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## Supporting Women In Science, Engineering And Technology Programmes: A TU Dublin Approach

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# Supporting women in Science, Engineering and Technology programmes: A TU Dublin approach

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## **Abstract:**

The under-representation of women studying engineering in higher education is gaining increasing attention in Universities throughout Europe and other jurisdictions. This has led to under-representation of women in many of the professions in the Science, Engineering and Technology fields also. Numerous initiatives and programmes are being developed in universities to gain more information about the embedded issues in these disciplines that inhibit female applicants or lead to unsuccessful outcomes in university programmes. One such initiative that has been developed and piloted in Technological University Dublin (Ireland) is a mentoring programme called 'Equality in Science and Technology by Engaged Educational Mentoring (ESTeEM)'.

This paper reflects on the development of the ESTeEM programme, which is a unique, award-winning mentorship programme for female students, including non-binary and transwomen in Science, Engineering, and Computing programmes. The ESTeEM programme has been piloted to students pursuing programmes at many levels in the university, including craft-based apprenticeship programmes, through to Higher Certificate, Honours Degree and Postgraduate programmes in Engineering, Science, and Computing. This paper outlines the origins of the ESTeEM programme, the experience of the facilitator and participants from the pilot programmes, as well as the initial contributions to the wider University community, through strategic priorities being achieved, in addition to increased participation and success of women, non-binary and transwomen successfully pursuing Science, Engineering and Technology Programmes. Finally, the paper concludes with lessons learned and suggestions for further roll-out and development of the ESTeEM programme.

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## **1 Introduction:**

The lack of equality in terms of gender and racial diversity in the professions aligned to Science, Technology, Engineering and Mathematics (STEM) has been recognised for many decades (Kanny et al. 2014). There is increasing international scrutiny on the causes and the development of potential solutions to combat the obvious inequalities in the STEM fields, but the search for a panacea continues. Some progress has been made in terms of raising awareness through discussion platforms, and policies at international, regional, corporation and university level, but success remains somewhat elusive (Dunne et al., 2022, Gagnon et al., 2021).

The causes of gender and racial inequality (not to mention other forms of inequalities, bias and rejection) are multifaceted and intergenerational with history, culture, education, socio-political factors, and societal attitudes all playing a part (McGinnity et al., 2018; Pineda and Mishra, 2022). Consequently, the definition of EDI remains broad and has multiple interpretations and applications. This is due to how these variables differ across the world, therefore influencing what EDI means in different regions (Pineda and Mishra, 2022).

For the purpose of this case study, the definition of EDI is '*...the fair treatment and opportunity for all. It aims to eradicate prejudice and discrimination on the basis of an individual or group of individual's protected characteristics*' (The University of Edinburgh, 2021). The context of this particular case study revolves around the issue of gender equality in STEM. Other broader issues relating to diversity and inclusion, whilst equally important, are not the main focus of this case study.

### **1.1 Women in STEM: The Landscape Ireland**

Women in Ireland have seen many advances in gender equality over the past 50 years, beginning with the removal of the Marriage Bar in 1973. While there were relatively few women pursuing professional careers before then, this laid the foundation for increasing participation of women in higher education programmes and professional careers. Ireland's membership of the EU (formerly the European Economic Community (EEC)) brought forward changes in regulation, legislation and for wider society in Ireland. Despite these positive developments, gender inequality persists across many domains in Ireland including income parity, housing, leadership, and employment rates (Barrett et al., 2022; King, 2022). For example, the overall employment rates for women in the Republic of Ireland remain below those elsewhere in northern Europe, including the UK and Northern Ireland, and the gender pay gap for Irish women continues to persist (K., 2022; PricewaterhouseCoopers, 2023).

Within the sectors of Engineering, including the craft apprenticeship, Computer Science, and Information and Communication Technology (ICT), both in higher education and in employment, the lack of women, including non-binary and transwomen, persists. Only 18% of Irish ICT graduates and 20% of computer science graduates are female (TechCentral, 2021). Given these figures, it can come as no surprise that as of 2022, only 32% of ICT workers in Ireland are women (O'Dea, 2022). In engineering, Engineers Ireland (2022) reported that only 23% of the engineering graduates are women, but the number of women within the engineering workforce is substantially less at 12%. This phenomenon known as the 'leaky pipeline' (Darmody, 2022; Engineers Ireland, 2022; Grimson and Grimson, 2019). In craft apprenticeship, women make up a scant 1% of participants (Department of Further and Higher Education, Research, Innovation and Science, 2022). In addition,

it is accepted the LGBT+ (Lesbian, Gay, Bisexual, Transgender +) community is under-represented in third level and the STEM disciplines workplace (STEM Women, 2021). This data clearly reflects the gender disparity that is present in higher education as well as the STEM workplace.

### ***1.2 EDI and Mentoring:***

Mentoring is gaining popularity across several areas including higher education as well as in enterprise as a tool to effect real change. Recent research has demonstrated how, now more than ever, it is important to include equality, diversity, and inclusion (EDI) issues as part of the mentoring process. There are mentors and mentees who will have already experienced systematic barriers in their lives, and some participants will still be experiencing these impediments. Therefore, recognition and understanding of what EDI is, and the impact these barriers can have on underrepresented groups are vital to the mentoring process (Dahlberg and Byars-Winston, 2019; Deanna et al., 2022). Within the higher education context, as well as other contexts, if a mentor lacks cultural awareness about their mentee, they may fail to recognise their mentee's important accomplishments and milestones. This, in turn, has the potential to negatively impact the outcomes for the mentee (Cornwall, 2020; Dahlberg and Byars-Winston, 2019). An individual's self-identity is important to understand how people view themselves, and this includes gender identity, ethnicity, place of birth, values, hobbies, etc. Some aspects of identity are fixed over a person's life and other parts are more dependent on the social context and the stage of life a person is at (Dahlberg and Byars-Winston, 2019). People can hold multiple identities at any given time (for example, I can be a mother, a sister, a daughter, a wife/partner, a student, a care-giver, etc.). Therefore it is important to be aware of how individuals will not have the same experiences even if they share similar identities. For example, a mature student will have a different experience in college when compared to a student who is on the autism spectrum, and their experiences will be different to the third level experience of an international student, even if they are all on the same programme (Bauer et al., 2021; Dahlberg and Byars-Winston, 2019).

### ***1.3 Mentoring and the Benefits for the Students, Staff, and the University***

Considering the diverse groups of staff, researchers and students present in TU Dublin, it is important to include equality, diversity, and inclusion (EDI) as part of the induction and training process both for staff and for students. Some of the mentors and mentees will have already experienced systematic barriers in their lives and others will still be experiencing them. Therefore, awareness and knowledge in this area is vital to assist in creating equal opportunities for all parties in TU Dublin. When EDI is incorporated into mentoring initiatives it leads to many positive outcomes for both mentors and mentees in the domains of academic progression, career satisfaction and advancement, plus there are also psychological benefits more generally (Clutterbuck, et al., 2012; Dahlberg and Byars-Winston, 2019; Deanna et al., 2022).

In the higher education sector, students, university staff as well as early career researchers report numerous gains from participating in mentoring programmes. This in turn benefits the university. Mentoring is an aid for student retention (Bhatia et al., 2013; Rosillo, et al., 2018). Students who engage in mentoring initiatives describe feeling a stronger sense of community and a feeling of belonging, both within their academic programmes and within the university (Beauchamp et al., 2021; Kram, 1983). Mentoring also assists students with the acquisition of subject knowledge as well as with the development of academic skills. This, in turn, leads to an increase in motivation and

commitment to studies (Dahlberg and Byars-Winston, 2019; Rosillo, et al., 2018). These benefits are more pronounced for students who are from underrepresented groups, including women who are in STEM programmes (Dahlberg and Byars-Winston, 2019).

Mentoring also benefits new students. It assists with the transition to the educational demands of higher education and the other challenges associated with this developmental stage (Bhatia et al., 2013; Cross, et al. 2019; Kram, 1983). For the students who encounter difficulties adapting to this transition, their academic outcomes tend to be less favourable. This leaves this population at a higher risk of withdrawing from their programmes of study (Foy and Keane, 2018; Lowe and Cook, 2003).

For the university staff, including early career researchers, who engage in mentoring programmes, they report a variety of gains including broadening their professional network, professional support, obtaining career-related insights and developing work-based competencies and knowledge (Carmel and Paul, 2015; Deanna et al., 2022). Another mentoring outcome is feeling an increased sense of satisfaction with their employer which positively impacts the retention of these staff. (Cross, et al. 2019; Fishman, 2021; Nick et al., 2012).

Because of the breadth of applications for mentoring in a University context, for this case study, mentoring is defined as: *the purposeful and intentional commitment on the part of the mentor to the growth, development, and success of the mentee to facilitate that person's career and personal and/or academic development* (Baker and Griffin, 2010; Roberts, 2000).

## **2 Equality in Science and Technology by Engaged Educational Mentoring (ESTeEM):**

ESTeEM was piloted in 2017 by the School of Electrical and Electronic Engineering, City Campus, TU Dublin in response to two factors: the low recruitment of women, including non-binary and transwomen, into Engineering programmes and craft apprenticeship in TU Dublin, and the retention of these students. In 2018, the remit of the ESTeEM programme was expanded to include the disciplines of Computer Science and ICT. The ESTeEM programme became an award-winning mentoring programme for female students, including non-binary and transwomen, as a successful collaboration between industry and TU Dublin. The current industry partners include ABB, Amazon, Arup, DBFL, Dublin City Council, Eaton Intelligent Power, ESB, MasterCard, SAP, and Schneider Electric. In April 2018, Athena Swan selected ESTeEM as the example of best practise.

The development of the ESTeEM programme was shaped by gender equality research in education and STEM subjects as well as from research pertaining to women and mentoring. In 2015, research from the Organisation for Economic Co-operation and Development (OECD) and from Accenture identified how adolescent girls lacked confidence in their abilities with STEM subjects. These reports noted the lack of women STEM role models may be a contributing factor to this as well as the concerning persistence and strength of the prevailing stereotypes held about the types of careers women 'should' be pursuing (Accenture, 2015; OECD, 2015). Further longitudinal research examined the factors that impacted the retention rates of women in higher education engineering programmes and in the engineering workforce. The data demonstrated it was the culture both in higher education and in the workplace that influenced women to leave engineering (Seron et al., 2015). The women from the study spoke about being treated in a stereotypical gender-specific manner while in higher education and in the workplace, including programme related internships.

Many of the women described experiencing gendered stereotyping from fellow classmates, lecturing staff and co-workers. Some women also reported being subjected to sexual harassment and being isolated when in internships and/or the workplace. The women in the study reported these were the reasons they chose to leave engineering (Seron et al., 2015).

When women are mentored by other women in a professional setting, Neal, Boatman and Miller (2013) found that the mentees experience beneficial career related outcomes both in the short term and in the long term. It was found this was even more worthwhile when the women were working in predominantly male environments. Interestingly, Chesler (2002) demonstrated how women-to-women mentorships created a more collaborative and supportive community amongst the other female employees instead of one based on women competing against the other women in the company for promotions and other opportunities. The latter more commonly arises when women were mentored by men and when there are few women in senior roles.

### ***2.1 Purpose of ESTeEM:***

Based on the findings of these studies, it was decided ESTeEM would address these factors in TU Dublin. Female students from relevant engineering, computing and ICT programmes, as well as from apprenticeship programmes, would be mentored by women from a related discipline in industry. The purpose of this is to assist the TU Dublin students in recognising they have the aptitudes needed to undertake not only their chosen programme of study but also a career in their chosen profession. As part of the mentoring, the student participants would develop a broader understanding about their chosen profession, the range of career paths available as well as details about the skills required to be a successful STEM graduate.

### ***2.3 Format:***

Annually ESTeEM holds five lunch events as well as an induction for the students and an induction for the mentors. The TU Dublin staff who assist at the lunch events are invited to the mentor's induction. Planning for ESTeEM events begins on day one of the academic year. The dates, themes and speakers for each event are discussed and agreed and the recruitment for industry mentors, student mentees and TU Dublin staff begins. All participants are volunteers.

Once the mentor-mentee matching has occurred, students attend an induction session. The purpose of this is to outline the ESTeEM programme, what is required of the students and details about the mentors. The mentors are also provided with an induction which includes mentor skills training and details about the mentees. The TU Dublin staff who volunteer at the ESTeEM events also attend the mentor's induction.

Each ESTeEM event follows the same format. The welcome desk opens thirty minutes prior to the function commencing. Lunch is available at this time. Each event starts with a fifteen-minute talk by an enterprise speaker from one of the participating companies. The theme of each event focuses on the early career needs of the mentees. The remainder of the session is when the mentoring with the industry mentors and mentees occurs. After the final ESTeEM event, all participants are sent a survey to measure the impact the initiative has had.

### **2.4 Covid – from 2020 – 2022:**

In March 2020, the fifth and final ESTeEM event of that annual cycle was postponed due to Covid-19. Due to the ongoing pandemic restrictions, it was decided to pilot an online version of ESTeEM. The online event, which was hosted in TU Dublin's virtual learning environment, Brightspace, was held in early June 2020. The feedback from the TU Dublin students who participated was that the online experience was poor. The preference for in-person, mentoring events was clear.

In September 2020, a cross-campus and multidiscipline group was established by Dr. Leslie Shoemaker. The purpose was to create four online panel discussions for the academic year. The companies that were already engaged with ESTeEM agreed to participate in these events. It was determined the theme of each event would focus on women, including non-binary and transwomen, who were in craft practice apprenticeships or who were in Engineering, Computer Science or ICT related programs. Invitations to each online event for the 2020-21 cycle were sent to all female students, including non-binary and transwomen, across all TU Dublin campuses who were studying Engineering, Craft Apprenticeship, Computer Science and ICT. Invitations were also extended to second-level schools and Further Education Colleges in County Dublin.

Due to the ongoing restrictions in Ireland during Covid-19, a further four online events were held in 2021-22. The same format was replicated for these events.

### **3 Impact and findings:**

Annually, the mentors, mentees and TU Dublin staff are surveyed to evaluate impact of the ESTeEM programme. Research by Crisp and Cruz (2009b) and Jacobi (1991) has demonstrated when mentoring students, this can be evaluated through these four domains:

- Psychological and emotional support
- Degree and career support
- Academic subject knowledge support
- Having a positive role model

Recent research has demonstrated that having a sense of belonging is important for higher education students who are part of underrepresented groups (Strayhorn, 2018). For the purpose of this case study, a sense of connectedness is being defined as a sense of connection and belonging to the university, peer community, and chosen profession (Beauchamp et al., 2022). Due to how the focus ESTeEM programme is not on academic knowledge support, this outcome was not evaluated for the purpose of this study.

It has been documented that individuals who volunteer to be a mentor gain from this experience because acting as a mentor contributes to a positive workplace and is linked with improved job satisfaction and lower rates of burnout (Beheshti, 2019; Fishman, 2021; Jeong et al., 2018). It also leads to promotions and higher salaries which means this can be a win-win activity for both the mentors and mentees within a company (Bierema, 2017; Coates, 2012; Nick et al., 2012). When measuring the impact for the mentors, the focus was on improving their leadership skills as well as interpersonal competencies such as communication and problem-solving, as well as giving back to

the next generation of engineers (Banerjee-Batist et al., 2018; Baranik et al., 2010; Bierema, 2017; Coates, 2012; Nyanjom, 2020).

Finally, it should be noted, the university also benefits from ESTeEM although not all of this impact has been measured. When higher education has mentoring programmes that are linked with enterprise partners it facilitates engagement with alumni and philanthropy. This is an opportunity to either reinforce existing relationships or new ones can be developed (Jackson and Meek, 2020). Additionally, by the university providing holistic support and development of their students, including ones from under-represented backgrounds, this will lead to improved retention and student success (Dahlberg and Byars-Winston, 2019; Nora and Crisp, 2007; O'Brian, 2022). All of these benefits enhance the university's reputation since it will be bolstered by both the student and the alumni success (O'Brian, 2022).

### ***3.1 The inaugural year: 2017 – 2018***

In this first year, there were thirty-seven students from the full-time programmes in the School of Electrical and Electronic Engineering who volunteered to take part in the four ESTeEM events. The group included four Erasmus Bosnian students who joined ESTeEM for the two events in semester 2 only. Unfortunately, there were no women in the craft practice apprenticeship blocks during that academic year. Feedback was very positive in relation to the experience of all participants and some suggestions for improvement were identified.

### ***3.2 Year 2: 2018-2019***

There were changes to the programme for the second iteration of the ESTeEM programme which were based on the feedback from the last cohort. The most notable change was that it was decided to increase the number of events from four to five. Also, the School of Computer Science and the School of Marketing joined ESTeEM, and further companies, who contributed mentors, joined: ESB, MasterCard and SAP. This increased the number of student participants to ninety-four. Again, feedback was very positive in relation to all participants, with no suggestions for improvement identified.

### ***3.3 Year 3: 2019-2020***

All elements of the program remained the same, including the student numbers, although Dublin City Council joined ESTeEM as a mentor for this programme. Again, feedback remained very positive.

## **4 Lessons Learned and Recommendations:**

The ESTeEM programme has been a great success in terms of meeting the purpose, aims and ambitions of the programme. However, a review of the operationalisation of the programme is now timely to ensure that we continue to build on the success experienced to date.

The excellence and success of the ESTeEM programme has been acknowledged by the University and externally. This is making other Faculties and Schools consider the introduction of mentoring programmes to assist their students on their learning journey. Experience with the ESTeEM programme to date has demonstrated the need for formal policies regarding mentoring in TU



Dublin. There are no formal policies at present. A policy is required to outline how these programmes are implemented and managed, and to ensure staff resources and financial inputs are utilised effectively. The current lack of policy development in mentoring is leading to a lack of consistency across mentoring initiatives and many activities might not meet best practise guidelines (notwithstanding the fact that the ESTeEm continues to meet best practice guidelines at all times). TU Dublin is not unique in this issue, (see Nora and Crisp, 2009).

The ESTeEM programme is currently managed by one adjunct faculty member. Once formally adopted by the University, the programme would benefit greatly by being placed in the formal organisation structure. This would enable accountability for managing and overseeing ongoing mentoring activities. In addition, the operational issues that need to be managed would be dealt with in a consistent way. Such operational issues include setting up events, attending external events to develop an understanding for international best practise; manage and deliver student and mentor inductions; to manage, monitor and oversee each event and address any issues that emerge quickly and efficiently; promote the ESTeEM programme and recruit students; manage ongoing relationships with industry mentors and their companies; to measure impact and implement informed changes when appropriate; design and deliver ice-breaker events for first time mentors and mentees. Also a dedicated budget for the activities should be developed. This would streamline event management co-ordination activities such as lunches, project management and co-ordination and to improve efficiency of operations.

A specific website for the ESTeEM programme would be beneficial to highlight and share activities across the University and to a wider audience. This would assist with gaining visibility with professional bodies and philanthropy organisations who are focussed on EDI activities.

A consistent and dedicated space to be timetabled for ESTeEM events would enable organisational learning to occur and enable all events to be held on campus. This might involve creating a module descriptor for the programme so that it can be formally timetabled into University systems.

## **5 Conclusion:**

Mentoring, which enhances staff and student success, provides a mechanism for the university to enhance its reputation through the achievements of these individuals (O'Brian, 2020). Additionally, it facilitates the building and reinforcement of relationships and partnerships with enterprise as well as with alumni which also further strengthens the university's reputation. The contributions obtained through these connections will also benefit the university students, staff, and early career researchers (Jackson and Meek, 2020). The ESTeEM programme has been successful in improving retention of female (and other minority genders) students on STEM programmes. This success supports the need to formalise this activity in the university to continue to improve participation of minority groups in higher education as part of a broader EDI initiative.

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