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Breaking the bias: perspectives of a WiSTEM^{2}D programme inspiring female undergraduates for a technical future

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Abstract

Purpose – This is an account of student experiences with the 2020/2021 Johnson & Johnson (J&J) Women in Science, Technology, Engineering, Mathematics, Manufacturing and Design (WiSTEM^{2}D) intervention programme at the University of Limerick (UL).

Design/methodology/approach – The WiSTEM^{2}D programme supports female undergraduate students undertaking science, technology, engineering, mathematics, manufacturing and design (STEM^{2}D) courses, helping them develop and grow in their degrees, research and beyond.

Several recipients of the 2020/2021 WiSTEM^{2}D programme provided reflective journals on their experiences of the programme.

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Findings – During the programme, data were gathered from students in the form of qualitative information, which was used to analyse perceptions of the programme. This analysis revealed that students found the WiSTEM^{2}D programme beneficial to them and that it improved their confidence levels, career knowledge and overall networking abilities.
Originality/value – WiSTEM^{2}D is one of several initiatives globally that are attempting to empower and encourage women to be active in STEM.

Keywords Career, Confidence, Gender, Intervention, STEM, STEM^{2}D, Students, Women
Paper type Research paper

Introduction

Gender equality is a global issue in science, technology, engineering and mathematics (STEM) education and careers at all levels (Ertl *et al.*, 2017). Women are underrepresented in STEM, with the United Nations Educational, Scientific and Cultural Organisation (UNESCO) stating as recently as 2019 that women account for less than 30% of the world's researchers (UNESCO, 2019).

In 2019, there were 15.4 million scientists and engineers in Europe, of which 6.3 million (41%) were women and 9.1 million (59%) were men (Eurostat, 2021). Looking at the breakdown of these figures by individual member states, they show that the proportion of female scientists and engineers ranged from 28% in Luxembourg to 55% in Lithuania. The number of female scientists and engineers in particular sectors ranged from 21% in manufacturing to 46% in the services sector. In 2020, the number of scientists and engineers in Europe increased to 16 million. Of this, 6.6 million (41%) were women and 9.4 million (59%) were men (Eurostat, 2021, 2022). This represents an increase of 254,500 women in science and engineering compared with 2019 (Eurostat, 2022). In 2011, women represented 38.7% of scientists and engineers (Catalyst, 2022). Even though the number of women has increased, they still only represent 41% of scientists and engineers. In 2020, the proportion of women scientists and engineers ranged from 31% in Hungary to 52% in Lithuania, Portugal and Denmark and to 45% in Ireland (Eurostat, 2022). In 2020, the number of female scientists and engineers in particular sectors ranged from 22% in manufacturing (up 1% from 2019) to 46% in the services sector (no change from 2019) (Eurostat, 2021, 2022). While it is positive to see a year-on-year increase in the overall number of female scientists and engineers, the increase is small in terms of achieving parity between women and men.

In Ireland, 2017 STEM graduate numbers of 32.7 per 1,000 persons aged 20–29 were the highest rate in Europe. Despite this, women are under-represented in third-level education STEM courses. However, with 46.0 male and 19.4 female graduates per 1,000 persons aged 20–29, this represented the highest gender differential in STEM graduates in Europe (Ireland, Department of Education, 2020; The Irish Times newspaper, 2019). Furthermore, many female students in STEM courses fail to graduate.

Women cannot be heard if they are not seen. How can women be included equally in the world in which they live if their voices are not heard and opinions considered equally regarding decisions that affect them? For example, it is only since 1997 that women must be considered when appropriate medicine doses are researched. Therefore, many drugs currently in use were approved based on clinical trials conducted solely on men (Zucker and Prendergast, 2020).

Unfortunately, in many countries, there are differences in involvement and attainment between women and men in both STEM education and careers, typically to the disadvantage of women (Ireland, Department of Education, 2020). The quality of learning experiences for female students is compromised by gender stereotypes and biased attitudes that limit their education choices (UNESCO, 2017). This is despite recognition both nationally and internationally that there is a need to advance STEM education to meet social and economic challenges and to help develop technically literate citizens (Ireland, Department of Education, 2020). Education can play a key role in this, and STEM initiatives have been

developed by interested parties such as voluntary groups, academia and industry at all stages of primary-, secondary- and third-level education.

This paper examines one STEM intervention undertaken at the University of Limerick (UL) in Ireland. This initiative is the Johnson & Johnson (J&J) Women in Science, Technology, Engineering, Mathematics, Manufacturing and Design (WiSTEM^{2}D) university programme, which is an international programme in which UL is a partner. The WiSTEM^{2}D programme is focused on STEM disciplines but expands its reach further by adding two more relevant subject areas, namely manufacturing and design. Participation in the programme is competitive. Successful students receive a scholarship, mentoring from J&J and education through specific workshops. The programme has been running at UL for seven years, and since 2020, it also includes UL undertaking research on the topic of *women in STEM^{2}D*.

The research presented in this paper identifies the results that demonstrate the impact of this intervention programme. We commence our paper with a background section examining the state of the art for such initiatives, leading to a section describing WiSTEM^{2}D at UL. This is followed by a discussion on the research methodology. We then present the results and discussion of our study. Finally, we conclude the paper.

Background

The term STEM pipeline was first introduced by Berryman (1983). Berryman examined the representation of women in STEM, describing various pathways in a manner which allows us to examine the barriers and obstacles that can be encountered. Ideally, women who are interested and inclined towards STEM would be engaged early in their education, pursue it up to third-level and follow this with a STEM career. However, this is not the case for most women, as unfortunately there is a leaky pipeline (an umbrella term for the loss of women from STEM at various points in their educational or professional careers). Concern regarding this loss is such that research has been undertaken into finding its causes and examining "leak prevention" initiatives. In the research presented in this paper, causes were analysed, and an initiative was implemented to prevent leaks of talent at all points along the pipeline. Bennett reviewed the STEM pipeline and outlined future research directions in this area (Bennett, 2011) (Table 1).

The most prominent leaks identified are the low numbers of women entering STEM careers, problems retaining women in these careers and issues for women progressing in such careers. Problems faced by women predominantly include negative attitudes, stereotypes and a lack of role models (Almukhambetova *et al.*, 2021).

The field of computer science, information and communication technology (ICT) and related fields within Ireland and the UK comprises only 20% students who are women (Berry *et al.*, 2022). Computer science is often viewed as a male or masculine subject. Having more women included in such fields would reduce gendered interpretations, allowing them to be more "transgendered" and viewed as less masculine by potential students (Lagesen *et al.*, 2022).

Unfortunately, not much has changed since Bennett (2011) identified these research directions over a decade ago. The leaky pipeline still exists (Almukhambetova *et al.*, 2021). An Irish survey examining the main causes of fewer women in STEM professions and leadership roles found that female STEM undergraduates think this is due to social bias, balancing work and family life and a lack of role models (Kelly *et al.*, 2019). There has been, however, a radical change globally over the last two years in the way people work, brought about by the COVID-19 pandemic. In terms of following the future research areas, Bennett (2011) identified some positive stereotypes of future selves – reimagining workplaces and maximising women's potential. Workplace technology has allowed many of those with STEM careers to use technology to work more flexibly remotely (often at home). Targeted STEM interventions can encourage women to have more confidence in their potential contributions.

Areas captured in the leaky pipeline	Theoretical contributions	Barriers/Obstacles found	Future research directions
Low numbers of women entering STEM careers	Stereotypes of - "women's work" - women's aptitudes - scientific occupations	Girls' attitudes towards STEM qualifications	Positive stereotypes of future selves
		Gender blind teaching practices/environments	Moving from binary dualisms to multiple subjectivities
	Binary contrasts based on essential sex differences		Welcoming diversity
			Gender-aware teaching
Retention of women scientists/ early exit	Organisational policy: work-life balance	Flexible working over long working hours	Reimagining workplaces
	Women's preferences	Choice of motherhood over paid employment	Awareness of women's commitment to employment
Progression of female scientists	Gendered workplace cultures	Few women in senior roles, women can out-number men in a small range of "flexible" science occupations	Governance issues and women's representation in science hierarchies
	Gendered measurements of achievement		Branching career paths
		Female strategies for dealing with harassment	Revaluation of women's contribution
		"Ideal" worker being normally a male	Maximising women's proven potential

Source(s): Bennett (2011)

Table 1.
The leaky pipeline current and future research directions

In 2017, Microsoft interviewed over 11,000 female students across Europe to gain an understanding of why women are not studying STEM (Microsoft Corporation, 2017). They found that the key enablers for girls who want to continue studying STEM subjects were having role models, getting support from home and getting support in the classroom. Also, in 2017 in Ireland, a gender balance policy defined methods to ensure STEM education is successfully executed in second- and third-level education (Ireland, Department of Further and Higher Education, Research, Innovation and Science, 2017). This was needed, as existing STEM education was not appealing to girls.

Stringer *et al.* (2020) reviewed interventions such as *Girls in STEM*, *Science Olympiad* and *Math Counts*. Stringer *et al.* found that when women participate in STEM intervention programmes, they have a stronger STEM career identity and greater motivation than non-participant females. Altoum (2021) carried out a study of boys and girls in middle and high governmental schools who were also enrolled in STEM-related extracurricular programmes in Qatar. Altoum outlined a positive relationship between attending STEM programmes and aspirations towards STEM careers for both boys and girls.

In 2017, Blackburn (2017) carried out a review of related literature from 2007 to 2017, examining the status of female STEM students in higher education. Blackburn found that significant financial resources, educational support and social support must be available to help females transition from higher education to careers (particularly for underrepresented minority students).

STEM intervention programmes have been used in many countries. In STEM education, there is no one type of intervention that would seem to be the preferred approach to tackling

gender inequity (Ireland, Department of Education, 2020). However, there are similarities in the approaches that can guide policy and practice in this area; for example, the idea of creating a multi-level, interlinked STEM ecosystem has been proposed (Ireland, Department of Education, 2020). While Blackburn (2017) found that there is value in students accessing STEM interventions, more research is needed to assess how and where interventions and retention strategies are best used to be most beneficial to female students. This may also identify shifts in how such interventions are implemented.

In 2020, the Irish Government commissioned a review to examine international STEM interventions, hoping to uncover effective methods (Ireland, Department of Education, 2020). They found that traditionally, STEM interventions have been aimed at adolescents and up, are once-off and try to change beliefs. The authors of the review recommended that interventions start earlier, be more inclusive, be longer-term and seek to change the structures and systems that create barriers to women entering STEM.

In practice, addressing the challenges that women must overcome to successfully pursue STEM programmes requires a multi-faceted approach and the following should be considered: individual levels, family perspectives, societal levels and the work environment (The African Academy of Sciences, 2020).

WiSTEM^{2}D: an industry-supported intervention

The WiSTEM^{2}D intervention has been led by a joint industry-academic team from J&J and UL. J&J is a multinational healthcare company that has developed several empowering initiatives. One of these is the global WiSTEM^{2}D programme (www.jnj.com/wistem2d), which aims to support female undergraduate students undertaking STEM^{2}D programmes. In Ireland, the programme currently runs at five universities, namely UL, University College Cork (UCC), University of Galway, Munster Technological University (MTU) and Trinity College Dublin (TCU). Every year, female undergraduate STEM^{2}D students apply to participate in the programme through a competitive selection process, and over the past 7 years, around 400 female students have participated. In the research presented in this paper, we were interested in understanding:

(1) What benefits, if any, were identified by the WiSTEM^{2}D participants in this STEM intervention?

To answer this question, a single case study approach examined the 2020/2021 J&J WiSTEM^{2}D programme run at UL.

At UL, WiSTEM^{2}D is run within Lero, the Science Foundation Ireland Research Centre for Software. There were 30 participants in total chosen for the 2020/2021 programme, and they formed two distinct cohorts. Ten were individual awardees, while twenty were team awardees, with four on each team. Individual awardees received a bursary and were each provided with a mentor. Each team had one mentor collectively.

J&J is the industry partner, and, through Lero, UL is the academic partner, collaborating and working towards a shared vision of providing mentorship and information to the WiSTEM^{2}D programme participants. J&J and Lero contributed financially to support the programme, with J&J also providing mentors for the participants. Lero@UL coordinated the participant events and led research related to the programme.

All participants were given early career development opportunities. These included networking with their peer group, J&J business leaders and UL academics. Workshops led by UL academics, J&J staff and external speakers were also organised. In 2020–2021, due to the COVID-19 pandemic, participants were unable to meet in person, so the programme interactions were instead supported in an online/virtual format. This did have unexpected benefits – for example, more speakers could be facilitated in workshops as they could join

virtually, regardless of their location. One main disadvantage was that the participants had no actual face-to-face meetings, which made networking harder. The programme had to be virtual, including the interview process to select programme participants, workshops, meetings and the J&J site tour. The organisers had to be agile in their delivery of the programme. One such example of this was the site tour. In previous years, this was an exciting part of the programme as participants visited a J&J site and saw first-hand how such an industrial facility works. A virtual site tour was facilitated using photo stitching and narration from the site staff. This proved to be a less-than-ideal but, in the circumstances, a successful alternative.

The team participants carried out research into various STEM^{2}D topics. When the programme began, participants were given a list of proposed project titles to choose from and the option of proposing their own title. Each title had to be on a topic related to women in STEM. A sample of titles is as follows:

(1) How could second-level schools present a better image of STEM^{2}D to their current students?

(2) How can the availability of STEM^{2}D subjects be improved in second-level schools?

An example of a title proposed by participants was:

(1) Women in STEM Podcast, where the podcast's aim was to interview women pursuing careers across the disciplines in STEM.

The team participants researched their project titles and produced a video and a poster, which were also presented to an audience during an online meeting. Guidance was provided by UL in terms of areas such as ethics, project planning and teamwork. The J&J mentors were also available to guide the teams. Each team presented their research project to a panel made up of staff from UL and J&J. A prize was given to the best overall project, which was titled "An investigation into how the availability of STEM subjects in single-sex schools affects college/career choices".

In addition, when the teams had completed their detailed projects, they were encouraged to submit their work to a conference. Two teams were accepted to present their posters at the Association for Computing Machinery ACM womENcourage 2021 conference. The students who received individual bursaries did not participate in the research project element of the programme.

Research methodology

To answer our research question, we undertook a reflective practice project with all 30 of the WiSTEM^{2}D programme participants. Reflective practice is thinking about one's own experience. Self-reflexivity "remains closer to the social sciences since its purpose is to contribute to an understanding of social processes" (O'Connor, 2019). O'Connor acknowledges that while it has limitations, it does provide insights that are not obtainable in other ways. Reflection is a fitting methodology to answer our research question. It can provide guidance for the reflection activity by acting as an arbitrator for students to help them engage in reflection (Risko *et al.*, 2009). Finley *et al.* (2018) used a method of guided discussions for documenting implementation phenomena. Reflections are a useful tool (Cowan, 2017), and we found that this was indeed the case in helping us to understand the effect of the intervention.

Ethical approval was granted by UL (Number: 2021_10_18_S&E) to gather the participant reflections. After completing the programme, participants were asked to individually consider their involvement and write a reflection piece on their own personal experiences. As none of the authors of this paper were teachers of the students, there was no

requirement to mitigate the influence of power dynamics that would arise from investigating one's own students. The author tasked with collecting the reflections was a Lero@UL team member whose role was operationalising the programme from UL. The other author roles were UL leads, a J&J leader and a J&J team member. Areas of the programme that were evaluated in previous years were given to the participants to aid them in this task. These were:

(1) Confidence levels before and after the programme;

(2) Career aspirations before and after the programme;

(3) Expectations before and after the programme;

(4) Workshops;

(5) Mentorship;

(6) Speaker topics;

(7) Team dynamics;

(8) High and low points and

(9) Engaging in the programme while working remotely.

While we strongly encouraged participants to decide on their own topics for reflection, they were able to consider these topic headings as guidance. In total, 29 participants submitted their reflections on being part of WiSTEM^{2}D in an essay-style format. While there are numerous implemented interventions, a significant gender gap continues (Marquardt *et al.*, 2023). The benefit of using the participants' own reflections on various parts of the programme is that it provides a unique insight into the participants' personal thoughts on a STEM intervention. Also typically, in the literature, there are different tools used to evaluate STEM programmes. For example, the highly cited book by Fisher and Margolis (2003) uses interviews to gain students insights.

Open coding has been shown to be a useful technique in qualitative research (Khandkar, 2009). This technique was used when analysing the data gathered. For example, the code *confidence* was applied to the following quotes:

(1) "My confidence levels before entering the programme were not very high" and

(2) "This has given me confidence for my future career in STEM^{2}D".

Some quotes were given multiple codes; for example, the latter statement was coded under both *confidence* and *career*.

These reflections were examined using thematic analysis, and coding of the text allowed us to identify emerging themes, aggregate the information and make comparisons between the different participants. This facilitated the building of a story around specific events, facts and interpretations.

Results

We were interested to know the benefits, if any, identified by the WiSTEM^{2}D participants. They gave us some insight as to where we could make changes to the programme. We also identified where their reflections supported and/or challenged other published literature. Themes discussed by the participants included positive relationships between STEM interventions and career aspirations, confidence levels, a lack of career knowledge and networking.

Participants rated their overall experience, and this resulted in the following codes: excellent, satisfactory and not satisfactory (Figure 1), with the vast majority feeling it was either "excellent" or "satisfactory". We identified that participants who stated that their experience of the programme was "satisfactory" were mainly describing how the virtual experience felt to them. They would have preferred to build their network in person rather than virtually and to have more flexibility in the timing of the workshops. Two of the participants felt that having to work on a research project took time, and partaking in the programme remotely meant that for them the experience overall was not satisfactory.

When the programme started, participants were excited and felt honoured to be a part of it, although eight were nervous. In terms of what they expected from partaking in the programme, the main areas identified were availing of mentorship, gaining an understanding of STEM careers and building a network.

Industry and J&J were mentioned a lot in the participant reflections. In total, 22 participants felt overall that their expectations were met and that both their industry and career planning knowledge increased. Ten participants didn't explicitly expect to increase their confidence at the beginning of the programme. However, they remarked how confident they felt after the programme due to their increased industry and career knowledge.

Our analysis suggests a link between attending a STEM intervention and STEM career aspirations, as exemplified by the following quotes from the reflections:

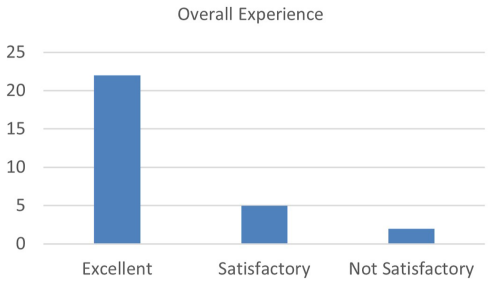
(1) "The programme inspired me to think differently and know my self-worth, by allowing me to engage with females already working in STEM careers and to learn from them".

(2) "This gave me inspiration and role models to follow throughout my career journey, something foreign to me up until this point".

This aligns with the sentiment discussed in the background section, where we outlined how Altoum (2021) points to the positive relationship between attending STEM intervention programmes and aspiration towards STEM careers.

The unique access participants had through J&J provides mentorship, which is open to multiple industries and has a global reach. Over the years, J&J has expanded the programme reach to more universities, and in 2023, all the Irish WiSTEM^{2}D partnered universities came together for an in-person event. This was an opportunity for the participants to meet their peers from other universities and to expand both their academic and industry networks.

We now discuss in more detail the three main themes identified in the participant reflections: confidence levels, career knowledge and networking.



Source(s): Authors' own creation

Figure 1. Participant's experience of the programme

Confidence levels

We identified that students had a relative lack of confidence at the beginning of the programme and that this had improved significantly by the end of the programme. Lack of confidence was seen to manifest in the form of feelings of self-doubt among the ten participants who did not expect to increase their confidence.

What follows are several quotes from the participants that illustrate their feelings regarding confidence:

(1) "My confidence levels have shot up since the beginning of the programme".

(2) "My confidence levels before entering the programme were not very high. I am generally a confident person but when it comes to academic activities, I generally lack confidence".

(3) "Receiving this award has boosted my confidence".

(4) "The WiSTEM^{2}D programme overall afforded me with a boost in self-confidence that I barely possessed previously".

(5) "I am confident that come what may, I will be persistent and self-assured as a woman in STEM!"

Career knowledge

The second theme uncovered was a lack of knowledge in terms of the options available for different career paths. Before the programme, participants were not clear on all the possible career paths available to them. However, their knowledge was expanded by the end of the programme because they met a range of people working in different STEM areas. This change in career view is evident in the following participant quotes:

(1) "Genuinely speaking, the whole programme has been motivational and has provided me with a personal drive in the field of WiSTEM^{2}D for the rest of my career".

(2) "This has given me confidence for my future career in STEM^{2}D."

(3) "I think the programme has most definitely shaped my career aspirations and future".

(4) "The programme has also given me a sense of belonging in STEM^{2}D and has opened my eyes to what careers I could possibly venture into".

Networking

The third theme that emerged was networking and its importance, especially given that the programme was delivered online because of the COVID-19 pandemic. Participants were eager to network and meet other women in STEM^{2}D areas.

(1) "To see these females, talk about their journey, how it was growing up in a home that was say, culturally different to those around them, and the challenges they faced, was something I was able to easily relate to".

(2) "The programme has given me the opportunity to network within peer groups and with Johnson & Johnson business leaders".

(3) "The only aspect I felt was missing in the programme was getting to know other recipients. It would have been good for networking and making friends during this isolating time".

Discussion

The three main themes our research revealed displayed interlinks in how they impact each other; for example, a greater knowledge of career options coupled with networking opportunities increases confidence levels. Experiences in STEM are a major factor in the confidence levels of female students (Chemers *et al.*, 2011). Role models act as a support to women, often increasing their confidence levels (Lockwood, 2006). The participants in the WiSTEM^{2}D programme found it very informative to have a mentor that they could contact to ask questions, discuss issues and get career advice. Having someone available to them who was working in a relevant STEM role meant that they had an accessible role model.

The mentorship and workshops provided as part of the programme also covered areas such as career and curriculum vitae (CV) development, which enabled participants to become more informed about their career options after finishing university. Many participants were not aware, before taking part in the programme, of the multitude of careers available to them within the STEM field. The programme increased the participants' industry knowledge, which in turn increased their career knowledge. Having a forum such as a workshop, where speakers from diverse academic and industrial backgrounds presented their career paths, further broadened the participants' ideas of potentially available careers. For example, several participants did not think it was a feasible option for them to return to university after working in industry to, for example, complete a master's degree or change careers. Dresden *et al.* (2018) state that approximately 30% of women who enter engineering leave the career. Francis *et al.* (2017) found that women often do not continue a STEM career once they have graduated. Unfortunately, this is a common occurrence, but initiatives like the WiSTEM^{2}D programme are attempting to facilitate women in staying in, or returning to, a STEM career. The consequence of the leaky pipeline is that it reduces diversity in the workforce, which can in turn reduce innovation (Hewlett *et al.*, 2013).

The networking that participants engaged in on the programme 2020/2021 was vastly different from participants in previous years. They were unfortunately not able to meet in person. This online programme format had distinct advantages and disadvantages. Team participants were required to manage all their team-based interactions using online mediums as they worked collaboratively to carry out their research projects. This meant that, in addition to teams being multi-disciplinary, they were also based at multiple locations and had to manage all the additional overhead that this entailed. Doing this effectively was a great achievement and the participants adapted well given the paradigm shift in terms of how the meetings were held. Networking and mentorship help women remain in STEM careers (McCullough, 2020). Within the WiSTEM^{2}D programme, these were provided by both women and men, and the participants greatly appreciated it. They felt empowered and not so much in the minority, as they were now part of a bigger group. Networking and mentoring also provided them with role models and examples of how their careers could progress.

The results of our research are in line with the results detailed in existing literature in terms of greater confidence and career knowledge. For example, Microsoft found that key enablers were having role models and support at home and in the classroom (Microsoft Corporation, 2017). These enablers are facilitated in WiSTEM^{2}D through mentorship and support. In the subsequent year (2021/2022), there were several changes made to the programme. This was done to provide more support to participants and allow all of them to work in teams. We moved from individual bursaries to everyone working in team groups, and every participant was provided with an individual mentor. The mentors are typically 2–5 years ahead of the students so that students can see early career path trajectories. When in-person meetings were permissible, participants were able to meet and network. An in-person site visit was also facilitated by J&J.

Certain WiSTEM^{2}D programme benefits identified and discussed are different from what is presented elsewhere in the literature. This is because the programme provides extensive industry input and engagement from J&J, including industry mentorship and industry networking. As J&J is a multinational organisation, there are vast resources at hand –a larger pool of industry mentors to choose from, a larger pool of people to network with and access to a bigger pool of resources. Mentorship from J&J is different from, for example, only having academic mentorship. The industry element opens the door to a bigger pool of talent that can be accessed through the industry mentor, providing a broader reaching network to leverage.

The career options knowledge gained, coupled with networking opportunities, increases participant confidence levels. This could not have been done without industry involvement. In the WiSTEM^{2}D programme, industry and academia work together to improve participant outcomes. The collaboration with industry provides future role models, which upcoming students can see as an example of what women in STEM^{2}D can do once supported.

To illustrate the point, one university providing mentorship would be limited, whereas having industry involved broadens the pool of mentors and industry mentors who are at the cutting edge of innovations in the public domain. J&J has access to a network that a single university cannot compete with; for example, J&J is not only a multinational, but it is also comprised of multiple industries such as pharmaceuticals and MedTech. J&J was named to Fortune's 2023 America's Most Innovative Companies List. J&J mentors can provide global access to various types of industries. One of the participants expressed an interest in setting up their own company after graduation, and their J&J mentor was able to leverage their considerable professional network to introduce the student to an entrepreneur.

Another advantage of working with J&J is that the WiSTEM^{2}D programme is far-reaching, as it is not just focused on university students. The programme is divided into three pillars (youth, university and professional), targeting girls and women at various stages from school to university to careers.

Conclusions

During the WiSTEM^{2}D programme, a record of the "lessons learnt" was maintained. This record was subsequently used to inform and improve the programme going forward. A focus group was held at the end of the programme with four participants to ascertain how the programme should progress. The participant reflections also informed the planning of the upcoming programme. Some of the changes made are:

(1) A LinkedIn group was created for current and past participants of the WiSTEM^{2}D programme;

(2) There is more information provided on the team projects in terms of time commitments and expectations at the outset;

(3) Extra workshops, such as strength-finding, were added;

(4) Even though in-person meetings are now allowable, a mixture of online and in-person events is still provided to allow for flexibility and

(5) Early-career mentors now participate, with whom students can relate better.

WiSTEM^{2}D is an intervention programme that aims to support female undergraduate students undertaking STEM^{2}D courses. The data gathered for analysis and reported on in this paper were in the form of qualitative information. Programme participants provided reflections on their experiences. We have learnt that if other groups were to run a similar programme, then it is important to be agile and to pivot when needed. Having a team with access to large resources is key, including experts from both academia and industry.

For example, a workshop led by expert speakers (a health psychologist from UL and two nurses from J&J) was added during COVID-19 to address mental health struggles.

Participants found the WiSTEM^{2}D programme to be a success, and the key benefits they identified were improved confidence levels, career knowledge and overall networking abilities. This programme is one of several initiatives globally that are attempting to empower and encourage women to be active in STEM.

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