2023

Supporting Women In Engineering and Technology Through A Collaborative Practice And Support Network Using Targeted Interventions

Michelle LOOBY
TU Dublin, Ireland, Michelle.Looby@tudublin.ie

Marie ARMSTRONG
TU Dublin, Ireland, marie.armstrong@tudublin.ie

Una BEAGON
TU Dublin, Ireland, una.beagon@tudublin.ie

See next page for additional authors

Recommended Citation

Looby, M., Armstrong, M., Beagon, U., Dunne, E. M., Hensman, S., Higgins, F., Kelly, P., Killane, I., Lynott, S., McMahon, O., & Pahlevanzadeh, B. (2023). Supporting Women In Engineering and Technology Through A Collaborative Practice And Support Network Using Targeted Interventions. European Society for Engineering Education (SEFI). DOI: 10.21427/Y7Q2-XQ60

SUPPORTING WOMEN IN ENGINEERING & TECHNOLOGY THROUGH A COLLABORATIVE PRACTICE AND SUPPORT NETWORK USING TARGETED INTERVENTIONS

M. Looby [1], M. Armstrong,
Technological University Dublin, Faculty of Engineering & Built Environment,
Dublin, Ireland
0009-0001-3490-6973, 0009-0000-3131-8669

U. Beagon, E. Dunne,
Technological University Dublin, Faculty of Engineering & Built Environment,
Dublin, Ireland
0000-0001-6789-7009, 0009-0001-5691-9935

P. Kelly, I. Killane, S. Lynott,
Technological University Dublin, Faculty of Engineering & Built Environment,
Dublin, Ireland
0009-0001-9980-5655, 0000-0002-4770-5273, 0009-0009-6656-2093

S. Hensman, O. McMahon, B. Pahlevanzadeh,
Technological University Dublin, Faculty of Digital & Data,
Dublin, Ireland
0000-0002-1804-2925, 0009-0009-3680-4530, 0000-0002-5130-4528

F. Higgins,
Technological University Dublin, Faculty of Business,
Dublin, Ireland
0000-0003-0083-805X

Conference Key Areas*: Equality Diversity and Inclusion in Engineering Education*
Keywords*: Diversity, Engineering Education, Women in STEM, Gender Equality, Inclusion*

[1] *Corresponding Author: M. Looby*
Michelle.Looby@tudublin.ie

ABSTRACT

Despite ongoing efforts to recruit and retain women in third level engineering programmes in Ireland, there is still a lack of diversity in these programmes with typically fewer than 20% of students being female. This paper will describe the evolution of a female focused university wide network called WITU (Women in Technology United), which aims to retain female students in engineering and technology programmes, and to increase the number of gender minorities coming onto these programmes. It is also a response to the Sustainable Development Goals, particularly, SDG 4 (quality education), and SDG 5 (gender equality), and addresses actions highlighted in a recent Athena Swan review in our University. The network was formed in 2020 and extended to become University wide during lockdown, which in itself presented specific challenges.

This paper describes the activities of the WITU network which runs events and celebrations for female students on our engineering and technology programmes such as 'Meet & Greet' events for incoming year one students, scholarship workshops, coding camps and International Women's Day celebrations. The events are run collaboratively with students, academics and employer networks, with participation from recent female graduate role models, who are contributing to the wider engineering community. This paper describes these events and their impact on participants. Outcomes and feedback from participants show the critical role of these types of targeted interventions in supporting women and gender minorities and address some of the most pressing global challenges relating to the above-mentioned SDGs.

1 INTRODUCTION AND BACKGROUND

Gender inequality exists in science, technology, engineering and maths (STEM), not because of a lack of talent or ambition, but because of barriers and culture, that means talent is not always enough to guarantee success. The importance of connections built through support networks is highlighted with successful strategies and mechanisms to improve the attraction, access, guidance, and retention processes for women in STEM (García-Peñalvo et al., 2022). In an effort to overcome gender related barriers and improve career outcomes, these networks provide support, mentoring and networking opportunities, from second to third level education and throughout their careers. Bringing people together to share experiences and demonstrate support and leadership is an essential aspect of building a culture of inclusiveness ("CWIT - Connecting Women in Technology", 2023; "I WISH", 2023; "Women in Science and Engineering Research, WiSER". TCD, 2023; "Women in Technology and Science IRELAND", 2023). The WITU network in TU Dublin was established in 2020 in direct response to identified challenges around increasing gender diversity within engineering and technology fields. This paper explores some of these challenges and describes how WITU operates as a collaborative pan University network to achieve its goals and describes the impact that targeted interventions have had on participants.

Ireland is rated seventh on the EU-28 Gender Equality Index, scoring 74.3 in 2022, compared with an average score of 68.6 (European Institute for Gender Equality, 2022). The index measures gender gaps between women and men in six domains; work, money, knowledge, time, power and health. However, despite Irish women being more likely to have a higher education qualification than men (43.2%F compared with 40.7%M) (Central Statistics Office, 2017), there is still a dearth of

women in STEM disciplines (Tomassini, 2021). On a global level, the evidence shows typically 8% of women choose courses in engineering, manufacturing and construction and 3% choose courses in ICT (UNESCO, 2017). An Irish HEA report from 2021 found 21% of ICT students were female (Higher Education Authority, 2021), while in the EU it was 19% (EUROSTAT, 2021). This translates to only 11.3% of engineers working in industry (Kent Doyle, Costello and Kopacek, 2019). The attrition of women in engineering courses and in industry has been labelled as “the leaky pipeline” (Kent Doyle, Costello and Kopacek, 2019) and it is recognised that attrition occurs at multiple time points along a woman’s engineering career.

The significance of STEM education for economic growth and innovation, especially in engineering and technology, is increasingly acknowledged (Dunne at al., 2022; Ribeiro at al., 2023; Croak, 2018). This has resulted in augmented investment in education and research in these fields, alongside initiatives to promote diversity and inclusion. Historically, reasons identified which have discouraged women from pursuing careers in STEM include societal biases, gender stereotypes, lack of self-efficacy, lack of access to resources and mentoring, and an unsupportive environment (Lester, 2010; Kordaki and Berdousis, 2020). To counteract this, it is important to highlight the many reasons why women should pursue careers in engineering and technology. These fields can be intellectually challenging and rewarding, providing opportunities for personal and professional growth. They offer opportunities to be creative and innovative, as well as to solve complex problems with critical thinking and analytical skills. Additionally, contributing to society with high flexibility can be particularly attractive to women who prioritise work-life balance or have caregiving responsibilities and are interested in making a difference in the world. Encouraging women to choose these fields is critical to achieving gender equality, eliminating the gender wage gap, promoting financial independence, and ensuring that diverse perspectives are represented in solving the world's most pressing problems.

Women’s under-representation in STEM is an untapped talent, and one needed to meet our commitments for sustainable development, as women are key players in crafting solutions to improve lives (UNESCO, 2017). Thus, Higher Education Institutions have a critical role to play in the implementation of measures to recruit, retain and thus reduce the gender gap in STEM (García-Peñalvo et al., 2002; UNESCO, 2017). Further, a multi-faceted approach that includes the education sector, employers, and policymakers is needed. By promoting equal access to STEM education and resources, challenging gender stereotypes and biases, and supporting positive role models, we can work towards achieving gender equality in STEM. As a network within a third level institution, WITU is establishing links with primary and secondary education institutes and also with industry, and is a point of contact on issues relating to gender. According to the SDG report on graduates in STEM fields (SDG Index and Dashboards - Global Report, 2021) the long-term objective is to ‘leave nobody behind’ and obtain a female share of STEM graduates of 50% in Ireland. The ethos of inclusivity underpinning the WITU aims, as set out below, is directly in line with this national objective. The creation of the WITU network grew out of a need to address our commitments to the SDGs (particularly SDGs 4 and 5) and at a more local level, the outcome of the Athena Swan review undertaken as part of the University strategy (Higher Education Authority, “Athena SWAN Charter”, 2015).

2 METHODOLOGY – AIMS AND SCOPE OF WITU NETWORK

The aim of the WITU network is to retain students in engineering and technology courses, increase gender diversity, and create pathways for all ("Women in Technology United (WITU)". TU Dublin, 2023; "SDG Goal 5 Gender Equality". TU Dublin, 2023) To achieve this, the network implements targeted interventions such as hosting events, creating a support network for students, reaching out to schools, and promoting Equality Diversity and Inclusion (EDI) in technology on social media. WITU collaborates across three campuses, nine schools, and eleven disciplines ("Women in Technology United (WITU)". TU Dublin, 2023).

WITU operates collaboratively through its working group of 41 members who are representative of engineering and technology programmes in the University. Communication among members is conducted through a Microsoft Teams channel, while communication with STEM students is through email, Instagram, and LinkedIn. WITU has marketing strategies to raise awareness of the network among students, which includes a WITU website page and social media accounts. The Instagram page has been a focal point of communication with industry, with companies making contact through it. WITU engaged the services of a graphic designer who designed a branding suite for WITU. Events and initiatives being held across multiple campuses are unified under the WITU banner, with consistent advertising and design employed for posters, invites, social media notifications using the WITU branding.

The events organised by WITU bring together gender minorities, so there is a space created where they can connect with students and alumni in STEM and become part of a larger network. These connections can last throughout their college lives and the sense of belonging generated can encourage them to complete their studies. The next section describes each of these targeted interventions and the feedback and impact from each.

The WITU network is aimed at students on STEM courses, and results of an analysis of the percentage of female students in engineering and technology programmes in TU Dublin is given in Table 1. The data reflects the national and European landscape in terms of the low numbers of female students on technology and engineering programmes.

Table 1. % Female Students in Engineering and Technology Programmes in TU Dublin

TU Dublin % Females	2018/2019	2019/2020	2020/2021	2021/2022
Engineering Programmes	10%	11%	12%	11%
Business Technology	26%	28%	31%	23%
Computing Programmes	14%	16%	17%	23%

3 INTERVENTIONS AND IMPACT

This section describes some of the key activities organised by the WITU network and the feedback of and the impact on the participants.

3.1 Interactive Design Workshop

The online Interactive Design Workshop for female students in technology and engineering programmes was the first pan-University event organised by WITU, aimed at expanding the network across the university and creating connections among students. The project was funded through the 2021 EDI Fund and involved a panel of speakers who discussed gender and diversity in design, including topics such as artificial intelligence (AI) and bias in data, gender inclusivity in industry, and universal design considerations. Students worked in teams on a design challenge, with a key criterion being to explore universal design solutions. A total of 44 participants, including 24 students from various technology disciplines, attended the event. A panel of judges provided feedback on the design solutions, with participants also invited to provide feedback which included some of the following observations.

Participants enjoyed the interactive nature of the event and how the presentations in the first part linked with the design challenge in the second. They noted that the event was insightful and found it interesting to learn about issues around gender bias in technology design. They enjoyed interacting and ideating with students from other programmes and disciplines within the design teams, and found that this enabled them to expand their contacts. In addition, working in teams to ideate, problem solve and present their solutions, helped develop their communication and teamwork skills. Participants highlighted the importance of seeing and understanding different viewpoints when designing, and acknowledged that this gave them a different perspective and understanding of products and technology that are commonly used. They recognised issues around coding and bringing unconscious bias into technology design such as in AI systems. They reported that the event increased their understanding of universal design, and the importance of the user experience in design.

Feedback suggested that the majority of respondents (86%) would be interested in further events, in particular around universal design, events creating awareness around technology, engineering, and design, and with a focus on redesigning women's products that may traditionally have been designed from the male perspective. There were also suggestions for other events including focused graduate recruitment and how women cope and succeed in technology and engineering communities. Ten participants also expressed interest in being part of a focus group exploring the experiences of gender minority groups in engineering and technology programmes. This is planned as a future WITU initiative. In addition, 71% of participants noted that they would be interested in being an ambassador for their programme, and 71% were interested in joining a student-run society for women in STEM.

On asking participants how they thought greater gender diversity can be achieved in our technology programmes in TU Dublin, their responses included:

- Increase number of technology related subjects and workshops in all-girls schools
- Create an impression from a younger age by holding workshops such as this for students in 1st – 3rd year in secondary school
- That they themselves are role models to the younger generation and should spread awareness of design and promote STEM
- Increase advertising for networks such as WITU and the work being done
- Visit schools and talk to younger girls about opportunities available

- Encourage women to study STEM at a younger age
- Educate people in a fun and engaging way, like this event
- More events like this with diversity in speakers and scenarios and create awareness at a younger age
- Encouraging successful women to express themselves to younger generations

The event celebrated women in technology and was a reflection of the importance of gender diversity in technology design. Although it targeted female students, the event was open to all genders to be inclusive and increase awareness around the issues discussed. This finding guided the organisers in their approach to subsequent events in terms of who is targeted and invited.

3.2 Annual 'Meet & Greet' Event for Incoming Year 1 Students

WITU hosts an annual "coffee morning" event as part of the first-year induction for all female students in technology and engineering programmes. The event provides an opportunity for female students to meet each other, as well as later-year students and lecturers. The event includes refreshments, campus tours, mentor and role model talks, and career talks. Feedback has been very positive with students sharing contact information for further interaction. The students from later years share their experiences and give advice to the first years on how to succeed, both in their studies and also from the social perspective, for example by joining clubs and societies. To date this event has been run successfully on all campuses. See Figure 1 (inclusive design of invite) and Figure 2 below.

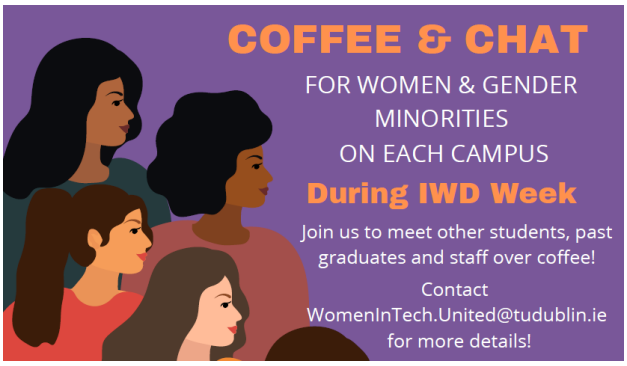

Fig. 1. Inclusive design of invites

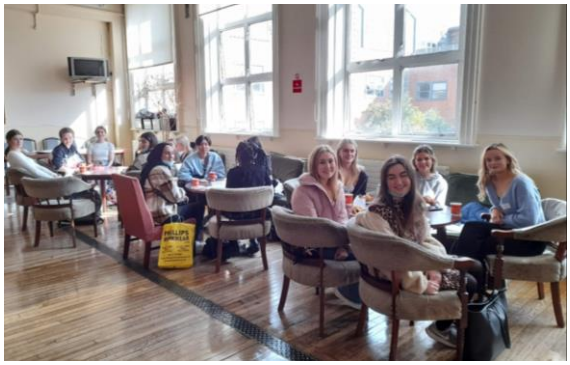

Fig. 2. Meet and Greet Coffee Morning

3.3 Scholarship Workshops

In recent years, industry is prioritising the recruitment of women into engineering and technology roles and are enabling this through financial investments in higher education scholarships. Academic scholarships, awards, and bursaries can have a significant financial impact on a student's life at university and can help with retention of women in engineering and technology programmes. In 2021, the TU Dublin Foundation had a total of €195,916 awarded to 85 students through 17 funds and scholarships, with a median award of €3,000 ("Scholarships". TU Dublin, 2023.). In response to this, WITU facilitated scholarship application workshops in October 2021. These workshops aimed to support female engineering and technology students in the scholarship application process. The workshops signposted students to available scholarships and helped students improve their applications through tips on completing forms, improving their CVs, and preparing personalised pitches.

Data was gathered from 16 Engineering and Technology scholarship application forms and requirements were summarised into an easy to digest toolkit for students. Some of the scholarships that the students applied for included; Huawei Tech4Her Scholarship, Huawei Seeds of the Future, Generation Google Scholarship, Marco Women in Engineering Scholarship and the Intel Scholarship for Women in Tech. The workshops were a great success with 46 students attending the workshops, 12 students applied for scholarships and 8 scholarships were awarded with a median value of €3,000 per scholarship. The workshops highlighted other initiatives for the female students to get involved in, such as, CodeFirst:Girls, TU Dublin Sustainability Hackathon, Dell Aspire mentoring programme and Workday Future Females in Tech events. These initiatives also help build the students confidence for scholarship applications for the following year and increase their self-efficacy in their ability to apply for these awards. The outcomes of these workshops are highlighted in Table. 2.

Table 2. Outcomes from WITU Scholarship workshops

School/Discipline	**Attendance at Workshop**	**Scholarship Applications**	**Scholarships awarded**
Business Technology	15	6	3
Engineering	16	1	-
Computer Science	10	3	3
Enterprise Computing & Digital Transformation	5	2	2

3.4 Industry and Alumni focused intervention: Annual IWD Networking Event

Students' perceptions of a career in engineering and technology can be based on narrow stereotypical views, which in computer science can sometimes be an image of a socially awkward, "geek" or "boffin" (Archer at al., 2013). According to Gladstone and Cimpian (2021) positive role models that have a perceived similarity and similar attainability of success to students in terms of their gender, race/ethnicity, age, and identification with STEM can positively shape a student's perception of careers in STEM. Students need strong role models and need to see successful exemplars who are just like them. As educators, we need to reinforce the slogan "if you can see it, you can be it" with our students.

In response to this, each year on the 8th March, WITU organises a series of university-wide, networking events to celebrate International Women's Day. These events focus on showcasing positive female role models in engineering and technology careers (both alumni in industry and university staff). In 2022, WITU members created videos for each school showcasing staff, alumni and students from their school speaking about their current career journeys and giving a one-liner piece of positive advice to female students in engineering and technology. These videos have been collated and disseminated on the WITU website. At these networking events, staff and alumni speak of the opportunities available to the students, from summer internships, third-year internship opportunities, industry-sponsored scholarships to international competitions and co-curricular activities that helped them on their career paths.

3.5 Coding4Girls - Attracting More Females onto STEM Programmes

The "Coding4Girls" is a funded one day camp which aims to inspire secondary school girls to explore the exciting world of technology and engineering. The objective is to encourage young girls to consider pursuing careers in technology and engineering and to promote gender diversity in the STEM field. Coding4Girls features a variety of hands-on activities and practical sessions, including fun coding challenges, programming arduinos to learn about robotics, and hands on design challenges such as tower building. Experienced faculty members lead these sessions and provide guidance and support throughout, enabling participants to learn in a fun and interactive way. Additionally, the participants have the chance to engage in informal chit-chats with current female students, allowing them to learn about the experiences of other women who have pursued similar interests and fields of study. The feedback from the camp was positive with 80% of the participants indicating that they would like to do more coding.

4 CONCLUSIONS

As well as the promotion of gender diversity within technology and engineering programmes across TU Dublin, these targeted events were a vehicle to expand the WITU network. A realisation is that even though female students may be the target audience, this does not mean that events cannot be opened to a wider audience. This is in recognition that all genders need to be part of the solution in achieving the aims of WITU and wider national aims around diversity and inclusion in STEM. A related conclusion is around the importance of language and imagery used in branding, invitations etc in terms of being inclusive.

Providing opportunities for the students to make friends and increase their network, particularly in year 1, increases their sense of belonging and community within the University. This in turn impacts their likelihood of success both academically and holistically. Feedback from students also highlighted the importance of lecturers knowing their name and the Meet and Greet Coffee events were an effective way to achieve this. Events where alumni are invited back to speak with the students, highlights the importance of role models who they can relate to in terms of similar attainment of success and in increasing attributes such as confidence, drive and self-efficacy. Similarly, by inviting scholarship recipients to speak at the workshops and give advice, the female students are seeing what success looks like and what they can achieve.

These targeted interventions are examples of how the WITU network supports and champions women in engineering and technology through collaborative practice in bringing together students, alumni, staff from across a wide range of disciplines within the University.

REFERENCES

Archer, L., DeWitt, J., Osborne, J., Dillon, J., Willis, B., and B. Wong. 2013. “Not girly, not sexy, not glamorous: Primary school girls’ and parents’ constructions of science aspirations”. In: *Pedagogy, Culture & Society*, Volume 21, Issue 1, pp. 171–194.

Central statistics office. 2017. “Profile 10 - education, skills and the Irish language”. Cork: central statistics office.

Croak, M. 2018. “The effects of STEM education on Economic Growth”. *Honors Theses*. 1705.

“CWIT - Connecting Women in Technology”. https://cwit.ie. Accessed 04 May 2023.

Dunne, J., O’Reilly, A., O’Donoghue, A., and M. Kinahan. 2022. “A Review of Irish National Strategy for Gender Equality in Higher Education 2010–2021”. In: *García-Peñalvo, F.J., García-Holgado, A., Dominguez, A., Pascual, J., Women in STEM in Higher Education: Good Practices of Attraction, Access and Retainment in Higher Education*. Lecture Notes in Educational Technology. Springer, Singapore.

European Institute for Gender Equality (EIGE). 2022. “Gender Equality Index 2022”. https://eige.europa.eu/gender-equality-index/2022/country/IE. Accessed 25th April 2023.

EUROSTAT. 2021. “Women in Digital Scoreboard 2021”. https://digital-strategy.ec.europa.eu/en/news/women-digital-scoreboard-2021.

García-Peñalvo, F. J., García-Holgado, A., Dominguez, A., and J. Pascual. 2022. “Women in STEM in higher education good practices of attraction, access and retainment in higher education”. In *lecture notes in educational technology.* Springer.

Gladstone, J.R. and A. Cimpian. 2021. “Which role models are effective for which students? A systematic review and four recommendations for maximizing the effectiveness of role models in STEM”. In *International Journal of STEM Education* 8, Article number: 59. https://doi.org/10.1186/s40594-021-00315-x.

Higher Education Authority. “Athena SWAN Charter”. HEA, 2015. https://hea.ie/policy/gender/athena-swan/. Accessed May 4, 2023.

Higher Education Authority. “Key Facts and Figures: Fields of Study by Gender”. HEA, 2021. https://hea.ie/statistics/data-for-download-and-visualisations/key-facts-figures/. Accessed May 4, 2023.

“I WISH”. https://www.iwish.ie/ Accessed May 4, 2023.

Kent Doyle, M., Costello, O., and P. Kopacek. 2019. "Where are all the Irish women engineers: a case study." In: *IFAC-PapersOnLine* 52, no. 25: 136-141.

Kordaki, M., and I. Berdousis. 2020. “Identifying Barriers For Women Participation In Computer Science”. In *Pro Edu. International Journal of Educational Sciences* 2, no. 2: 5-20.

Lester, J. 2010. “Women in Male-Dominated Career and Technical Education Programs at Community Colleges: Barriers to Participation and Success”. In *Journal of Women and Minorities in Science and Engineering* 16, no.1.

Ribeiro, Ti., Silva, J., Paz, M., Cardoso, A., Teles, N., Nogueira, C., and Te Ribeiro. 2023. “Strengthening Bridges between STEM Education and Entrepreneurship: Pathways to Societal Empowerment towards Sustainability”. In *Enhancing Entrepreneurial Mindsets Through STEM Education*, pp. 25-47. Cham: Springer International Publishing.

“Scholarships”. TU Dublin, 2023. https://www.tudublin.ie/connect/the-tu-dublin-foundation/scholarships/. Accessed May 4, 2023.

“SDG Goal 5 Gender Equality”. TU Dublin, 2023. https://www.tudublin.ie/explore/about-the-university/strategicintent/creating-impact/sdg-goal5/. Accessed May 04, 2023.

SDG Index and Dashboards - Global Report. 2021. “Female share of graduates from STEM fields at the tertiary level”. https://dashboards.sdgindex.org/map/indicators/female-share-of-graduates-from-stem-fields-at-the-tertiary-level/trends.

Tomassini, C. 2021. “Gender gaps in science: Systematic review of the main explanations and research agenda”. In *Education in the Knowledge Society (EKS)* 22.

UNESCO. 2017. Division for Inclusion, Peace and Sustainable Development, Education Sector, Education for sustainable development goals: Learning objectives. 1-62.

“Women in Science and Engineering Research, WiSER”. TCD, 2023. https://www.scss.tcd.ie/Siobhan.Clarke/courses/wiser/ Accessed May 4, 2023.

“Women in Technology and Science IRELAND”. https://witsireland.com/ Accessed May 4, 2023

“Women in Technology United (WITU)”. TU Dublin, 2023. https://www.tudublin.ie/explore/about-the-university/equality-and-diversity/edi-initiatives-in-tu-dublin/witu/ Accessed May 4, 2023.