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Equity, Diversity, and Inclusion Strategies in Engineering and Computer Science

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Abstract: This article delves into the issues of equity, diversity, and inclusiveness (EDI) in the engineering disciplines in Canada and Spain and presents the challenges faced by underrepresented individuals and ways to promote an inclusive and diverse environment. Two strategic lines are identified: (a) facilitating university education access to underrepresented and minority groups and (b) guiding such students during university training to set them up for successful future careers. Accordingly, this article shows how the strategies mentioned above are implemented in some selected Canadian and Spanish universities, clearly distinguishing the approach taken in the two countries. In Canada, there is a more decentralized approach to addressing EDI issues, wherein the universities devise their agendas independently. In Spain, on the other hand, there is a stronger and more direct involvement of the government to ensure a comprehensive, system-wide approach to tackling EDI issues in academia. This article helps education policymakers to devise and implement pragmatic strategies for achieving EDI and the relevant UN-defined sustainable development goals.

Keywords: equity; diversity; inclusion; strategies; priority areas

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1. Introduction

In the ever-evolving landscape of engineering, the pursuit of innovation and progress relies not only on technical expertise but also on the cultivation of a diverse and inclusive community. Equity, Diversity, and Inclusion (EDI) issues have emerged as focal points in the engineering discipline, exposing the need for change within educational institutions, workplaces, and professional organizations. As two countries known for their significant contributions to the field, Canada and Spain find themselves confronted with similar EDI challenges within their engineering disciplines, although these challenges present themselves in distinct ways as a result of social and academic cultural differences. As the demand for sustainable and ethically conscious solutions intensifies, it is imperative to address the systemic barriers and biases that hinder the full participation and representation of marginalized groups. Recognizing the need for a more inclusive and representative industry, stakeholders from academia, industry, and governing bodies are actively seeking to address and overcome the systemic barriers that hinder diverse participation and impede equitable opportunities. This article aims to delve into the EDI issues prevalent in the engineering disciplines in Canada and Spain, shedding light on the common obstacles faced by underrepresented individuals and highlighting potential strategies to foster a more inclusive and diverse engineering community in these nations. By understanding the shared challenges and drawing inspiration from successful initiatives, we can pave the way for a future where EDI thrives, unlocking the full human potential for better engineering that ultimately helps advance our societies.

2. Methodology

While EDI challenges are prevalent in many sectors, this work focuses on a literature review on EDI-related issues in Engineering education, followed by an environmental scan of the EDI-related programs and initiatives conducted at Engineering faculties in universities across Canada and Spain. The literature review began with academic database searches for keywords such as "equity", "diversity", "inclusion", "discrimination", or "barriers" followed by the base term "engineering education". After an initial scan of these papers, a list of themes was created to note the dimensions of students' identities which commonly served as the basis of their discrimination (e.g., race, gender, income). Additional database searches were completed where the dynamics of each of these dimensions in Engineering education were researched further using the appropriate keywords. An environmental scan of the EDI initiatives was conducted separately by two teams of researchers in Canada and Spain. This included creating a list of Engineering Faculties at major Canadian and Spanish universities, consulting the websites for each respective Faculty (where one exists), and scanning faculty and departmental EDI policies. For major universities where a dedicated EDI page or policy in the Engineering Faculty could not be found online, such as McMaster University in Ontario, the researchers contacted the administrators of the faculty to obtain a status check or ask questions directly about the EDI initiatives. The inclusion criterion for the environmental scan is the existence of an EDI initiative or policy that is dedicated to the Engineering Faculty of the institution.

3. EDI Issues Prevalent in Engineering Education

Despite an ever-increasing demand for STEM and computer science workers, a concerning number of students in these disciplines leave the field before finishing their degree, sometimes citing discrimination and unwelcome environments [1]. Only around half of students enrolled in these programs actually graduate with the degree [2]. Underrepresented minorities (URM) are disproportionately represented in this group. EDI is inextricably connected to the retention of URM students, as the promotion of diversity and inclusivity in the institution facilitates a sense of belonging for them [3]. Diversity can be defined as having people from different socio-economic backgrounds working together, and inclusivity can be defined as creating a welcoming community which allows for its members to have opportunities for growth and productivity [1]. The challenges faced by underrepresented and/or equity-seeking groups in Engineering academia are multi-faceted and often intersectional in nature. Nonetheless, the common themes found in relevant academic literature have been grouped into domains of race, gender, and socio-economic status.

3.1. Race

The lack of representation and retention of racialized students in Engineering programs is well researched [4–9]. Students in racial minorities have often reported experiencing biased interactions from their peers [10]. Biased interactions can lead URM students to hold lower perceptions of inclusivity and belonging in these programs, which unfortunately can push these students to change majors or leave academia entirely [10]. A US nationwide survey conducted in 2001 found that the level of technological preparedness in college freshmen varied significantly by race and class [11]. These disparities pose a barrier to students' academic success [12]. In particular, a recent study has found that the low rates of URM enrollment, academic success, and retention in computer science majors are caused by a lack of experience studying computing before entering college, lack of exposure to programming, and the poor promotion of these majors to the community [13]. Black and Hispanic students reported finding difficulty in applying theory from their classes due to having few opportunities for pre-college STEM preparation [14]. The students tied this lack of adequate preparation to coming from unfunded schools in which they were not given much exposure to computing, nor were they adequately taught about the importance of time management and studying. This gave URM students a distinct disadvantage as they had to "catch up" to their Caucasian and Asian peers while simultaneously taking on a

rigorous course load [14]. It also impacted how these students viewed themselves with respect to their peers, which is discussed in the Section 3.5 in this work.

Another significant barrier to racial minorities in engineering is a lack of representation in the student body, the faculty, and their own families. When URM students see a sufficient number of same-race peers, it can provide a feeling of acceptance and belonging in the academic community [1]. It can explain why students who have mentors with a similar racial/ethnic background, or who go to minority-serving institutions, report a greater interest in their field [1]. Conversely, a lack of same-race peers has caused some URM students to internalize the notion that it is rare for someone who looks like them to succeed in STEM [14]. URM students set up an expectation of being isolated when they enter the field due to this lack of representation. To this end, having diversity in faculty members also impacts the students' sense of belonging, as the student may feel more comfortable approaching faculty members with similar lived experiences [14]. Finally, students can feel isolated from their racial/ethnic communities as they may feel that they can either be a member of that community, or an academic, but not both. Some URM students are reluctant to consider engineering as a career option due to not having family members or members in their social circle who are in that field [15]. Further, when they do choose engineering or any other field where there is low representation, the students often feel burdened by the pressure of having to "represent" their race and adopt a "prove them wrong" attitude [14,16].

Some scholars have even gone further and questioned the systemic nature of EDI issues in engineering academia. In general, systemic oppression or discrimination is perpetuated by dominant groups who wield hegemonic power to manipulate societal structures and beliefs to maintain their privilege and power [17]. The demographics of the engineering field and student body in North America is predominantly White or east Asian, male, and wealthy [18]. Thus, it is unsurprising when scholars point out that traditional engineering curricula exhibit principles that favour colonial and masculine knowledge over alternative knowledge systems [18]. This can discourage women and students of colour from pursuing the field as it sends a signal that engineering is exclusively owned by a particular culture.

3.2. Gender

Despite approximately 46% of the US workforce being female in 2020, the representation of women in engineering and computing fields is significantly low. Only 20% of computer science bachelor's degrees and 22% of engineering bachelor's degrees were awarded to female students [19], with White and Asian males comprising the majority [1]. Female participation in computing was higher in the 1980s (around 40%), but it has declined to less than 20% in recent times [1]. Multiple factors contribute to the decline in female participation in engineering, such as gender bias, stereotypes, and an unwelcoming environment [1]. Women face barriers in pursuing computer science degrees, including differential treatment by professors and hostility from male peers and faculty members [13]. Female engineering students have reported feeling as if they are not taken seriously by their male peers and faculty members [15]. This phenomenon has often been referred to as the "chilly climate" of STEM [20]. It refers to an unwelcoming atmosphere for women and people of colour in male-dominated STEM fields, which threatens their sense of belonging and leads to attrition. Being at the receiving end of these micro-aggressions has led female students to report moderately severe levels of depression [20]. The situation in Spain is quite similar. The representation of women in STEM disciplines remains low. It is crucial to emphasize the importance of active societal preparation to address the challenges posed by the rapid changes that have occurred in recent decades in the social, cultural, technological, scientific, labor, and economic fields. This starting point allows us to analyze studies related to STEM in Canada and Spain, and the participation of women.

Despite constituting the majority of the university population, the presence of women in scientific and technological disciplines is significantly lower than that of men. Studies demonstrate that similar reasons exist in both countries for this disparity, and one of the

prominent causes is the lack of female role models, which contributes to widening the gender gap in STEM careers.

The second major obstacle to retaining women in engineering is a lack of resources for ensuring STEM preparedness. Similar to the experiences of students from racial minorities, female students often report coming into college with inadequate programming skills and training to succeed in their discipline [12]. This lack of prerequisite knowledge not only causes female students to struggle to perform comparatively with their male peers, it also leads to feelings of low self-confidence and self-efficacy [15]. According to some scholars, this loss of confidence often precedes a loss of interest which ultimately leads to more women transferring out of engineering and computer science fields than men [21].

Finally, lack of representation and biased perceptions from teachers and parents also negatively impact female students' representation in engineering before they even enter the field. Stereotypes in STEM textbooks that depict higher male representation can influence girls' perceptions of fields like computer science as being "better suited for men" [13]. Family influences also play a major role in girls' career decision-making [10]. From the outset, female students tend to receive less encouragement to pursue engineering or computer sciences compared with their male peers, despite having the same core competencies [1].

3.3. Socio-Economic Status

While the under-representation of women and students of colour in STEM is well-researched [5,22–24], there are significantly fewer discussions around the socio-economic diversity of the student body [25–27]. This is particularly troubling given that social classes in Westernized countries like Canada and Spain are largely distinguished by income levels. In 2016, the median annual income for a household of two or more members in the US was around $68,000, but around two-thirds of engineering students came from households that earned greater than $100,000 every year [17]. Additionally, a household income of less than $50,000/year was the single largest predictor of a student's failure to graduate. The COVID-19 pandemic strongly highlighted the digital divide that permeates North America, with income level underpinning inequalities in access to computers and reliable internet [28]. At this point, it is important to note that many Spanish universities have programs that focus on identifying and assisting vulnerable groups. The purpose of these programs is to develop and validate an intervention approach tailored to the characteristics of these groups. This process involves defining the foundations of the intervention, such as characterizing vulnerable collectives, as well as using tools to identify and assist them, and finally, measuring the results. This approach is common in many institutions as it allows for diagnosing the level of vulnerability in different groups and contributes to improving inclusion in universities.

3.4. Intersectionality

To properly catalog and discuss the experiences of URM students and/or students from equity-seeking groups, a special consideration needs to be made about the interconnections of groups. University EDI research and initiatives tend to focus on a single attribute of students' identities and connect this attribute to their educational outcomes. This ultimately misses the nuances of how intersectional identities are situated in the engineering social context [20]. Intersectionality itself is a relatively novel concept when discussed in STEM research [17]. Most studies that look at race, gender, or income level as the distinguishing characteristic of student outcomes often forget to account for the distinct lived experiences of those who occupy multiple marginalities, such as women of colour or low-income students with disabilities. Intersectionality is a necessary approach to consider in engineering pedagogy research because the dynamics of gender unfold differently across racial groups, while the dynamics of racial groups vary across income levels [20]. For example, while women of all races are underrepresented in Engineering programs, a study found that Black mixed-raced women were the least underrepresented at 33% and 31.3%

(out of the total population of students who share the same racial identity), while White women were more disproportionately represented at 26.3% [17]. The same study found Black, Hispanic, Indigenous and low-income students were largely underrepresented, while also noting the severe overlap between these groups, as they also contain the greatest proportion of working-class students. These results were consistent with findings reported in other literature [23,24]. In contrast, White and wealthy students were overrepresented, while displaying significant overlap with each other [17]. They were also the only groups that experienced higher representation between matriculating and graduating from the program. The graduation rates of students were proportionally related to income levels, which, in turn, correspond to the student's racial status. On average, the Black, Hispanic, and Indigenous students were less wealthy [9,22,29].

3.5. Engineering Identity

One commonality across the previously mentioned EDI issues and identity dimensions is the need for a sense of belonging and self-efficacy. A student's sense of belonging in their academic community and their performance satisfaction are significant positive indicators of their intention to persist in Engineering [15,30]. This phenomenon is attributed to the existence of an "engineering identity", which is the degree to which a student sees themselves as an engineer and to what extent the student exhibits qualities that they believe are needed to be an engineer [31–34]. Key approaches to measuring a student's sense of engineering identity include their self-efficacy, interest in the field, and feeling of being recognized as competent by peers and teachers [30]. As previously mentioned, the chilly environment of STEM education towards equity-seeking groups and URM has led to a feeling of discrimination and isolation amongst students in these groups. At the same time, systemic issues that contribute to a lack of adequate pre-college preparations for these groups and/or lack of representation lead to students feeling incompetent or not suited for the field. All of these contribute to a lower sense of engineering identity in women and racialized students, with a sense of higher engineering identity in White students [20].

4. EDI Strategies: Recruitment and Retention

With a good knowledge of all of the above factors, universities around the world are actively seeking EDI strategies to help achieve equitable opportunities for all types of students. To this end, there are a variety of strategies that are being followed that can be broadly categorized into two types: (a) Increasing URM student enrolment and (b) Facilitating a safe environment for current URM students, staff, or faculty. In the ensuing paragraphs, we describe the typical strategies used in Canadian and Spanish universities.

4.1. Strategic Line 1: Facilitate the Access to University Education for URM Students

An important fact is that the number of students in vulnerable situations decreases as they overcome the different educational stages, and this is the case in the university system. Higher education provides abilities and advanced knowledge in specific fields that will allow students to earn better salaries while making more impactful contributions to the community. For this reason, it is important to initiate measures that are specifically directed at underrepresented groups.

1. Students with disabilities:
    a. Transition program: Pre-college students live the transitional period with high stress levels, as this is a critical juncture where they make decisions about their careers and are anxious about the uncertainties. These circumstances are accentuated in students with disabilities and/or with necessities of educative support, especially because, in addition to the above, they are often worried about the availability of an equitable and accessible environment. To address this, universities often offer transition and orientation programs.
    b. Support in the university entrance exam: Admission into Spanish universities is based on common entrance exams. This entrance exam must guarantee

equity and equal opportunities through special actions such as supervision and additional time during the tests, sign language interpreters, reading questions, computer use, and the accommodations for students facing difficulties in reading and writing. The coordination among the university access service, the functional diversity care unit, and the units responsible for the orientation programs in the pre-university levels facilitate the information exchange and special protocols for pre-college students needing educational support.

c. Reservation of 5% of the places of access to university degrees for people with a degree of disability equal to or higher than 33%: The Charles III University of Madrid helps students with excessive disabilities by reserving 5% of the seats for such students. This helps such students continue their studies, eliminating economic burdens due to enrolment and other university services.

d. Organization of courses directed at people with intellectual disabilities: The universities have a social function for people with intellectual disabilities. These people have limited access to official university studies, though the universities offer training for such groups in Spain. Every year, more universities offer an Expert Course in Professional Qualification for Employment, directed at people with intellectual disabilities. With this course, students receive training in skills for ordinary work, given that training is conducted by using the methodology of working with support. Given that the philosophy of this program is included in the inclusive dimension of the university, there exist common activities shared with official undergraduate students. It must be noted that starting April 2023, the Organic Law on Universities in Spain explicitly recognizes the duty of universities to offer degree programs adapted for individuals with intellectual disabilities. This legislative change is a significant step toward academic and employment equality.

2. Students in low socio-economic situations:

   a. Reservation of 1% of the places for accessing university studies to people at risk of social exclusion: This initiative has been recently approved in the Spanish region of Andalucia and it is directed towards students whose families are at high risk of social exclusion and who receive economic support from the state through the “Minimum vital income” program.

   b. Economic support for students with low incomes: The University Office of the Spanish Government offers a program of scholarships, but the universities also have their own programs of support scholarships, which include different modalities, such as enrollment support, moving support, meal grants, support for housing, as well as support to get a certification of a foreign language or economic support for special situations arising during the training at the university.

3. Gender and racial minority students:

   a. Awareness: It is very important to raise awareness in society about increasing the gender diversity in STEM degrees, which can be achieved by means of training campaigns and awareness events.

   b. Visibility: Another important initiative is to count on female leaders in the STEM fields who could serve as role models for female students. To this end, the universities have programs that include lectures and events where such leaders are invited to share their experiences and organize workshops.

   c. Female STEM networks: Universities are creating female networks to connect students, professionals, and professors in STEM fields to get mutual support, tutoring, and mentoring opportunities.

   d. Leadership programs: Universities offer leadership programs to help women in STEM fields to develop their skills in managing and leadership, allowing them to be promoted to higher positions in the industry.

4.1.1. Strategic Line 1 in Canadian Universities

In Canadian schools, individual universities facilitate their own EDI strategies that increase engagement with, and outreach to, URM communities. For example, McGill University developed a Faculty of Engineering Action Plan Against Anti-Black Racism in alignment with a university-wide action plan to address this issue. The key pillars of this action plan include increasing Black student representation through STEM outreach activities in Black communities and securing funding to improve the accessibility of Black students to the programs through dedicated undergraduate scholarships, graduate fellowships, or need-based bursaries. It also states a commitment to broadening the training curricula for current and future Faculty to address issues related to anti-Black racism in the University environment and the workplace. McGill's Engineering Action Plan also vows to improve the Black student experience by pursuing dedicated funds to support Black student organizations like the National Society of Black Engineers.

Similarly, University of Toronto Eagles' Longhouse is a committee working on a blueprint to improve the Faculty of Engineering's relationship with Indigenous peoples. The name draws on the symbols of both the majestic bird messenger of wisdom and the place of community and learning. The Eagles' Longhouse was formed in response to the university's Truth and Reconciliation steering committee, which released 34 calls to action for the university. The committee focuses on four key areas: adding Indigenous spaces, including more Indigenous curriculum, hiring more Indigenous faculty and staff, and improving access for Indigenous students. The committee is made up of Indigenous Elders, faculty members, and staff. The Eagles' Longhouse has smaller, specialized working groups who consult with external experts and Indigenous partners to come up with ideas to better address student needs, from not having all the required courses, to coming from a remote location, to being a mature student with a family.

At McMaster University, a concerted effort is being made to recruit more female and gender-nonconforming students into engineering disciplines. The university hosts a robust "Women in Engineering" network that provides academic, emotional, and financial support to incoming female engineering students. Women in Engineering at McMaster University also facilitates outreach programs at secondary schools to increase exposure about the field to younger girls. Another group at McMaster University is the EngiQueers, a student body that is dedicated to enhancing the campus experience of Engineering students who are a part of the 2SLGBTQ+ community. The NSBE McMaster Chapter Entrance Scholarship provides $2500 a year to first-year Black students who demonstrate strong leadership skills and valuable contributions to their community. There are also Entrance Awards by Application valued at $5000 for the Black students entering the university.

4.1.2. Strategic Line 1 in Spanish Universities

Spanish universities address recruitment issues for URM by participating in a more systemic approach. The European Commission establishes equity and inclusion as key aspects to reach a fair society that provides opportunities to citizens to develop as individuals who reach their hopes and higher education. However, there is still an important problem of inequality to deal with in higher education in Europe, as described in the Eurydice reports published by the European Commission (2012, 2015, 2018, 2020, and 2022). Hence, strategies pertaining to EDI in higher education are crucial to guarantee that people at a higher risk of exclusion have access to higher education and can realize their maximum academic and professional potential. To this end, the Eurydice report 2022 collects ten principles that should help to strengthen the social dimension of higher education and the universities' role. These principles range from encouraging life-long learning and adequate staff training to enhancing funding opportunities to URM students and students in vulnerable situations.

Examples of these actions in Spain can be found in Madrid Polytechnic University, which has a plan called "Women and Engineering" that aims to promote the participation of women in STEM degrees through different activities such as workshops, lectures, and

meetings. The plan offers mentoring and scholarships for women aiming to study STEM degrees. The University of Valencia has a program called "Women and Science" to promote gender equity in STEM degrees through mentoring programs, scholarships and awareness events. Similarly, the University of Granada has created the program "Gender Equity and Diversity in the University" to promote gender equity and fight against gender gap in STEM degrees.

In the University of Almeria, the strategic line called "Science, Engineering, Gender and Vocation" has been initiated, which undertakes special actions such as "Technological Campus for Women", directed towards female students in schools and high schools during summer, or "A scientist visits your School", which aims to awaken the vocations among girls by means of visits by STEM female researchers. The "inclusive campus, campus without limits" program is jointly supported by foundations and the University Office of the Spanish Government. It helps young people with disabilities know and experience the university, and also helps the universities imbibe inclusive practices. This program aims to reduce the attrition rates among students with disabilities as well as pre-college students. To date, 52 editions of this program have been administered in 36 Spanish universities, with the attendance of about a thousand students.

4.2. Strategic Line 2: Accompanying and Guiding URM Students during University Training

The actions concerning access to university are traditionally assumed and concreted in different programs at each university. However, the measures directed to boost retention rates are very scarce. In other words, guaranteeing access to education is not enough, and we need to seek the necessary measures to improve retention [35]. Among the adopted actions in different Spanish universities, we can identify the following.

a. Zero-Level Course: This training activity aims to complement the reception actions. During some sessions, the new students with disabilities and other support necessities would be receiving information about the support resources that can be found in the University, such as the library or the service of virtual teaching. To further assist the students, trained professionals accompany the students during their first activities. Such programs are aimed at newly enrolled students.
b. Periodic supervision: There is an initial interview with these students, and every student has an individualized intervention program. In this, they receive information on the organization and services offered by the functional diversity and care unit. Among these services we can find periodic supervision through tutorships, working in different strategies, and tools for a better training organization, such as schedules, exams, etc. These activities are framed in a safe, confidential, and accompanying environment, trying to identify new necessities that could arise.
c. Accompanying student: A considerable number of students with functional diversity experience difficulties related to taking notes or orientation and mobility on campus. In order to cover these necessities, they are provided with an accompanying student who is usually enrolled in the same subject or group. This is a voluntary activity, and the accompanying student is rewarded with a limited number of hours recognized as part of his/her academic record.
d. Choosing group and partial enrolment: The student with functional diversity sometimes presents a better or worse academic performance depending on their learning schedule (morning or evening). These students have the right to adapt their schedules and academic groups depending on the nature of their specific training necessities. They have also the option to use the modality of partial enrolment due to disability, as asserted in the permanence regulations in the different universities.
e. Orientation, monitoring, and advising: The students are academically advised whenever this is required in order to adapt their capabilities, motivation, and preferences to the different degrees, helping them maximize their educational outcomes, training satisfaction, as well as personal and professional development.

f. Access to psychological attention and safe and friendly places: We must be sure that students have access to psychological attention due to mental health and that they receive resources and tools to handle stress or depression. Friendly and safe places are created in the university, where they can feel comfortable and find emotional and social support, such as study places, rest or game areas, and rooms reserved for associations of students.

4.2.1. Strategic Line 2 in Canadian Universities

To begin with, numerous Engineering faculties in Canadian universities have established standing committees that are committed to propelling EDI initiatives throughout the department to boost retention of URM students, staff, and faculty. For example, McGill University has a Faculty Equity Committee which aims to identify actionable issues and opportunities regarding EDI within the Faculty of Engineering community and responds by direct action or by proposing strong recommendations to a Department, School, or Faculty. The role of committee members is to support their respective Chair or Director in conceptualizing, developing, and implementing local, unit-specific EDI strategies that align with the Engineering Faculty's Six EDI Strategic Priorities. Similarly, Western University's Engineering Equity, Diversity, Inclusion, & Decolonization (EDID) Steering Committee was established to develop high-level recommendations to Western Engineering Dean's Council in creating and maintaining an inclusive and safe environment for all underrepresented groups in the Faculty (e.g., women, persons with disabilities, Indigenous Peoples, racialized minorities, individuals from the LGBTQ2+ community). York University's Faculty of Engineering hosts the Lassonde EDI Committee, which focuses on collaborating with institutional EDI champions and sub-committees to create policies, procedures, and programs that work to eliminate barriers and unwelcoming conditions on campus. At McMaster's faculty of engineering, every department has a designated Equity and Inclusion champion. These members undergo mandatory training in EDI issues and serve in a variety of committees to ensure that the university's overall EDI strategy and core principles are adhered to in all activities.

At the University of Toronto, the Indigenous Cultural Competency Toolkit was created in 2021 as part of the Engineering Faculty's commitment to improving Indigenous inclusion. The toolkit includes workshops, events, and self-educational tools that have been curated from consultations with the U of T's Indigenous Initiatives Office and Indigenous-identifying community members. Another initiative taken by their Engineering Faculty is the creation of an Office of Diversity, Inclusion and Professionalism, which was the first office of its kind for a Canadian engineering school. The Office developed a confidential disclosure framework to provide skilled and compassionate support, accountability, and systemic change for their engineering students who have experienced or witnessed harassment, discrimination, or harmful unprofessionalism. The framework gives students the option to disclose this information and choose their level of involvement in the next steps through various disclosure pathways. Each year, an anonymized report on disclosures received will be delivered to the U of T Engineering community.

For Engineering professors who are hoping to integrate EDI principles into their teaching strategies, McGill's E-IDEA's Teamwork Initiative is a program that focuses on integrating EDI content into students' educational experience and developing modes of strategic measuring with respect to skills development. It entails relationship-building with staff collaborators and student groups, as well as developing a robust strategy for website, social media, and newsletter content. A major goal for this initiative is to decentralize information about EDI strategies and progress tracking for the public. Additionally, McGill's EDI Advocacy Program offers robust training and engagement opportunities, boosts awareness of university resources, and enhances EDI communication within the Faculty of Engineering. Through the Ambassador Program, volunteer staff and faculty members are designated as Equity Ambassadors by the Faculty Equity Committee. All Equity Ambassadors are to complete active listening and equity-related training designed

to better equip them to act as resources for staff and students seeking support for EDI-related issues. This is very similar to the program at McMaster University wherein the ambassadors are simply called 'champions' who, as described previously, operate in an almost identical manner.

4.2.2. Strategic Line 2 in Spanish Universities

As mentioned earlier, Spanish universities' strategies have included measures to eliminate the different barriers and obstacles that impede access to higher education in accordance with the Eurydice report. It must be noted that barriers could be physical, technological, economic, or social. Complicating matters further, additional barriers have emerged during the recent COVID-19 pandemic. Some remediating strategies used in Spanish universities include adapting the environment and physical spaces to make them accessible; providing technologies and support tools; training the staff and educators to offer an inclusive education; and promoting policies that promote inclusion and equal opportunities. Thus, higher education strategies with a social dimension are crucial to guarantee that everyone has the opportunity to access an education of quality and contribute to the development of society in equal conditions. The strategies and policies adopted is consistent with the fourth objective of sustainable development of the United Nations [36] and the Spanish 2030 Agenda. The commitment of all public universities in Spain to resolving the EDI issues is very remarkable and it has translated into the existence of two work networks, which serve as a forum for discussions and the evolution of new policies. In the disability ambit, the commitment for inclusion is shared by the Conference of Rectors of the Spanish Universities (CRUE) and its role is evidenced in the network called Diversity and Disability of CRUE-Students Affairs (SADPU). This network, with constituents from 66 Spanish universities, acts as a catalyst of inclusion policies in all the Spanish universities and has achieved, in partnership with the individual work at each university, significant advances pertaining to discrimination, equity, and universal accessibility.

To achieve gender equity, 54 public Spanish universities take part in the Network of Units of Gender Equity of the Spanish Universities for University Excellence (RUIGEU). This network coordinates initiatives that promote gender equity in university, as well as assisting women into the labour market. The network guarantees the establishment of synergies and collaboration in good practices and serves as a channel of information, advice, and mutual support. The more recently created Network of Universities for Diversity (RUD), formed by a group of 30 Spanish universities, works towards an inclusive environment on campus, promoting diversity in the university system, sexual and gender diversity in particular. More precisely, the work ambit of this network includes sexual orientation, corporal and affective diversity, gender identity and expression, as well as origin, culture, beliefs, and all related aspects.

5. The LGBTQ+ Community

While the manuscript has largely focused on EDI strategies relating to gender, race, and disability, there is also an urgent need to cater to the LGBTQ+ community. Most higher education institutions fall short in ensuring equitable and inclusive conditions for students (and, for that matter, staff too) from this group who want to pursue higher education. It is very easy for students from this group to face discrimination and feel left out, ultimately perhaps forcing them to opt out of university education altogether. Universities can change this and offer better education prospects by doing some of the following:

(a) Institutions should support the growth of professional LGBTQ+ networks on campus, allowing the people from these groups to feel assured that they are in an inclusive environment that continues to understand and affirm their unique experiences. The members from such forums can also help the university formulate policies and practices for the university.
(b) The institutions should support the visibility of the LGBTQ+ community by showing commitment to cultural activities like pride month and local pride events.

(c) The universities can formulate LGBTQ+-conscious policies, incorporate sensitivity training, provide gender-neutral amenities, and encourage the use of pronouns in communications.

In summary, demonstrated strategies such as dedicated inclusive spaces on campus and support services such as mentoring, counselling and peer programs will significantly encourage students from such groups to pursue higher education.

6. Conclusions

Overall, universities in Canada and Spain are actively addressing and remediating various EDI-related concerns in Engineering faculties (Table 1). Both regions have taken a particular focus on building networks among students from equity-seeking groups and providing mentorship opportunities to guide these students throughout their degrees. Where the two regions divulge is the particular scope of the initiatives, as it seems that Canadian initiatives are run on an institution-by-institution basis, whereas the Spanish schools have undergone a more systematic change. Neither approach is considered better than the other; rather, it demonstrates the flexibility that nations and universities have in enacting EDI strategies that best suit their organizational structures. For example, in Canada, the post-secondary education system is relatively divorced from the government compared with the European system. As a result, a secular approach to implementing EDI strategies is more feasible for universities compared with a nation-wide strategy. In contrast, Spanish universities have a closer relationship to the government through social assistance programs that enable a larger population of residents to access university-level education. This close relationship lends itself well to a comprehensive, system-wide approach to tackling EDI issues in academia. Readers of this article may find inspiration for conceptualizing and designing similar EDI strategies for their own Engineering faculties that are well aligned with their regional educational structures.

Table 1. Summary of strategic actions for addressing EDI issues related to recruitment and retention in universities across Canada and Spain.

Country	Strategic Line	University Name	Strategy Title/Name	Strategy Type	URM Target
Canada	Recruitment	McGill University	Faculty of Engineering Action Plan Against Anti-Black Racism	Action plan	Racial minorities
		University of Toronto	Eagles' Longhouse	Committee	Racial minorities
		McMaster University	NSBE McMaster Chapter Entrance Scholarship	Scholarship	Racial minorities
		Multiple Universities (n = 32)	Women in Engineering & EngiQueers	Mentorship Program	Gender and sexual minorities
	Retention	McGill University	Faculty Equity Committee	Committee	Various
		Western University	Engineering Equity, Diversity, Inclusion, & Decolonization Steering Committee	Committee	Various
		York University, McMaster University, and McGill University	Equity, Diversity, and Inclusion Champions	Ambassador Program	Various
		University of Toronto	Indigenous Cultural Competency Toolkit	Educational Resource	Racial minorities

Table 1. *Cont.*

Country	Strategic Line	University Name	Strategy Title/Name	Strategy Type	URM Target
Spain	Recruitment	Madrid Polytechnic University	Women and Engineering	Action Plan	Gender minorities
		University of Valencia	Women and Science	Mentorship Program	Gender minorities
		University of Grenada	Gender Equity and Diversity in the University	Mentorship Program	Gender minorities
		University of Almeria	Technological Campus for Women	Summer Workshop	Gender Minority
		Multiple Universities (n = 36)	Inclusive campus, campus without limits	Action Plan	Student with disabilities
	Retention	Multiple Universities (n = 66)	Diversity and Disability of CRUE-Students Affairs	Policy action network	Various
		Multiple Universities (n = 54)	Units of Gender Equity of the Spanish Universities for University Excellence	Policy action network	Gender minorities
		Multiple Universities (n = 30)	Network of Universities for Diversity	Advocacy network	Various

In conclusion, this article has explored the intricate landscape of Equity, Diversity, and Inclusion (EDI) issues within engineering education, shedding light on the challenges faced by underrepresented groups in Canada and Spain. The article underscores the importance of fostering an inclusive and diverse engineering community to drive innovation and progress. The methodologies employed, including literature reviews and environmental scans, have revealed common obstacles and strategies employed by both countries. The shared commitment of academia, industry, and governing bodies to address these challenges is evident, as evidenced by the myriad of strategies implemented to promote equity and inclusion in engineering education. The collaborative efforts showcased in both Canadian and Spanish universities illustrate the progress being made to dismantle barriers and create supportive environments for marginalized individuals. By learning from each other's experiences and successes, we can collectively work towards a future where Equity, Diversity, and Inclusion flourish, empowering individuals from all backgrounds to contribute fully to the advancement of engineering and society at large. Ultimately, these efforts are vital for unlocking the untapped potential of diverse talent and ensuring a brighter and more inclusive future for engineering disciplines globally.

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