solutions provided in courses, for example, in order to better respond to the women students' interests and diminish difficulties they have been observed to encounter more often (e.g., spatial visualization) or to adapt courses and assessments to the specific needs that some women students may have (e.g., family/school balance). Promoting equitable education by providing training to faculty members or incorporating equitable education into an engineering institution policy would therefore be beneficial in improving the retention of women students.

Second, it is interesting to see that most of the actions listed under measure 3.3 "Eliminating potential sources of sexism and harassment" are institutional rather than engineering faculty- or department-specific practices. According to the findings of a 2018 report by the National Academies of Sciences, Engineering, and Medicine on the sexual harassment of women at universities in the United States, there are at least four main characteristics that create an environment with a higher risk of sexual harassment: 1) a predominantly male environment with men in positions of power and authority; 2) organizational tolerance for harassment behaviour (e.g., not taking complaints seriously, not punishing those involved, or not protecting whistle-blowers from potential retaliation); 3) hierarchical and dependency relationships between faculty and students/interns; and 4) isolated environments such as laboratories, field studies, and hospitals where those involved spend a significant amount of time. In such circumstances, victims of sexual harassment, whether gender-based harassment, unwanted sexual attention or sexual coercion, often do not dare to denounce what they are experiencing or have experienced, in order to avoid jeopardizing their relationship and, consequently, their advancement. Hence, implementing practices in high-risk environments such as engineering institutions should be a priority in order to reduce the possibility of sexual harassment.

Table 5
Summary table of Objective 3: Create an inclusive, attractive and respectful environment for women students

MEASURES IMPLEMENTED	WHAT ACTIONS (ACTIVITIES OR INITIATIVES) AT THE FACULTY, SCHOOL OR DEPARTMENT?
3.1 Welcoming women students to the faculty, school or department in an adequate way that fosters their integration	Having integration (initiation) activities supervised by the faculty, school or department so that women and men students feel welcomed by their peers (e.g., plan drafted and submitted for review by student services and security, post-initiation meeting and assessment of the activity, training program for organizers and supervisors of the initiations) * Special focus placed on women students (e.g., clear guidance on welcoming girls, particular consideration given to preventing sexual violence, etc.)
	Support for student group hosting activities to promote the integration of new women students (e.g., welcoming happy hour with Les INGénieuses)
3.2 Fostering women university students' sense of belonging to their engineering program, the faculty, school or department, as well as the profession	
3.3 Eliminating potential sources of sexism and harassment	Developing activities in collaboration with engineering student committees (e.g., forums on equity with the equity student committee)
	Establishing institutional and student committees to raise the awareness of women and men students (e.g., harassment prevention and resolution office, anti-harassment and violence committee, equity student committee, feminist committee, etc.)
	Establishing institutional policies for women and men students (e.g., anti-harassment policy)
	Partnering with an institutional awareness campaign targeting women and men students (e.g., Sans oui, c'est non!)
	Developing a prevention campaign unique to the engineering faculty, school or department and targeting women and men students (e.g., Fais la différence)
3.4 Offering information, support and assistance services to women students	Putting mentoring programs in place for under-represented groups in the student population (e.g., Faculty Equity Ambassadors program, student equity committee)
	Inviting specialized organizations to raise awareness among women and men students (e.g., Centre d'aide et de lutte contre les agressions à caractère sexuel – CALACS, Mouvement d'aide, d'information et de soutien – MAINS, etc.)
	Establishing resources to assist women students at parties or events (e.g. Sœurs jumelles [twin sisters] program)
	Establishing resources for the safety and support of women and men students (e.g., on-demand accompaniment to student residence)

3.5 Distributing information on the benefits of diversity to faculty, school or department staff and administration as well as students	Creating training and presentations for administrative and teaching staff to foster greater inclusion of women and men students (e.g., equity training, diversity training for individuals responsible for recruiting faculty)
	Promoting International Women's Day to women and men students (e.g., videos promoting the inclusion and the recruitment of women, awareness-raising through open discussions, etc.)
	Clear and transparent positioning of the administration with respect to faculty members and staff on the recruitment of women students (e.g., at gatherings and meetings, having open discussions on issues facing women, and possible solutions)
3.6 Raising awareness of unconscious biases, false beliefs and taboos among faculty, school or department administration, staff, and women and men students	Presenting principles of equity and unconscious bias to women and men students in engineering (e.g., in the introductory course to the profession)
	Introducing faculty members to the principles of writing letters of recommendation free of unconscious bias in order to show equivalent support for women and men students wishing to pursue graduate studies (e.g., various communications on the vocabulary to use)
3.7 Promoting equitable education among administrations and faculty	
3.8 Providing a welcoming physical environment for women students	Creating and adding decorative elements to make women students feel like they belong (e.g., mural featuring success stories of women [and men] who studied at the engineering faculty, school or department)
	Designing the environment in a spirit of openness and inclusiveness in order to provide a healthy and supportive environment for women and men students to study in (e.g., reading spaces, open and closed study spaces, break areas, etc.)
3.9 Providing female role models for women students	Graduate mentoring program for women and men students (e.g. Phonathon)
	Highlighting women and men student role models in the communications of the faculty, school or department (e.g., articles on student projects or individuals who stand out in their programs)
	Celebrating women and men with successful careers who graduated from the engineering faculty, school or department (e.g., faculty ambassadors) * Special focus placed on women (e.g., consciously choosing to appoint a female ambassador)
	Providing female role models among the faculty (e.g., establishing faculty recruitment measures based on diversity principles; developing programs for the retention of women professors; involving women faculty in female student activities)
	Organizing conferences to present staff and women and men students with female role models of success from different backgrounds (e.g., BRAVE interview, guest women researchers)

2.2.4 Objective 4: Prepare women students and their employers for positive internship experiences

Very few different actions were collected from participating institutions in terms of preparing women students and employers for positive internship experiences (see Table 6). Among other things, this may be explained by the fact that not all engineering departments, faculties and schools offer internships. Nevertheless, those that do offer internships should be more alert to possible issues for women students, because even though internships have many benefits for their professional development and are motivating experiences in general, women students still today feel the effects of gender bias. The preliminary findings of a study on engineering interns show that women students in bachelor's programs experienced challenges and obstacles during their internships, such as 1) the impression of having to prove themselves more or being "tested" more than male interns; 2) the impression that appearance and clothing during job interviews send a contradictory message to employers about their belonging in the field; or even 3) the perception that employee relationships with authority are more strained when women find themselves in supervisory positions (Deschênes & al., 2019a). These negative experiences may affect students' choice as to whether or not to pursue a career in engineering. Recognizing these experiences and putting in place means to monitor them would improve the response of those responsible for supporting women students during their internships. Engineering institutions would then be able to target more appropriate practices, such as activities to raise awareness of inclusion, diversity and the effects of a gendered culture in engineering, so as to prepare women students and employers for more positive internship experiences.

Table 6
Summary table of Objective 4: Prepare women students and their employers for positive internship experiences

MEASURES IMPLEMENTED	WHAT ACTIONS (ACTIVITIES OR INITIATIVES) AT THE FACULTY, SCHOOL OR DEPARTMENT?
4.1 Providing women students with internship preparation activities tailored to their needs	Producing educational materials and professional integration courses for women and men students (e.g., three mandatory courses, activities dealing with cover letters, resume and interviews, etc.)
4.2 Raising employers' awareness of the reception, integration and presence of women students in the context of internships	Organizing events to encourage connections between companies and women and men students in engineering (e.g., "career days")
4.3 Identifying the difficulties encountered by interns and the integration best practices established in businesses	Producing instructional materials to introduce women and men students to these difficulties (e.g., video clips)

2.2.5 Objective 5: Improve graduation rates for women students

In the initial grid submitted to participating institutions, two measures were proposed for this objective. A third was suggested by one of the participating engineering institutions, which increases the number of potential practices to support women students in their studies (see Table 7). However, few different actions carried out directly in faculties, departments or programs were listed in this part of the inventory. Although the recruitment and retention of women students is a very real emergency, one study has suggested that undergraduate science and engineering programs that focus solely on the recruitment and retention of women students are less successful in terms of women's graduation rates (Fox & al., 2009). This may be explained by the fact that these programs tend to see women's under-representation in science and engineering (SE) from a more individual perspective, focusing on the characteristics of the students that are thought to affect their participation and performance. For example, women students' low degree of self-confidence in mathematics can be seen as an individual barrier to pursuing a scientific career. Programs adhering to this vision may more strongly expect women students to adjust to the environment or, in other words, to "conform" and "adapt to the mould" of the dominant environment. They may tend to offer extracurricular activities for women students only, such as mentoring or skill development workshops, to respond to their shortcomings within the established system.

However, experts who have studied the under-representation of women in science and engineering tend to favour a more systemic view of the status of women in SE. Research by Fox & al. (2009) shows that science and engineering programs adopting an institutional perspective, i.e., focused not only on the recruitment and retention of women, but also on the structural changes to be made to the institution, are associated with more positive outcomes when it comes to women students' graduation rates. This view more strongly considers the characteristics of the environments in which women are educated and in which they work as the factors that maintain the under-representation of women in SE. For example, patterns of inclusion, exclusion, or even isolation in research groups, selective access to human and material resources, the portrayal of science and engineering as highly competitive fields, and potentially different assessment standards and practices for women compared to men may contribute to "eliminating" women from the curriculum. Programs that focus on this angle may tend to adopt new ways of teaching (e.g., equitable education), reform existing structures, and create links between programs and faculty members in order to support the faculty members in these changes.

Hence, engineering institutions may be more successful in attaining their graduation targets for women students when adopting an institutional and structural perspective. To this end, actions aimed at strengthening and improving women students' interest may be developed, while also creating an equitable environment for them at the academic, professional and social levels (Fox & al., 2009). This can take the form of activities included in the program that allow women students to develop new skills that they have not always had the opportunity to develop, unlike many of their male peers, due to gender bias in their education. For example, incorporating introductory programming courses or spatial visualization development workshops into programs may benefit struggling female and male students, though it would meet a greater need among women students. Continuing education and career-related activities that create a more inclusive environment may also encourage women students to persevere in engineering. Adding courses or training for all students on leadership, communication and negotiation, among other things, to a program may enhance the interest of women students and, by extension, of male students as well, while targeting skills often less acquired by the former even though these skills are essential in the engineering job market. UNESCO suggests that actions to improve women's motivation and interest help foster their engagement in STEM (UNESCO, 2017). Putting in place support measures tailored to the needs of women engineering students who are experiencing special difficulties would therefore be beneficial in fostering higher graduation rates. It should also be noted that some individual activities that are not included in programs, such as peer mentoring, may make women more comfortable in a male environment, since they can connect with other women, but can also isolate them more (Fox & al., 2009).

Table 7
Summary table of Objective 5: Improve graduation rates for women students

MEASURES IMPLEMENTED	WHAT ACTIONS (ACTIVITIES OR INITIATIVES) AT THE FACULTY, SCHOOL OR DEPARTMENT?
5.1 Providing women students with activities to promote their success in their engineering program[5]	Giving women and men students free access to resources and tools that will help them submit better work (e.g., French language help centre, mathematics help centre, psychological assistance, health and wellness, learning support, special needs, etc.)
	Setting up activities to develop 3D spatial visualization (which is often less developed in women than in men and which is statistically linked to success in engineering)
5.2 Providing support to help women students persevere in their engineering programs	Mentoring program for women students at different levels (e.g., POWE, Synapse)
Other measures? (please add any here). Add rows as needed…	
5.3 Offering financial support to encourage women students to persevere and continue their engineering studies	Offering scholarships for women engineering students (e.g., development fund scholarships, etc.)

2.2.6 Objective 6: Prepare women students for the labour market or graduate studies

In the summary table for the sixth and final objective of the inventory (see Table 8), it can be seen that the two measures initially identified were supplemented with two other relevant measures listed by participating institutions. This expands the pool of potential practices to improve the success of women students, even if, as in the case of Objective 5, few concrete actions were collected. It is worth pointing out that, depending on possible interpretations, certain actions taken under Objective 4 could have been included in this table, such as preparatory courses for the profession or career days, since the first two measures of Objectives 4 and 6 are similar. However, the actions were left in the boxes as they were provided by the persons responsible.

Indeed, measures 4.1 "Providing women students with **internship** preparation activities tailored to their needs" and 6.1 "Providing women students with preparatory activities for the **labour market** and **graduate studies**" are similar but correspond to different orientations. Measure 4.1 is focused on retention, since the internship experience can affect the choice of whether or not to stay in engineering, while measure 6.1 emphasizes the success of women students, since the labour market and graduate studies create difficulties that can slow down and even hinder their progress. This is also the case for measures 4.2 "Raising employers' awareness of the reception, integration and presence of

5 It should be noted that items in Objective 5 mention "women students" as a targeted group, as in almost all measures in the inventory. This does not automatically imply an individual perception of the issue. Structural actions more focused on women students were possible. However, this way of writing the items may have steered the answers of participating institutions toward this individual rather than structural perspective.

women students in the context of internships" and 6.2 "Raising employers' awareness of the reception, integration and presence of **women graduates and engineers**." While women students still face some gender-related internship challenges, research conducted in Quebec shows that women engineers also experience these challenges yet report being happy with their career choices and love their work. These challenges can include the presence of sexist behaviours or harassment, difficulty striking a balance between personal and professional life, the strong demand to demonstrate their value and skills early on in their career, or some employers' bias, which hinder women's progress in their careers (Deschênes & al., 2019a). For their part, the difficulties faced by women university professors in engineering are even more numerous. While the flexibility of their working environment and their passion for teaching contribute most strongly to their persistence in this career, other factors, such as hiring and recruitment, access to and integration into professional networks, as well as the distribution of work in departments, promotions and leadership roles, and the personal and professional life balance within a competitive environment, make progress more difficult for them (Deschênes & al., 2019b).

Hence, concrete actions to remove these barriers should be adopted by engineering faculties, schools and departments, especially those that do not offer work placements, as they are less likely to offer preparatory activities. Incorporating activities to raise awareness of equity, diversity and inclusion issues into academic programs (e.g., courses or training on unconscious bias, the benefits of diversity, etc.) should better equip women and men students to professionally respond to difficult situations they encounter, whether in graduate studies or in their future employment, and help them become ambassadors of change. In addition, facilitating and modifying recruitment practices in collaboration with businesses, industries and universities should enable women graduates to aspire to a more promising future less fraught with challenges.

Table 8
Summary table of Objective 6: Prepare women students for the labour market or graduate studies

MEASURES IMPLEMENTED	WHAT ACTIONS (ACTIVITIES OR INITIATIVES) AT THE FACULTY, SCHOOL OR DEPARTMENT?
6.1 Providing women students with preparatory activities for the labour market and graduate studies	Having a group work guidance program for women and men students (e.g., to raise awareness of group dynamics in the presence of members of minorities)
6.2 Raising employers' awareness of the reception, integration and presence of women graduates and engineers	
Other measures? (please add any here). Add rows as needed…	
6.3 Valuing women's technology entrepreneurship	Hosting and organizing events and meetings with women entrepreneurs from the technology industry (e.g., hosting Women Techmakers Montreal)
6.4 Offering labour market integration activities for women graduates	Establishing communities of practice for women and men graduates (e.g., to discuss issues, share best practices, develop new knowledge, etc.) * Special focus placed on women graduates (e.g., the community of women engineers)

2.3 In summary

The inventory of recruitment, retention and academic support practices for women students in engineering in Quebec has shed light on the current overall situation of engineering faculties, schools and departments. It is clear that a variety of actions are currently being implemented, and require different levels of effort and resources. Although engineering institutions have different geographic, financial and social contexts, it is possible to work toward improving the situation of women students according to the available resources and priorities of each.

Nevertheless, the above findings suggest that engineering institutions are ill-equipped to address the issue of women's under-representation. Indeed, the current lack of data does not allow them to fully grasp the situation of women students in their programs and to act in accordance with their real needs. On the recruitment side, actions rarely appear to be appropriate in terms of attracting the interest of girls, even though studies show that it is possible to interest them just as it is possible to interest boys. Similarly, communications are rarely adapted to speak to girls about engineering and programs. Yet the fact that more varied and targeted actions can change girls' image of engineering.

Other findings had to do with the retention of women students. First, no actions were listed under measures to create a sense of belonging and promote equitable education—measures that promote the inclusion of women students. Second, the actions taken to eliminate potential sources of sexism and harassment are institutional rather than faculty-based or departmental, in a context where engineering faculties and departments generally possess the characteristics of higher-risk environments. Third, very few different actions were collected from participating institutions in the way of preparing women students and employers for positive internship experiences. However, it has been shown that women students continue to experience difficulties because of their gender in certain workplaces.

Few actions were listed under the orientation of ensuring women's success. While many actions focus on recruiting and retaining women students, one study explains that actions should also be put in place that modify the current structures of programs in order to promote the graduation of women students. As stated earlier in this report, women engineers and professors continue to experience gender discrimination and that engineering institutions can take action by preparing women students for entering the job market or going on to graduate studies, as well as by raising awareness in the environments that welcome them.

The question now arises: What to do? The second part of this report sets out to answer to this question by detailing each measure in the inventory and presenting promising or proven practices from elsewhere in the world.

PART TWO

DISCUSSION AND EXAMPLES OF PRACTICES

This second part is a logical continuation of the data collection, inventory development, and findings set out in part one. For each of the measures that make up the six objectives, a justification of the relevance of the measure and some examples of practices from elsewhere will be presented where possible in order to help engineering faculties, schools or departments in Quebec to establish concrete actions within their institutions to intensify recruitment, retention and academic assistance for women students. It should be noted that these examples of practices come from an exploration of the literature which is non-exhaustive, given its broad scope. Also, some measures (e.g., 3.9 "Providing female role models for women students") may apply to more than one objective, but are associated with a single objective in order to avoid duplication.

1. IDENTIFY THE CURRENT SITUATION

The first step in order to increase, assess and improve recruitment, retention and academic support practices for women students in engineering faculties, schools or departments in Quebec is to sketch a portrait of the situation. This goal comes before all the others, given that it can help achieve all of the others, either individually or collectively. Indeed, identifying the state of play makes it possible to take the pulse of the situation and know the actions to take in order to meet all the objectives.

1.1. Assessing the internal portrait of women students' situation

As a first step, this measure raises awareness among managers and staff of ongoing challenges, as well as strengths and areas for improvement, and helps plan and prioritize actions to increase the number of women engineering students and make sure that they feel comfortable throughout their university careers.

To identify ongoing challenges, strengths and areas for improvement, the student population may be surveyed and interviewed. Surveys collect quantitative data (e.g., the percentage of women students whose choice of field of study was influenced by a family member), while interviews collect qualitative data (e.g., students' perceptions of their physical or psychological well-being).

Table 9
Examples of quantitative and qualitative results in order to assess the internal portrait of the situation of women students

QUANTITATIVE RESULTS	QUALITATIVE RESULTS
Workforce (e.g., gender representation, intersectionality)	Climate and psychological aspects (e.g., harassment, discrimination, domination, confidence, socialization)
Available resources	Available resources and their impacts
Success (e.g., graduation rate)	Impact of the environment on confidence and success
Integration into the labour market or higher education (e.g., placement rate)	First experience of integrating into the labour market
	Reasons for enrolling in higher education

Used in a complementary manner, these two methods make it possible to collect all the data desired in order to implement concrete actions which will help achieve the desired objective. The questions asked during this survey and interviews will make it possible to:

- // Identify recruitment methods that encourage women students to enrol in the field of engineering;
- // Establish retention methods that ensure the physical and psychological well-being of women students;
- // Define methods to help women students succeed; and
- // Adopt an intersectional approach,[6] given that immigrant and disabled women students, for example, more often face challenges as a result of double discrimination.

For instance, while its actions do not specifically target women, Toronto's Ryerson University (2019) has committed to conducting an annual self-identification survey of its student population and staff to comprehensively assess the composition of the university community. As part of this initiative, it publishes an annual statistical report, *Our Community, Our Diversity*, which provides a comprehensive picture of the diversity within the institution. The information in this report is then used to develop feasible, measurable strategies and action plans to improve the experience of everyone at the university. For a concrete example of a questionnaire used to draw up an internal portrait of the situation of women students, see the document *Exemple de sondage portant sur les pratiques de recrutement, de rétention et d'aide à la réussite*.

6 An intersectional approach is a method used to understand the points of intersection between different categories of an individual's identity, such as, among other things, gender, background, class, language, and disability status (Crenshaw & Bonis, 2005). These points of intersection create additional barriers for the people faced with them. For example, immigrant women and women with disabilities often face more barriers than non-immigrant women and women without disabilities. Moreover, women often face more barriers than men.

In order to guide action planning and prioritization, it is desirable to associate actions with objectives, targets and indicators. This is known as the objectivestargets-indicators triad (D'Auteuil, 2003). The triad is easy to put into practice. When an organization wishes to implement a change, 1) it expresses its intention through an objective, 2) it expresses the 'level' of the anticipated result through one or more targets, and 3) it measures the result obtained using one or more indicators and compares it with the target to evaluate progress toward achieving the objective (D'Auteuil, 2003). Measuring actions' impact helps to determine whether they will have the desired effect and to adjust them as necessary. This is why the objectives-targets-indicators triad is an approach to be promoted when aiming for change.

Table 10
Example of an objectives-targets-indicators triad

OBJECTIVE	Increase women students' sense of inclusion at the Faculty of Engineering

TARGETS	// At least 40% of women students feel properly included
	// 50% of women students feel somewhat included
	// At most 10% of women students feel poorly included

INDICATORS	Obtained from a survey, for example:
	// Percentage of students who feel properly included
	// Percentage of students who feel somewhat included
	// Percentage of students who feel poorly included

Also, from a change perspective, it is important to define a SMART objective (Government of Canada, 2017). SMART objectives are:

Specific (defined clearly and precisely);

Measurable (quantifiable);

Audience-specific (tailored to a target audience);

Realistic (achievable over time and with available resources); and

Time-bound (with a time frame and a deadline).

Example of a SMART objective

During a meeting with the people concerned, the administration of a faculty of engineering sets the objective of achieving a 30% female enrolment rate at the faculty within the next five years.

The goal is SMART in that it is:

// Specific: The dean clearly expresses the goal;

// Measurable: Each year, the data is quantifiable (rate of enrolment of women in the Faculty of Engineering) and can be compared with previous years in order to analyze progress;

// Audience-specific: Women;

// Realistic: The goal is realistic, as it is spread over five years; and

// Time-bound: The length is clearly defined.

1.2. Assessing faculty/school/department positioning with respect to other Quebec and Canadian universities

A university can assess its positioning itself by comparing its institutional practices with those adopted in other Quebec and Canadian universities. This approach helps self-reflect on practices, but also helps develop new practices inspired by those already established at other universities. Moreover, students can develop a notion of one university's positioning in relation to others when trying to choose a university or field of study. Promoting the university's best practices at events (e.g., open houses) or various platforms (e.g., website) is therefore a way for universities to inform prospective students so that they make a choice that fits their values.

In Europe, the Athena SWAN program is an example of university classification that encourages the promotion and success of women in science, technology, engineering and mathematics (STEM; Shen, 2019). To earn an Athena SWAN award, a university must apply to the program. Following a review of their application, they may receive a bronze, silver or gold medal. This recognition can positively influence the recruitment of students and faculty. Canada has been creating its own version of the Athena SWAN program with the Dimensions pilot program seeking to promote equity, diversity and inclusion in Canadian universities (Shen, 2019). However, unlike the Athena SWAN program, it is not exclusive to STEM fields (Shen, 2019).

1.3. Monitoring the integration of women students from the faculty, school or department into the labour market or higher education

Several studies (Brière, 2016; Lalancette & al., 2012; Rey & Battistini, 2013) have identified women's difficulties integrating into a traditionally male workplace. Indeed, at less than 20%, the proportion of women professionals in the field of engineering is low (Deschênes & al., 2019a). Some difficulties are related to the masculine character, "often seen as particularly macho", which remains associated with the profession and is less consistent with female ways of doing things (Rey & Battistini, 2013, p. 81, freely translated).

Another study (Szczepanik, 2007) reports that women students' negative experiences with teachers who leave them to their own devices can lead to a pejorative view of the subject matter and program. The fact is that, in some cases, these professors can play a role in diminishing academic perseverance and hindering the passage to higher education. However, the opposite is also true: the more positive their experiences are, the more women students tend to view the associated subject as interesting to them, thus helping along the transition to higher education (Szczepanik, 2007).

In Australia, the Australian Human Rights Commission and the federal government have established numerous measures to promote a healthier workplace for all women employees in traditionally male jobs (Australian Human Rights Commission, 2013). For example, when a woman leaves her job, she is invited to participate in an optional interview in order to understand the reasons for her departure. Also, women are asked to answer surveys where they can indicate what is working or not in the culture or policies of their work environment. These are open-ended surveys that allow for collecting much more detailed information. The

same kinds of measures could be applied to the job market and to universities in Quebec in order to find out why professionals or students leave their jobs or their education in the field of engineering. These measures will also help shed light on the working culture in companies and universities in the province.

Monitoring women students' integration into the labour market or higher education is therefore one measure for helping young graduates integrate into the labour market, but also for providing feedback to universities on the quality of courses and programs, or the relationships between women students and faculty. This feedback can be incorporated into a review of practices. Are these practices promoting women students' successful transition to a career in their field or to graduate studies? Are women students well prepared for their entry into the labour market or for a transition to higher education? To become an engineer, a bachelor's degree is the only possible educational route. This is why engineering faculties, schools or departments have a mandate to prepare students well for the difficulties they may encounter.

The following measure (not included in the inventory) is presented in addition to the measures already listed in order to best assist engineering faculties, schools or departments in Quebec to improve their recruitment, retention and academic support practices. It was inspired and developed following an exploration of the literature.

1.4. Analyzing the structure of programs offered in engineering faculties, schools or departments

A wide-scale national study (Fox & al., 2009) conducted in the USA on programs for women in science and engineering undergraduates concluded that the most successful programs[7] in terms of women's graduation rates focused more on institutional structures (e.g., the classroom environment). Conversely, the least successful programs focused more on women as individuals and on helping women students. In other words, the least successful programmes adopt a position of "supporting" the institution and women students, without challenging institutional structures and educational methods as in the more successful programs. The less successful programs should not be seen as useless, but rather as temporary or as a form of support for a deeper change that is underway.

To reach this conclusion, Fox, Sonnert and Nikiforova (2009) analyzed 49 programs designed to include women in science and engineering from 45 institutions across the United States to determine where they differed in their approach and response to women's issues in science and engineering. Hence, a structural examination provides insight into programs as organizational phenomena by highlighting both their potential and their limitations.

Clearly, there is an interest in analyzing the institutional structure of engineering programs (e.g., civil engineering, mechanical engineering, electrical engineering, mining engineering) within the various universities of Quebec to determine their strengths and weaknesses. To this end, the heads of engineering faculties, schools or departments could form advisory committees to analyze their program structures.

7 In the study by Fox, Sonnert and Nikiforova (2009), performance measurement was based on the difference in the graduation rates of women students before and after the creation of the program for women.

2. INCREASE THE INTEREST OF GIRLS AT ALL LEVELS OF EDUCATION IN UNDERGRADUATE AND GRADUATE ENGINEERING PROGRAMS

Girls' and women's interest in engineering are influenced by multiple overlapping factors, whether from an individual, family or peer-to-peer perspective, in school or in society. Research shows that the barriers faced by girls are not based on their cognitive abilities, but are more related to the socialization and learning processes in which they are educated and which shape their identity (UNESCO, 2017). Importantly, although girls generally express less interest in engineering than boys, their interest can be enhanced through various types of interventions. To increase female enrolment in engineering programs, the second objective is to attract girls at all levels of education to undergraduate and graduate engineering programs.

2.1. Supporting elementary and high school teachers with science and technology instruction

This measure can help increase and maintain girls' interest in these fields, and technology in particular. Indeed, the quality of teaching, including subject matter expertise and instructional skills, can significantly influence girls' participation and learning in SE. The attitudes, convictions and behaviours of women and men teachers and their interactions with students can also affect girls' choices in terms of their future studies and career (UNESCO, 2017). Women and men teachers act as role models for students. In its report entitled *L'enseignement de la science et de la technologie au primaire et au premier cycle du secondaire*, the Conseil supérieur de l'éducation (2013) noted the many challenges associated with teaching ST in elementary school: initial teacher education for elementary school has very few ST courses; this discipline is given little consideration in schools; and the limited teacher education in this subject area is reported to create a sense of incompetence and insecurity for many elementary school teachers. At the high school level, trainee teachers undergo much more in-depth training in ST, but ST teaching is hampered by the sheer number of school subjects. Furthermore, technology (engineering-related content in the high school curricula) appears to be considered the weakest point in initial teacher education: "many teachers consider themselves ill-equipped to teach the technological part of the curriculum" (p. 47, freely translated). Thus, while it is desirable for engineering institution initiatives striving to generate interest in engineering to directly target girls, training and support activities for technology teachers are also welcome. An American study recently showed that the majority of engineering awareness and promotion (outreach) programs and initiatives are aimed directly at pre-college students and few directly target

elementary and high school teachers (Barnes & al., 2017). These types of interventions with teachers, which should be carried out in parallel with those directly addressed to girls, nevertheless hold non-negligible potential since these women and men teachers teach many girls (and many boys) and are in contact with them in schools on a daily basis.

2.2. Demystifying engineering careers for girls in elementary school, high school and college within the region

Demystifying engineering careers among elementary and high school students, particularly girls, helps to bring to light the engineering tasks that could be of interest to girls. According to a study on ST interest conducted in 2013 with 2,628 Quebec elementary and high school students (Hasni & al., 2015), nearly half of the students answered that they "did not consider that they were very familiar with jobs that could be held after studies in ST" and "considered that natural talent was a requirement to complete studies that lead to a job in ST" (p. 75). Girls also reported a significantly lower intention of "learning more about jobs in ST" and "studying ST" than boys (p. 78). In addition, the findings of studies in which students are asked to draw an engineer (Draw-an-Engineer studies) generally indicate that boys and girls more strongly associate engineering with the male gender (Fralick & al., 2009; Knight & Cunningham, 2004). Moreover, girls who conform to these gender stereotypes associated with science and mathematics (men are better at mathematics and science) report and score lower grades in these areas (Nosek & al., 2009), a phenomenon known as stereotype threat (Delisle, 2008). Other studies show that students tend to view engineering as a physically demanding profession, associated primarily with fixing or manufacturing things, and as "boring" or "nerdy" (Cunningham & al., 2005; Powell & al., 2012).

These misconceptions, and sometimes even caricatures, can, however, be improved when students are exposed to diverse role models and realistic contexts that highlight the human dimension of the profession. This can include, for example, spotlighting the social, environmental or biomedical significance of engineering, or emphasizing the importance of creativity or teamwork. Indeed, careers are more likely to be of interest to girls when they highlight diverse experiences that connect with social issues, and provide opportunities for genuine research that involves real-world experiences as well as opportunities for experimentation, practice, reflection and conceptualization (Lyons, 2006).

The common thread in successful interventions is likely the way in which the field of engineering (and science in general) is approached and presented. In 2008, the National Academy of Engineering (NAE) published the report *Changing the Conversation*, which, based on extensive consultations with youth and the public, put out four messages that could further encourage young people to pursue a rewarding career in engineering. Among the many key findings, they note that, unlike engineering, the medical profession does not make itself known to young people by stressing that they will have to study organic chemistry or by focusing on the long and difficult path required to become a doctor. The image of physicians presented to young people is one of a person who heals disease and alleviates human suffering. Similarly, efforts to promote engineering should resonate with the hopes and dreams of future students and the public. This approach may have the added advantage of correctly promoting mathematics and science as two of the many skills and

dispositions necessary for success in the profession, such as collaboration, communication and teamwork. When girls were interviewed during these consultations, they found messages such as "engineering makes all the difference" and "engineering is essential to our health, happiness and safety" more appealing than "engineers find creative solutions to problems" or "engineers apply science to the real world."

Another avenue to consider in demystifying the field of engineering among young people (and among teaching staff) is distinguishing between the engineering design process and the scientific process. In Quebec's ST curricula, the two processes are distinguished, but the commonalities and differences between scientific and technological (engineering) processes are sometimes unknown to students and (women and men) teachers. Developing engineering activities in which girls are involved in a technology design process can help foster their interest and positively influence their attitudes toward engineering, starting in elementary school (Cunningham & al., 2019).

2.3. Promoting the faculty, school or department to high school and college girls in the region

There are many ways to make engineering studies and career opportunities known to girls. For example, camps and visits can encourage girls' interest in science by providing real-world learning opportunities (Levine & al., 2015). An American study found that students' attitudes toward and interest in science improved after a five-day camp on a campus where students participated in practical problem-based learning activities together with women and men professionals in SE (Mohr-Shroeder & al., 2014). Other researchers have concluded that summer activities have been successful in encouraging girls to take science and pre-engineering courses in junior and senior high school and to consider careers in SE (Veenstra, 2012).

Additionally, advising girls on their career choices is crucial in order to support their scientific education and foster a career path free of stereotypes (AMGEN, 2016; UNESCO, 2017). For example, the non-profit organization WomEng has produced informative brochures on educational institutions offering engineering programs, scholarship opportunities, and FAQs on engineering careers for high school girls. This type of material, coupled with access to counsellors who are familiar with SE studies and careers, can generate interest and encourage girls to choose careers in SE. These careers must be attractive to girls and counter notions that are sometimes common among them about the incompatibility of their skills, interests and background for a career path in STEM (UNESCO, 2017).

2.4. Conveying a welcoming image of the faculty, school or department for high school and college girls in the region

Every year, the Society of Women Engineers publishes an annual synthesis of more than 100 scholarly publications on the place of women in engineering. In 2017, based on recent studies, the report maintained that women's low representation in engineering arises from a constant daily reality where engineering is perceived as a typically male field pervaded by values considered to be less of a priority for women. It is not the result of a lack of skills or interest in this field (Society of Women Engineers, 2017). The image of engineering conveyed by faculties, schools or departments therefore continues to be a major aspect to consider in the promotion and recruitment of girls. Examples include the image of engineering programs put forward on institutional web pages or photos used to portray program activities. Do they feature women? Are promotional messages inclusive? What image do girls and their mothers perceive during their first visit to an open house? The research has also found that the need to belong and identify with one's chosen field of study leads to better grades and greater engagement (Master & al., 2014). Yet women find it more difficult to identify with SE than men and some feel that their academic identification with SE is incompatible with their gender identity (Master & al., 2014).

2.5. Specifically targeting women students in promotion and recruitment

Having access to inspiring role models of women who have successfully completed these programs is one way, among others, to target girls. This may be achieved by featuring images of girls and women (e.g., in photos, videos, promotional materials), but also providing mentoring opportunities. For example, mentoring programs have been found to generally improve women's participation and confidence in SE studies and careers (UNESCO, 2017). According to a United States study, high school girls who were mentored by female role models during summer activities showed greater interest in science and mathematics when presented with career opportunities in SE (Sadler & al., 2012). Another US study on an after-school mentoring program turned up an important association between the quality of the mentoring relationship and girls' self-confidence in mathematics (Holmes & al., 2012). Women and men mentors can also encourage girls to learn to improve their self-confidence, self-esteem and motivation, and to overcome their anxiety about assessments. They can also give advice on financial resources, such as scholarships, special programs, networks and employment opportunities, and help create ties with other girls and women who share a similar socio-economic background or ethnicity and who have encountered similar barriers in their SE careers (Bystydzienski & al., 2015). Ambassador activities can also bring women role models into contact with girls in elementary and high schools as well as colleges. For example, the L'Oréal Foundation and the French Ministry of Higher Education, Research and Innovation joined forces to create the L'Oréal-UNESCO Prize, which rewards "science ambassadors" who visit classrooms to act as role models in order to deconstruct prejudices around women in science (the L'Oréal-UNESCO Prize also exists in Canada in collaboration with NSERC; UNESCO, 2017). These efforts have reached more than 30,000 students in France to date. In 2015, 75% of the 2,000 students who participated said they were more interested in scientific careers after the outreach (compared to 46% initially).

2.6. Promoting graduate studies to undergraduate students

Few studies have been conducted on women's experience in engineering at the graduate level. Quebec data shows that engineering remains the field of study with the lowest representation of women at the master's and doctoral levels (below 30%; Belletête & al., 2019). A study conducted in the United States (Masterman, 2014) analyzed women's progress in doctoral studies by interpreting and comparing the experiences of 10 PhD students in education and 11 PhD students in engineering. After 63 in-depth interviews and two focus groups, several conclusions were made, including the suggestion that the culture of doctoral studies (in general) more closely reflects male gender patterns, such as independence and competition. The cultures of doctoral education (both in education and engineering) have been found to exhibit more male than female gender patterns, which explains why both groups of women perceived the environment of the doctorate as globally unfavourable to women. Counter-intuitively, some female gender patterns (e.g., flexibility, collegiality/collaboration) were more apparent in the doctoral culture in engineering, a traditionally male field, than in the doctoral culture in education, a traditionally female field. The study also found better experiences and progress for women engineering PhDs. Women in engineering reported more positive experiences and fewer barriers to graduation than women in education due to the nature of the financial support, the research structure and their relationship with the research supervision team. Finally, peer support is believed to be a significant factor in facilitating graduation. Women and men peers, especially advanced ones, were observed to be the primary source of support in both education and engineering, acting as advisors for women students who had difficult relationships with research supervisors. These findings demonstrate that, in addition to focusing on the possibility of financial support and quality research structures and guidance, greater emphasis should be placed on the social environment and peer support in research teams in order to effectively promote graduate studies in engineering among girls.

3. CREATE AN INCLUSIVE, ATTRACTIVE AND RESPECTFUL ENVIRONMENT FOR WOMEN STUDENTS

A commitment to creating an inclusive, attractive and respectful environment is, for engineering faculties, schools and departments, evidence of supporting women students. More specifically, this objective aims to retain women students by promoting their physical and psychological well-being.

3.1. Welcoming women students to the faculty, school or department in an adequate way that fosters their integration

From the first weeks, the transition into STEM fields is a challenge for women students (Ahlqvist, 2014; London & al., 2011). Their perception of whether they are "gender compatible" and in the right place, as well as the social support they receive and will receive, can predict women students' commitment, belonging, trust, motivation and retention in their program (Ahlqvist, 2014; London & al., 2011). Moreover, a study by Barbara Hogue (2013) highlights that the support offered from the outset by the members of the institution and peers has a major impact on students' sense of belonging, which, in turn, will influence their motivation. Thus, women graduate students, faculty, support staff and administration all have a role to play in countering the isolation and dropout of women undergraduate students.

To help welcome and foster the success of women students, it may be beneficial to set up integration activities or support groups in order to establish a formal and informal (social) network between them (Bohanna, 2016). Women question their own STEM abilities more than men (Lewis & al. 2017), which explains why creating support groups can help them develop their self-confidence. Also, inclusive writing that promotes, among other things, the use of neutral wording in lesson plans, for example, can reinforce women students' sense of being positively welcomed at the institution (Université de Sherbrooke, n.d.).

3.2. Fostering women university students' sense of belonging to their engineering program, the faculty, school or department, as well as the profession

Sense of belonging[8] is a strong predictor of success, motivation, engagement and retention in a program (Ahlqvist, 2014; Lewis & al., 2017). Furthermore, perceptions of gender compatibility and social support received can predict engagement, belonging, motivation, confidence and retention in a STEM program (London & al., 2011). This is why it is valuable to foster a sense of belonging among women students in engineering programs. Indeed, it seems to be an effective way to encourage their retention. As mentioned by Monique Hayden Matelski (2016), STEM institutions should promote and facilitate mutual support and listening between women and men students in order to reduce dropout and strengthen a sense of belonging to programs. Positive interactions can take different forms, such as forming a community of learning to discuss and find solutions with peers. It can also help to offer workshops where more experienced students can discuss the challenges and problems they faced following their arrival in order to highlight the solutions and resources that can help on their journey. Quality of interactions is a strong predictor of women students' success, given that being understood and listened to and knowing that others are also facing the same problem leads women students to develop a stronger bond with the STEM community (Matelski, 2016) and reduces doubts about their belonging in the program (Walton & al., 2014). Group belonging has been found to be more important than sense of self-efficacy[9] for women compared to men in predicting persistence in STEM programs (Lewis & al., 2017). What is more, research (Brière, 2016) on traditionally male professions has found that women working for example in the inspection world wish to continue working in the field even if they sometimes experience gender-based discrimination, because they feel listened to and supported.

3.3. Eliminating potential sources of sexism and harassment

Several studies (Bergeron & al., 2016; Kuchynka & al., 2018; National Academies of Sciences, Engineering, and Medicine, 2018) show that eliminating potential sources of sexism and harassment against women promotes their academic success. Bergeron & al. (2016) published the research report Violence sexuelles en milieu universitaire au Québec, which is the outgrowth of a wide-scale survey (9,284 students) on harassment and sexism in university settings in Quebec. It does not specifically focus on the field of engineering, but rather on all university programs taken together. The report uncovers that 33.5% of college students had experienced sexual harassment since their arrival at university by someone affiliated with that university (e.g., derogatory remarks about a person's appearance, body, or sexual activities; p. 27, freely translated).

8 Sense of belonging is defined as a subjective feeling associated with being integrated and accepted as a legitimate, valuable member in a given setting (Lewis & al., 2007).

9 If-efficacy refers to an individual's belief in or sense of their being able (or not) to perform a task in a given context (Bandura, 2003).

This percentage breaks down into 37.1% women, 22.9% men and 54% gender minorities.[10] Of all women and men students who experienced sexual harassment, 60.5% did so in their undergraduate studies. The results also show that 89.7% of those who committed the harassment were identified as men and 26.9% as women.

Additionally, as mentioned in a report by the National Academies of Sciences, Engineering, and Medicine (2018) and described in section 2.2.3 on the inventory of practices and findings (see p. 22), the main characteristics that create a higher risk of sexual harassment among women are: 1) a predominantly male environment with men in positions of power and authority; 2) organizational tolerance for harassment behaviour; 3) hierarchical and dependency relationships between faculty and students and interns; and 4) isolated environments such as laboratories, field studies, and hospitals where those involved spend a significant amount of time. These main characteristics and the statistically significant results of the previous research beg the question: Might sexual harassment be a primary cause of women students leaving the field of engineering?

Finally, considering that sexism is a verbal form of sexual harassment (Commission des droits de la personne et des droits de la jeunesse du Québec, n.d.), one study (Kuchynka & al., 2018) answers this question by noting that sense of belonging can be diminished if women are exposed to various gender-based stereotypes in STEM programs, and that this may even lead to women students dropping out. The same study reveals two types of gender stereotyping:

- // Hostile sexism, manifesting in insulting jokes, making women feel inferior, or ignoring their contributions (e.g., a man showing disgust for a colleague's physique);
- // Benevolent sexism, which manifests in treating women as if they cannot meet the difficult challenges of STEM or lack the traits of common STEM personalities and are ill-suited to a competitive environment (e.g., a man not allowing a woman to lift a heavy object in the laboratory on the pretext that she might hurt herself).

Men tend more strongly to adopt benevolent sexism rather than hostile sexism toward women (Poole, 2014). However, in the presence of benevolent sexism, women's cognitive performance can be impaired and their self-efficacy, engagement and performance, diminished (Poole, 2014). These two studies clearly demonstrate the importance of investing in measures to eliminate all forms of sexism and harassment in universities in Quebec and particularly in engineering schools, faculties or departments where women are under-represented.

10 For the purposes of the research report ***Violences sexuelles en milieu universitaire au Québec***, the term ***minorités de genre*** or "gender minorities" refers to participants who did not answer that they were men or women; trans people; and non-binary people (Bergeron & al., 2016).

3.4. Offering information, support and assistance services to women students

Research by Hogue (2013) has shown that the support and assistance services offered by institutions and peers increase women students' sense of belonging and self-efficacy. In particular, the author explains that support provided by faculty members and peers, who were available to listen and discuss respectfully about difficulties encountered in classes, personal problems and career goals, helped build a sense of belonging that increased motivation and led to greater success (Hogue, 2013). Accordingly, as soon as women students arrive at the engineering faculty, school or department, it is beneficial to inform them of where they can go to find various helpful resources in order to counter isolation and potentially prevent their dropping out of engineering (Hogue, 2013). It may also be beneficial to designate faculty members as resource persons to listen to students in need and refer them to the right resources.

3.5. Distributing information on the benefits of diversity to faculty, school or department administrations and teaching staff and students

More and more efforts are being made to value diversity in Quebec's university settings. For example, the creation of the Réseau québécois en équité, diversité et inclusion (RQÉDI) in recent years demonstrates this desire to promote diversity among the entire university community. What is diversity? According to Langelier and Brodeur (2020), "diversity refers to a group of individuals who possess different characteristics by virtue of their identity, geographical, cultural or religious background, age, sex, gender, sexual orientation, discipline, etc." (p. 9, freely translated). There are many potential benefits to leveraging gender diversity. Some of these benefits have been listed by the Regroupement des groupes de femmes de la région de la Capitale-Nationale (RGF-CN; 2016). The presence of women is said to encourage a more relaxed working environment. In addition, thanks to certain qualities (e.g., consistency, speed and thoroughness) that are more developed in women due to their different socialization, the presence of women may have a motivating effect on male coworkers. The presence of women is also reported to promote increased productivity, as they see problems differently than men, thus yielding multiple perspectives and a variety of solution avenues. Occupational health and safety may be improved, as women have been found to tend to make greater use of the tools at their disposal to facilitate their work and, in so doing, advocate for safe working methods, which would have a positive impact on the rest of the staff. Beyond the benefits reported by the RGF-CN, there are numerous studies showing that the presence of women in typically male workplaces can spark and advance creativity and innovation. For example, in a study (Díaz-García & al., 2013) in Spain, a survey on innovation was conducted among 4,277 companies. Data analysis showed that gender-diverse research and development teams produced more breakthrough innovations than other teams. For more information, see *Introduction à l'équité, la diversité et l'inclusion en enseignement supérieur et en recherche : Quoi et pourquoi?* or these pamphlets on diversity in the field of engineering

3.6. Raising awareness of unconscious biases, false beliefs and taboos among faculty, school or department administrations, staff, and women and men students

Unconscious biases,[11] false beliefs and taboos are at the root of many ideas that give a false image of reality, such as when women are said not to be as good at science and engineering (Lebel & Bergeron, 2019). According to Lebel and Bergeron (2019), these false beliefs are the result of cultural inertia, i.e., the tendency among staff members and the student community to think and act a certain way. To counter these misconceptions, the first step is to raise awareness and educate staff and students about unconscious biases, false beliefs and taboos, as many are unaware that they have them. To this end, the Canada Research Chairs (CRC) program has made available a Training module on unconscious bias on its website, free of charge. The *Réseau québécois en équité, diversité et inclusion* (RQÉDI) has also made available free training on its website on unconscious bias and recruitment. It is desirable for this training to potentially prompt a realization both individually (e.g., staff and students) and collectively (e.g., the organizational culture at the faculty) so that women feel welcomed and respected in all fields and especially in engineering where they are under-represented.

3.7. Promoting equitable education among administrations and teaching staff

Equitable education[12] is reported to help students feel included in their academic environment. One study (Hogue & al., 2010) suggests that all faculties, schools or departments can support equitable education in the classroom by focusing on interventions to enhance students' self-efficacy as well as on inclusive pedagogy[13] in which all teachers encourage university students to recognize their own skills. The study adds that in order to achieve equitable education, teachers must:

- // Cultivate optimistic relationships with women and men students;
- // Stress women's belonging in STEM fields;
- // Practice non-critical responsiveness;
- // Value multiple perspectives; and
- // Focus on the breadth of knowledge.

For its part, a study by Parson (2014) relates how, in a context of diversity, students from under-represented groups were more engaged when teachers used active teaching strategies such as collaborative learning and provided immediate feedback using more formative evaluations.

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11 An unconscious bias or prejudice "is an implicit attitude, stereotype, motivation or assumption that can occur without one's knowledge, control or intention. It is a result of our life experiences and affects all types of people" (CRC, 2018). Unconscious biases affect many spheres of life such as sex, culture, age, language, institutions, etc. (CRC, 2018)

12 Equitable education "aims to correct inequalities unjustly affecting certain students or other members of the educational community in order to strive for genuine equality" (Larochelle-Audet & al., 2020, p. 6, freely translated).

13 Inclusive pedagogy "prescribes a transformation of institutions in order to allow all individuals, in and with their differences, to be able to contribute" (Potvin, 2013, freely translated).

3.8. Providing a welcoming physical environment for women students

Engineering faculties, schools and departments often evidence a gendered institutional culture that forces women to conform to a version of success defined by male standards. Indeed, when women students enter the science and engineering buildings, they find walls plastered with photos of mostly male personalities who were the pillars of SE faculties. Moreover, the lounge areas are furnished with entertainment that corresponds to the tastes of boys, such as table soccer games. Cheryan, Plaut, Davies and Steele (2009) conclude that the physical environment (e.g., images, photos, furniture) can reinforce male stereotypes and deter women from pursuing these fields. The study suggests that exposure to more images of women who have marked SE can help women students project themselves into these fields and continue their academic journey.

For her part, Poole (2014) suggests also looking at the environment from a security standpoint. Universities have a mandate to provide a safe environment for all their students. For example, are the paths between buildings and parking lots well-lit and properly maintained? The two above-cited studies show that women students' physical environment has an impact on several spheres (identification, well-being, and security), and that each sphere is a priority in order to encourage the retention of women students in engineering.

3.9. Providing female role models for women students

The more female role models there are, the lower the belief in gender stereotypes (Bohnet, 2016). Indeed, when women students rub shoulders with female role models that they can identify with, it has a positive impact on retention and helps reduce stereotypes about women. This is why supplying female role models for women students is important in order to create an inclusive, attractive and respectful environment in engineering faculties, schools and departments in Quebec.

In one study (Parson, 2016), observations of men and women teaching in various faculties (arts, humanities, social sciences and natural sciences) indicated that they taught in a different way. The presence of women at the faculty appears to have a positive impact on the learning of all students since women teachers are more likely to use inclusive teaching and active learning methods. Women teachers are also more responsive to feedback, value participation and give more feedback to all students. As a result, students interact in the classroom four times more (by answering questions) in courses given by women than in those given by men (Parson, 2016).

In a different vein, several research projects mention that mentoring, in which a more experienced person guides a less experienced person or group, helps foster retention, sense of belonging, trust and academic success, not only for women, but also for under-represented groups (Bohnet, 2016; Dennehy & Dasgupta, 2017; Drury & al., 2011). Dennehy and Dasgupta (2017) furthermore argue that a shared identity (same sex) is a form of positive reinforcement in terms of retention in an engineering program. Indeed, women teachers are role models with whom women students can identify. One of the factors that can lead to cultural change within institutional departments and faculties is achieving a critical mass

of 15% under-represented groups, including women, within a student population (Parson, 2016). In other words, a critical mass of 15% women in engineering faculties, schools or departments in Quebec helps transform certain gender stereotypes and reduce inequalities between men and women.

In the USA, the National Science Foundation (NSF) established the "Advance" program in 2001 to foster the representation and advancement of women in academic careers in science and engineering (NSF, n.d.). Building on numerous partnerships, the actions undertaken support the development of innovative strategies to foster organizational change and improve gender equity in higher education institutions and the broader STEM community, including non-profit organizations. This program enabled an NSF research team to develop tools for institutional leaders wishing to create an institutional environment supportive of women's success (Laursen & Austin, 2014). The NSF identified strategies among which institutions can choose and adapt to their context. The leadership of Quebec universities can draw inspiration from these strategies to increase the representation of women professors (female role models) in engineering faculties, schools or departments. The strategies listed are:

// Establish faculty professional development programs for all teachers;
// Give more grants to women faculty members;
// Create mentoring and networking activities;
// Appoint and train institutional women leaders;
// Encourage inclusive recruitment and hiring;
// Establish equitable processes for promotion;
// Strengthen accountability for gender equity and diversity within the institution;
// Offer flexible work schedules;
// Support dual career couples;
// Develop strategies for improving departmental climate (e.g., improve communication or transparency in decision making);
// Organize activities in which at least 50% of visiting scholars are women; and
// Take measures to enhance visibility for women as academics, teachers and leaders in STEM disciplines, and to address women's issues.

4. PREPARE WOMEN STUDENTS AND THEIR EMPLOYERS FOR POSITIVE INTERNSHIP EXPERIENCES

Several universities in Quebec offer internships to students, in business and university settings. In all cases, despite the many benefits, there are also issues related to internship experiences that are often greater for women students than for male students (Powell & al., 2009). The aim of this fourth objective is, first, to equip women students to work in a predominantly male environment and, second, to help employers make their workplaces more inclusive in order to facilitate the integration of women students.

4.1. Providing women students with internship preparation activities tailored to their needs

While it is recognized that the presence of one or more internships in a university program has various positive impacts on women and men students (Andrews, 2018), studies have also shown that women engineering students can have more difficult experiences. While internships are opportunities for students to validate their choice to pursue their studies and begin a career in engineering, adapting or targeting activities to prepare them for the difficulties they may face could make their experiences more positive.

Powell, Bagilhole and Dainty (2009) interviewed 26 women engineering students in the UK and analyzed their behaviour and attitudes in internships. The findings show that many of them use acculturation strategies to secure the recognition of their male colleagues such as acting "like one of the boys," accepting some gender discrimination, or over-representing the benefits of adopting an "anti-feminine" approach in engineering. Another American study suggests that even if women students do well in engineering, their lack of confidence in their ability to perform the roles expected by this profession, or professional role confidence, can significantly lower the likelihood that they will persist in their studies and careers in this field (Cech & al., 2011). Professional role confidence refers to confidence in one's own ability to successfully fulfill the roles, competencies and identity features of a profession. Research has shown that women and men develop different degrees of confidence in their professional roles in areas strongly dominated by a given gender. In engineering, professional role confidence may be better cultivated in men than in women, which would decrease the likelihood that women graduate and pursue a career in engineering (Cech & al., 2011).

Fifolt and Abbott (2008) interviewed some 100 women and men engineering students and showed that women students face additional challenges in internship environments compared to men students. These challenges appear to be primarily associated with a lack of role models, being subjected to unconscious bias on the part of supervisors, and isolation. In the United States, Seron, Sibley, Cech and Rubineau (2015) tracked 40 women and men engineering students across four academic institutions from start to finish using logbooks completed by the students themselves on a bimonthly basis. The synthesis of their study results indicates that women students tend to have fewer opportunities for internship practice, are more often assigned support roles, and are more likely to be perceived by colleagues as having less experience in engineering. For women, an internship seems to be one of the primary experiences that leads them to doubt their integration into the professional

engineering culture. Indeed, internship experiences are a key factor in the persistence of women engineering students. Women students in the United States reported that exposure to male role stereotypes, isolation at work, sexual harassment, and generational differences in women's roles in engineering played a role in their decision of whether or not to pursue engineering (Kuntz, 2009).

Internship preparation activities are available for interested (women and men) students. In particular, it is worth pointing out the existence of Co-operative Education and Work-Integrated Learning Canada (CEWIL Canada), i.e., the Canadian association for co-op education and workplace learning, which publishes best practices, resources and reports on internships and co-op education on its website. Among other things, some of the resources cover job postings, mentoring and career development.

4.2. Raising employers' awareness of the reception, integration and presence of women students in the context of internships

Raising the awareness of employers may also help along women students' integration into internship settings. The job interview is the student's first point of contact with her internship environment, giving an indication of how she will be welcomed and integrated into the internship. On this subject, the UK law firm Thomas Mansfield interviewed (women and men) graduates about the worst question they had ever been asked during a job interview (Hurst, 2018). Here are some answers from the women graduate interviewees: "What do you think about dating someone in the office?" "Are you planning on having children soon?" "Can you wear more make-up next time?" and "Can you flirt with customers to make them stay longer?" The law firm mentions that these issues are inappropriate and illegal (Hurst, 2018). The women graduates' answers clearly show that gender issues remain pervasive in the labour market and that women students in engineering are likely to encounter similar questions or comments during their internship interviews.

In research on women students' experiences with internships in the Quebec context, one student's statement confirms the need to make employers aware of the presence of women students in the field of engineering, especially with regard to judgments around physical appearance:

> We have more pressure in terms of our appearance in a job interview […] If you're in a production environment, you want to look good at your interview, but they will say to themselves that she won't be welcome at a dirty factory. (Deschênes & al., 2019a, p. 121, freely translated)

This popular belief, that women do not want to get dirty compared to men, is also fueled by the presence of unconscious biases in employers.

Male, Gardner, Figueroa and Bennett (2018) argue that university institutions and employers can improve the culture in engineering workplaces, better prepare women and men students for mixed workplaces, and help them reflect on the impacts of this culture

during and after their work experience. Among other things, the Centre d'intégration du marché de l'emploi (CIME) in the Estrie region offers organizations the opportunity to raise awareness of gender diversity in employment and to support them in taking action to promote gender balance at their businesses.

4.3. Identifying the difficulties encountered by interns and the integration best practices established in businesses

As part of their research in Australia, Male & al. (2018) interviewed some 15 women and men engineering students in depth. Their findings indicate that engineering students experience a gendered culture in the workplace from their first internships. Girls receive gender-specific attention (e.g., changes in men's behaviour due to their presence) and receive requests related to stereotyped expectations of their gender (e.g., secretarial role for girls). Women students experience a marginalization of stereotypical female interests (e.g., co-workers congratulate a male co-worker on playing a sport, but show no interest in a girl's volunteer activities), perceptions of work / personal life incompatibility (e.g., assumptions that work must be full-time, without any scheduling flexibility), and greater difficulties on worksites than in offices (e.g., sexist remarks or jokes). In research on student internship experiences in the Quebec context, one women student corroborates the presence of this gendered culture at work:

> In terms of the work, I thought I would arrive and it would be: "Alright, let's split the tasks equally." But some guys were saying, "I have a technician background, I'm taking the technical side; you're a girl, go be the secretary." (Deschênes & al., 2019a, p. 120, freely translated)

This statement shows how, within internship environments specific to the field of engineering, a distinction is sometimes observed between the tasks of women and men students, as if there were masculine (technical) and feminine (administrative) tasks. Yet all students follow the same academic curriculum and should have comparable internship experiences.

Other research has also shown that women find it more difficult to negotiate their professional identity in engineering (Hatmaker, 2013). Moreover, some women students "in their internship settings have been able to observe and analyze situations illustrating issues of relationships to authority," as in the case of this women student:

> When you become a boss, it bothers people. Because almost all the employees are men, and it bothers them to have a woman as a supervisor. But it's not because we're in engineering; it's [a matter of] the relationship to authority. (Deschênes & al., 2019a, p. 121, freely translated)

Hence, if the goal is to make engineering more inclusive, it is not enough to increase the number of women; the workplace culture itself must be changed (Faulkner, 2009).

To identify the difficulties encountered by interns and integration best practices established in businesses, engineering faculties, schools and departments in Quebec can have students undergo surveys or interviews. For more on these methods, see the first objective of this report.

5. IMPROVE GRADUATION RATES FOR WOMEN STUDENTS

In *Des femmes dans des mondes d'hommes : regard sur l'expérience scolaire et apports d'une perspective féministe*, Sylvie Fortier describes the journey of Marie-Claude, a women student:

> Marie-Claude is studying to become a power line technician. A single parent, she was looking for training that would make it easy to find a job and secure good working conditions. But above all, Marie-Claude likes challenges and she liked the idea of working at high elevations. But after more than a year of training, she is now questioning her choice. She breaks down and cries in front of her teacher. She wonders if she should just give it all up, since she no longer feels she has the strength to put up with the comments of her male colleagues and being excluded. (Fortier, 2014, p. 5, freely translated)

This student's journey demonstrates "that once they have crossed through the door, women still face many hurdles and their professional integration is anything but smooth" (Fortier, 2014, p. 9, freely translated). The issues they might face include exist jokes, harassment, the constant obligation to prove themselves, and isolation (Fortier, 2014). Today, there is still "a strongly stereotyped institutional culture" in schools in Quebec (Fortier, 2014, p. 5, freely translated). Not only are women still under-represented in the field of engineering in the province, but sometimes they can also be excluded and mocked by their colleagues. Many universities invest time in boosting engineering enrolments, but they also have a responsibility to do what they can to make structural changes to support women students' success (Fox & al., 2009). Some actions have already been put in place in a number of engineering faculties, schools and departments in Quebec to promote the graduation rates of women students. These actions focusing on women students' progression and success include organizing activities to support women students in their academic progress.

5.1. Providing students with activities to promote their success in their engineering program

Holding activities for women students promotes their success in their engineering curriculum by providing access to resources, tools and contacts that they draw on when they need them. In his study, Steven J. Spencer assessed "the potential impact of expectations of success, anxiety, and self-efficacy" in women within the field of mathematics (Delisle, 2008, p. 14, freely translated). The results showed that "anxiety is a possible mediator between stereotype threat and performance" (Delisle, 2008, p. 14, freely translated). In other words, some women may perform less well when they experience anxiety in a

situation characterized by stereotype threat.[14] Based on this finding, it can be inferred that female engineering students may perform less well than male students due to the presence of stereotype threat and anxiety. In this case, women students need to be supported and reassured about their abilities. Ryerson University in Toronto has developed a *Cuddles with Our Therapy Dogs* activity where students can participate in a therapy session with a dog to relieve their stress and anxiety (Ryerson University, n.d.). For its part, the Massachusetts Institute of Technology (MIT) in the United States founded the Margaret Cheney Hall in 1882 in recognition of the many women who have traditionally been deprived of their own safe space, particularly in STEM fields (MIT, n.d.-b). Today, the Margaret Cheney Room is a living space reserved for all groups that are confronted with gender-based oppression systems (women, transgender women, non-binary individuals, etc.; MIT, n.d.-b). Events are organized to connect participants with resources pertaining to health, well-being, leadership, networking and education (MIT, n.d.-a).

Harvey Mudd College in California found that there were fewer women students (10%) in technology than male students (90%; Zomorodi, 2014). To correct the situation, in 2006, Maria Klawe, the college president, put in place actions to encourage women students to enrol in technology programs and make sure that they truly enjoy their experience (Zomorodi, 2014). For example, she changed a course title from *Introduction to programming in Java to Creative approaches to problem solving in science and engineering using Python*. This change was rooted in a desire to make the course more accessible through the use of words such as "creative" and "problem solving." Moreover, Python is a more practical coding language than Java. Maria Klawe's goal was achieved, as 40% of technology students who subsequently enrolled at Harvey Mudd College were women (Zomorodi, 2014).

Finally, several studies (Agogino & Hsi, 1995; Sorby, 2009; Uttal & al., 2013) have shown the difficulties often experienced by women students when it comes to spatial visualization development. Boys appear to be considered to have better spatial skills than girls, but this seems likely due to family environments that provide boys with more opportunities to practice these skills (Hoffman & al., 2011). Although not all studies on this topic confirm gender variations in spatial skills (Zhang & al., 2014), researchers argue that language, spatial and arithmetic skills—like other cognitive skills—are flexible and can be significantly improved with experience (Reilly & al., 2016). Research (Sorby, 2009; Uttal & al., 2013) has also shown that women and men students who improve their spatial visualization skills have a higher rate of engineering perseverance than those who have low spatial visualization skills and do not improve their skills. These findings justify organizing activities to evaluate all students' spatial visualization skills and then offering workshops to those who need them. These 3D visualization workshops allow students to improve their skills and to persevere in their studies in engineering.

14 Studies dealing with stereotype threat show that "the negative social reputations sometimes assigned to individuals, in addition to denigrating their identity, can lead them to adopt behaviour that validates these reputations in the eyes of all parties" (Desert, 2004, p. 34, freely translated). This mechanism also contributes to "maintaining social inequality" (Desert, 2004, p. 34, freely translated).

5.2. Providing support to help students persevere in their engineering programs

There is much research attempting to explain the determinants of student success and persistence, and "many indicate that the pedagogical practices of teachers, parenting style, and socioeconomic background play an important role in students' academic success" (Delisle, 2008, p. 2, freely translated). Engineering faculties, schools and departments cannot act on parenting style or students' socio-economic context. What about the pedagogical practices of faculty? As already mentioned in the third objective, equitable education is a means of nurturing self-efficacy in women students, but it is also a pedagogical practice that helps women students persevere in their engineering programs (Hogue & al., 2010). For example, men faculty and supervisors often provide informal mentoring (e.g., laboratory visits) that women students frequently do not have access to because of the similarity bias by which individuals naturally gather into groups of similar people. In equitable education, all students enjoy the benefits of this informal mentoring offered by faculty or research departments. This is why the shift from informal mentoring to formal mentoring is to be favoured, for example, by developing a mentoring program adapted to the different needs of the student community.

Also, research (Delisle, 2008) shows that there are many factors, including the presence of negative stereotypes about women and the difficulty of reconciling studies and family, that affect women students' motivation and self-confidence in science and engineering programs in universities. First, to counter the presence of negative stereotypes toward women students, exposure to more female role models is a good solution. Female role models are references when it comes to the skills needed and the strategies to be adopted (Delisle, 2008). As also mentioned in the third objective, women faculty members are more supportive of students than men faculty members (e.g., they give more feedback; Parson, 2016). Second, for students with children, Parson (2016) suggests that institutions create policies and mechanisms that are favourable to motherhood and allow a balance between studies and family life. For example, some universities offer flexible hours for parents or caregivers or free cafeteria meals for children. Larivière and Lepage (2010) mention that providing a "mobile" daycare (a person who goes to the home if the child is sick so that the parent can, for example, take an exam) or installing refrigerators for breast milk are also good ways to support student parents.

5.3. Offering financial support to encourage women students to persevere and continue their engineering studies

A UNESCO report mentions that offering scholarships and grants increases women's representation in science and engineering (Huyer, 2015). Specifically, it states that to encourage women to move into a science or engineering career, "that approaches to this problem need to change", and providing scholarships and grants is an approach to be encouraged (Huyer, 2015, p. 102). For example, the Canadian Engineering Memorial Foundation awards one undergraduate scholarship per year to a woman student enrolled in the Bachelor of engineering degree in Quebec. Also, worth mentioning is the Hats Off to You! contest and its Excellence in Science segment, which encourage girls who are heading into traditionally male professions by giving out numerous scholarships each year ranging from $2,000 to $5,000, for a total sum of nearly $160,000 (Gouvernement du Québec, 2020).

The following measure, not included in the inventory, corresponds to Measure 1.4 which suggests conducting an analysis of the structure of programs offered in engineering faculties, schools and departments. Indeed, this analysis helps identify the strengths and weaknesses of programs and then to focus on changes to improve them..

5.4. Changing the structure of programs offered at engineering faculties, schools or departments

The findings of the study by Fox, Sonnert and Nikiforova (2009) described in Measure 1.4 suggest that a "key ingredient of successful programs [for women in science and engineering] is that they consciously and strategically position themselves within the structure of their institution and work toward systemic transformation and change" (p. 348). Thus, they focus on factors related to the institutional context. In light of these findings, following an analysis of the structure of their programs, those in charge of engineering faculties, schools and departments in Quebec can concentrate on structural changes to promote the success of women students and help ensure greater numbers of women graduates in engineering. The same study (Fox & al., 2009) sets forth three recommendations:

1. **Redefine a program's issues, problems, and solutions in organizational terms:**
   Some individually based activities, such as peer mentoring, may make women feel comfortable, but keep them isolated. Mentoring can lead to isolation, as women students find themselves outside the normal academic setting. Activities that focus on building an integrative environment for women students by connecting them to continuing education and careers in the field may be the solution in terms of promoting persistence (e.g., workshops with faculty, or undergraduate research projects).
2. **Build supportive programs that connect the students to the larger environment and involve collaboration and alliances:**
   Strategic alliances involve partnerships with industry and alumnae that provide women students with financial support and connect them with ongoing opportunities. Women student-faculty research and interaction, and hands-on engineering or technological activities as well as courses on gender, culture and science, are also potentially important.
3. **Assess effectiveness to ensure accountability and to document the program's success:**[15]
   Leaders and administrators often seek justification that a program is making a difference. These types of inquiries put pressure on program directors to identify and select effective activities that are able to deliver positive results. A program's survival may indeed depend on its ability to demonstrate its impact.

The same study found that program directors in the most successful group in terms of female graduation were more likely to mention difficult or even negative aspects of their work, expressing accumulated frustration in terms of changing faculty attitudes that may be biased against individuals in under-represented groups. This finding points to the fact that faculty involvement is essential in order to be able to reform programs deemed to be less effective.

15 In the article by Fox and colleagues (2009), this recommendation echoes Objective 1, which mentions the importance of drawing up an overview of the current situation.

To demonstrate the effectiveness of focusing on the institutional context, Dartmouth College reported that it was becoming the first institution in the United States to graduate more women engineers (54%) than men engineers (46%; Braibant, 2017). To explain this success, the Dean of the Faculty, Joseph Helble, mentioned that the college has "been able to attract more students, and especially women, by letting them use their creativity to solve real-world challenges" (Braibant, 2017, freely translated). Thus, these changes in teaching methods have succeeded in promoting women's success in engineering.

6. PREPARE WOMEN STUDENTS FOR THE LABOUR MARKET OR GRADUATE STUDIES

After graduating, women graduates may encounter a number of barriers, either to their integration into the labour market or to their pursuit of graduate studies. Frequently cited barriers include the need to build credibility and also to obtain the approval of peers and sometimes even male faculty (Rey & Battistini, 2013). This is in spite of the fact that, according to a UNESCO report (Huyer, 2015):

> Companies and institutions are increasingly aware that a diverse labour force will improve their performance and enable them to reach more segments of their target customer or client base or relevant stakeholders. (p. 99)

This being the case, why do women graduates continue to encounter barriers? Measures are already being taken to help along young women's integration into employment or higher education. However, these measures have not yet succeeded in removing the barriers that these graduates may encounter. This it is why it is recommended, as a first step, to prepare women students for entry into the labour market or for graduate studies by equipping them for their integration into a new environment and, as a second step, to equip employers to welcome young graduates into their team.

6.1. Providing women students with preparatory activities for the labour market and graduate studies

The objective of this measure is to better equip future engineers to deal with the barriers they may encounter after obtaining their bachelor's degree and to facilitate their transition to the labour market or graduate studies (ECAMT, n.d.; Macdonald, 2018). To this end, work-integrated learning (WIL)[16] is an increasingly promoted means of enabling all students to be in contact with the realities studied, to stimulate their abilities and to improve their skills in their field through cooperative education[17] (ECAMT, n.d.; Jamieson, 1994). It places the student in various hypothetical situations or preparatory activities for the job market and

16 Work Integrated Learning (WIL) or on-the-job learning is "a model and process of curricular experiential education which formally and intentionally integrates a student's academic studies within a workplace or practice setting" (ECAMT, n.d., freely translated).

17 Co-operative education consists of alternating "academic terms and paid work terms" (ECAMT, n.d., freely translated). The student thus participates "in several co-op work terms back-to-back" (ECAMT, n.d., freely translated).

graduate studies. Academia, businesses and the federal government are aware of the added value of WIL in training students (Macdonald, 2018).

In fact, in 2017, the "federal government announced the creation of a new $73 million program to create 10,000 new paid internships over the next four years" (Macdonald, 2018, freely translated). To better equip future engineers to respond to the barriers they may encounter in the job market or during their graduate studies, one study showed that understanding the scientific research process, developing basic laboratory skills, and maintaining students' interest in science all improved when students participated in research experiments from their first year, which influenced their decision to pursue or not pursue STEM studies and a career in this field (Richardson, 2008). Moreover, the Chair for Women in Science and Engineering in Quebec (CWSE) has created training on leadership and on communication. These two trainings aim to help women graduates progress in the job market as well as in the pursuit of their studies by developing their communication and leadership skills.

6.2. Raising employers' awareness of the reception, integration and presence of women students in the context of internships

The working conditions that women face in the field of engineering are sometimes difficult, a fact probably related to the gendered culture that continues to predominate (Deschênes & al., 2019a). Indeed, some women are victims of gender discrimination in the field of engineering (Deschênes & al., 2019a; Powell & al., 2009). Some employers even "simply refuse to hire women" (Beeman, 2011, p. 68, freely translated). Hence, raising employers' awareness of the reception, integration and presence of women in engineering may help them better understand the potential barriers that women may encounter in traditionally male occupations and the potential benefits of gender diversity in the workplace. Employers would then be better able to establish a course of action (e.g., change in organizational culture, work-family balance) and to facilitate the integration of future women engineers upon completion of their university studies (Deschênes & al., 2019a; RGF-CN, 2016). However, this measure does not seem to be widespread among Quebec universities and businesses. Outside of academia, there are organizations, such as the Centre d'intégration au marché de l'emploi (CIME) for the Estrie region, which offer advisory services to employers to help them change their organizational culture and promote gender diversity in employment.

6.3. Valuing women's technology entrepreneurship

Women's entrepreneurship faces many socio-cultural barriers (stereotypical image of women, difficulty taking risks, work-family balance and access to business networks) as well as structural barriers (stereotypes, access to financing and lack of knowledge of different paths; Roy-Blais, 2018). Importantly, promoting women's entrepreneurship in technology can help introduce young women to the world of entrepreneurship in general and encourage them to become entrepreneurs if they so wish. This is also the goal of Women Techmakers (s.d.) which "is a program created by Google to highlight the talent of women in technology" (freely translated). Specifically, this community initiative "aims to promote talented and passionate women, increase the visibility of the Montreal technology community, and honour and empower women in technology" (Women Techmakers, s.d., freely translated). This program takes place annually in 52 countries and features more than 200 global events (Women Techmakers, s.d.). Every year, in Montreal, a multitude of speakers converge from around the world to celebrate women's talent in technology. This positive image of female entrepreneurship shows that it is possible to succeed as a woman. Organizing events and meetings between women entrepreneurs from the technology industry is a recommended way to encourage women's entrepreneurship in this field.

6.4. Offering labour market integration activities for women graduates

It is known that "entering the labour market is as fundamental a turning point as is one's choice of education" (Arena, 1986, p. 46, freely translated). Indeed, starting a first job can be a significant source of stress for many young women graduates and can shake their self-confidence (Lewis & al. 2017). Young women engineering graduates may experience even greater stress, as some "feel they need to prove themselves more than their male colleagues" at the risk of losing their jobs (Deschênes & al., 2019a, p. 121, freely translated). Establishing communities of practice (e.g., discussing issues, sharing best practices in developing new knowledge) for women and men graduates may help to ease the university-job market transition. In fact, the Ordre des ingénieurs du Québec (OIQ) has set up a "mentoring for women engineering students" pilot project to support Engineers Canada's 30 by 30 initiative, which seeks to raise the percentage of women among new members to 30% by the year 2030 (OIQ, n.d.-b). More specifically, the project is intended to offer young women wishing to become engineers support in earning the title of engineer. Also, since April 1, 2019, the Ordre des ingénieurs du Québec (2019) has replaced its juniorate program with an "engineer training access program." It is geared toward current junior engineers, new and future engineering graduates who wish to enter the profession, and employers. Thanks to this program, candidates will have a closer relationship with the order along their journey to join the profession (OIQ, 2019). They will also have access to support tools (e.g. guides, interactive platform, training), as well as a more personalized approach (OIQ, n.d.-a). The program will furthermore enable professional engineers to better share their expertise and knowledge with candidates to help them along in their development (OIQ, 2019).

PART THREE
RECOMMENDATIONS

The inventory of practices to promote recruitment, retention and academic success has helped draw attention to practices that need to be added or improved. The following recommendations are an outgrowth of the findings set out in part one of the report and are based on the exploration of the literature discussed in part two. The 14 selected recommendations are broken down in line with the structure of this document, i.e., current situation, recruitment, retention and success.

Recommendation 1:

That the administrations of engineering institutions set up means by which to qualitatively and quantitatively measure and assess women students' inclusion and well-being in order to better understand the situation internally and to establish action priorities.

Recommendation 2:

That institutional administrations undertake an analysis of the structure of their respective engineering programs with a view to making structural changes that will have more long-term impacts on the recruitment, retention and success of women students.

Recommendation 3:

That engineering faculties, schools and departments adopt a more welcoming image of engineering and their programs for girls by adapting their messaging and communications to this end.

Recommendation 4:

That institutions invest effort in promotional activities and content that are more relevant to girls and women students in order to increase their interest in engineering programs as well as in graduate programs.

Recommendation 5:

That institutions foster mutual support and listening in order to help create a sense of belonging among women students to the institution, the program and the profession.

Recommendation 6:

That engineering faculties and departments deploy their own measures to eliminate potential sources of sexism and harassment, given that their environment corresponds to a high risk level for this type of conduct.

Recommendation 7:

That administrations and committees encourage and promote equitable teaching and inclusive pedagogy among teaching staff by providing related literature or training.

Recommendation 8:

That engineering faculties, schools and departments, as well as internship services, have the means to recognize and monitor the problems that women students encounter because of their gender.

Recommendation 9:

That engineering institutions and internship services sensitize employers in industry and academia to inclusion, diversity, and the effects of a gendered engineering culture by providing related resources and tools.

Recommendation 10:

That engineering institutions include educational activities enabling women students to develop new skills complementary to the profession of engineer in order to better equip them to advance in their graduate studies or to facilitate their integration into the labour market.

Recommendation 11:

That engineering institutions provide measures to assist students who are experiencing difficulties with integration, organization, learning, etc.

Recommendation 12:

That engineering institutions include educational activities to raise awareness of equity issues for students in their programs.

Recommendation 13:

That engineering institutions, in close collaboration with teaching staff, introduce structural changes to promote the success of women students and help ensure greater numbers of women graduates in engineering.

Recommendation 14:

That engineering institutions, in collaboration with employers, modify recruitment practices for women graduates and promote their inclusion in the labour market.

CONCLUSION

Although there has been a movement toward greater representation of women in science and engineering over the past 30 years, and many associated efforts have been made to increase women's presence in these fields, they continue to be under-represented in Quebec universities. This being the case, how might it be possible to intervene to promote their recruitment, retention and success? This three-part report has attempted to answer this question for the field of engineering—which has the fewest numbers of women students of all university disciplines (and across all engineering sub-disciplines). For the years 2005 to 2019, women accounted for only 22% of undergraduate students. However, the project described in this report could be transposed to CEGEPs, scientific fields, and graduate studies.

Part one of this report presented the different steps involved in designing the inventory, followed by the practices collected and the main findings. Among other things, it explained how the project initially took shape in 2017 during a meeting between members of the CWSE and members of the community of women students, professors and professionals at Université de Sherbrooke. After some reflection, following this meeting, the members of the CWSE considered that it would be favourable to draw up an inventory of practices already established in Quebec universities in order to bring them together, share them and promote collaboration between institutions. And indeed, the practices collected from the seven participating universities show that there is a real awareness of the situation of women in the field of engineering, and an institutional desire to increase their presence.

Part two presented the objectives and measures in more detail, under the three orientations of women students' recruitment, retention and success. More specifically, an exploration of the literature and examples of practices elsewhere helped explain the relevance of the objectives and measures. For example, the annual statistical report Our Community, Our Diversity published each year by Ryerson University in Toronto emphasizes the value of assessing the internal situation of students and then developing actions to improve everyone's experience at the university.

Part three consisted of formulating 14 recommendations to enable Quebec universities to develop a strategic plan to improve women's representation in the field of engineering and to ensure that women students feel included and respected. There is no obligation to apply all the recommendations within the same institution. To select the recommendations that should be prioritized in order to implement actions, it is strongly suggested to start by examining the current situation of the institution in question. Subsequently, to ensure the success of each action, it is essential to follow up and adjust as needed.

The purpose of this report is to develop more appropriate actions to promote the recruitment, retention and success of women students. This purpose specifically applies to the field of engineering, in the hope that it will become more equitable and welcoming for women. The Chair for Women in Science and Engineering remains available to support engineering faculties, schools and departments in making decisions and implementing actions.

Here's to the success of all women students!

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