

EMPOWERING THE PIPELINE: DEVELOPING A HUMAN-CENTRED MULTI-LEVEL MENTORSHIP FRAMEWORK FOR WOMEN IN DESIGN & ENGINEERING

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ABSTRACT

This paper presents the preliminary work for the development of a Human-Centred Multi-Level Mentorship Framework designed to support and empower women in design and engineering. Despite growing awareness of the need for diversity, women in engineering continue to face challenges related to career progression, and a lack of tailored support. This research uses human-centred design principles to gather insights to aid in the development of a mentorship model that addresses these issues by placing the experiences and needs of women at the core of its development. The project focuses on gathering and analysing real-world mentorship experiences through a series of focus groups and interviews. By exploring their insights on mentorship, academic and career obstacles, and support mechanisms, the research aims to understand the critical elements of effective mentorship from a human-centred perspective. These qualitative findings will inform the creation of a practical resource aimed at fostering impactful mentorship relationships that support women's success in design and engineering fields. Through this resource, we aim to support women's advancement, strengthen their professional networks, and create a supportive pathway for success in design and engineering. This paper details the methodology of using human-centred design to extract and incorporate user experiences into a mentorship resource.

Keywords: Mentorship, Human-Centred Design, diversity and inclusion, design and engineering

1 INTRODUCTION

In recent years, the importance of mentorship in addressing gender disparities in STEM fields has gained increasing recognition. Despite ongoing efforts to promote diversity and inclusion, women in design and engineering continue to face barriers to career progression, a lack of tailored support, and workplace cultures that do not always facilitate inclusivity [1]. Research has shown that mentorship plays a crucial role in helping women navigate these challenges by providing guidance, confidence-building, and access to professional networks [1]. However, traditional mentorship models often fail to adequately address the unique needs of women in these fields, where they focus on the end results of transfer of knowledge rather than the process or relationship [2], leaving gaps in support and opportunities for career development [1].

Mentorship in design and engineering has historically been informal and unstructured, relying on personal networks and chance opportunities rather than structured programmes designed to meet the specific needs of women who are professionals. While many benefit from mentorship relationships, these are often developed through personal connections, making them inaccessible to those without established industry networks. Additionally, mentorship needs evolve over time, with early-career professionals seeking guidance on confidence-building and career navigation, while more senior professionals require support in leadership development and strategic career progression. The lack of a structured, human-centred mentorship framework means that many women miss out on the full potential of mentorship at crucial stages of their careers.

A human-centred approach to mentorship development ensures that the experiences, challenges, and needs of women in design and engineering are placed at the core of the framework. Unlike traditional mentorship models that adopt a one-size-fits-all approach, a human-centred methodology prioritises real

user experiences, tailoring mentorship structures to align with the diverse and evolving needs of women at different career stages. By engaging directly with students, academics, and industry professionals who are women, this research seeks to develop a mentorship model that is practical, inclusive, and adaptable. This paper explores preliminary qualitative insights obtained through questionnaires, focus groups, and interviews with women working at various levels within design and engineering industries in the UK. The study explores how mentorship is currently experienced, what aspects women value most in a mentoring relationship, and which elements they find lacking. By capturing these experiences, this research identifies key components essential for an effective mentorship model, helping to shape future initiatives that are both impactful and relevant.

The research aims to understand women's experiences with mentorship, their needs at different career stages, and the role of a human-centred approach in developing an effective mentorship framework. By gathering insights from women at varying career levels, from recent graduates to directors, this study explores how mentorship needs shift over time and identifies best practices for structuring and implementing mentorship programmes that support long-term professional success.

Applying human-centred design principles ensures that any proposed mentorship framework is not only theoretically grounded but also informed by real-world experiences. The findings will contribute to the development of a structured, multi-level mentorship resource that better supports women in design and engineering, creating more inclusive opportunities for career advancement, leadership development, and professional growth.

2 RESEARCH METHOD

2.1 Literature Review

Mentorship is often regarded as being essential in career development, particularly for women employed in male-dominated fields such as design and engineering [3]. Its impact on increased confidence levels, professional networking, and career growth has been established by research studies [4]. Traditional mentorship models can often overlook gender barriers such as workplace discrimination and the lack of female role models in leadership positions [5]. Research underlines the need for systematic mentorship programmes that have been tailored to the specific concerns women are bound to face [1]. Informal mentoring is certainly of value but is generally inaccessible to those lacking extensive professional connections. The literature further emphasises that changing mentorship needs occur across varying career stages.

2.2 Research Methodology

Adopting a pragmatic research philosophy, this study employs a mixed-methods approach, integrating survey data, and a focus groups to examine mentorship experiences among women in design and engineering sectors in the UK. A quantitative questionnaire was distributed via LinkedIn to assess mentorship accessibility, effectiveness, and perceived impact. The survey included Likert-scale ratings to assess mentorship experiences, as well as to explore personal experiences and career obstacles. 28 responses were collected.

To gain deeper insights, a semi-structured focus group was conducted with 4 women at various career levels, from recent graduates to senior professionals. These participants were all recruited through the initial questionnaire distributed via LinkedIn. These discussions explored key themes, including formal vs. informal mentorship, gender dynamics, confidence-building, and the evolving needs of mentees. By bringing incorporating perspectives from different career levels, the study examined how mentorship expectations and experiences change over time.

Data analysis involved identifying recurring themes through coding. Identified themes included barriers to mentorship, differences in needs at various career levels, and qualities valued in mentors. By combining both qualitative and quantitative methods, this research ensures a holistic and human-centred understanding of mentorship. The findings from this research will contribute to the development of a structured, multi-level mentorship framework that is accessible, inclusive, and impactful, supporting women's success in design and engineering across different career stages.

3 RESULTS AND DISCUSSION

The findings of this study highlight both the potential and the challenge of mentorship for women in design and engineering. Survey data provided a broad overview of participants' experiences and focus group sessions and interviews enabled further exploration of the complexities of mentorship in design

and engineering. Collectively, these findings inform an understanding of the role of mentorship in career progression, the challenges women face, and an insight into how to more effectively develop mentorship programmes to meet their needs.

3.1 Mentorship Access and Gender Disparities

Figure 1 shows that mentorship is frequently available to women who are engineering and design professionals, with 77% of respondents reporting receiving some form of mentorship, either formal or informal. However, the gender distribution of mentors is highly uneven, as 68% of respondents indicated that their mentor was not the same gender.

Findings from focus group and interviews further contextualised this trend. While mentorship from colleagues who are men was generally appreciated, participants expressed it may fail to address the unique challenges confronted by women in these fields. Respondents shared experiences where mentors who were men, though sympathetic, lacked awareness of gender barriers encountered by women, such as workplace stereotypes, gendered leadership expectations, and the need to support confidence in the workplace.

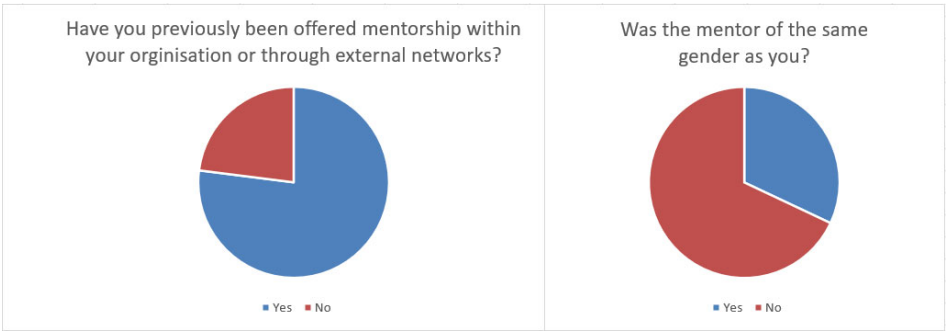


Figure 1. Access to Mentorship questionnaire results

The gender gap in mentorship is particularly relevant when addressing role models and career advancement. Several of the participants mentioned that seeing women as leaders as a model to work towards was necessary. Without visible female mentors, many women cannot envision themselves growing their careers, which again reinforces the necessity for mentorship programmes that directly match women with experienced female professionals within their field.

3.2 Success of Mentorship

Figure 2 demonstrates that the effectiveness of the mentorship as perceived by the participants was varied, with 50% indicating it was highly or extremely effective and 23% indicating that it had little or no effect. This variation shows that while mentorship can be a useful means of career progression, its success relies on many factors, including the design of the program, the relationship between the mentor and mentee, and the relevance of the mentorship to the mentee's career objectives.

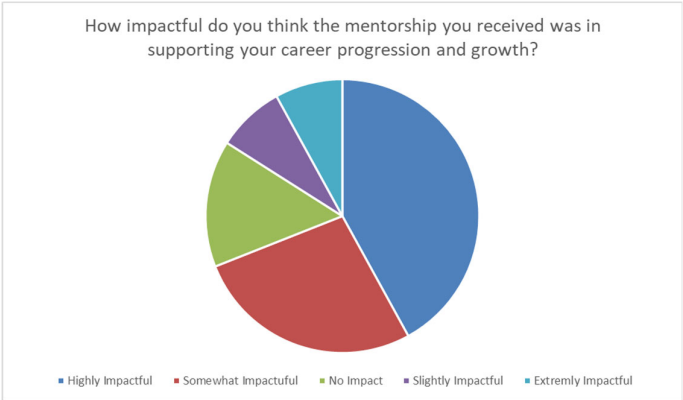


Figure 2. Effectiveness of the mentorship questionnaire results

The focus group showed that formal mentorship programmes function optimally when they have specific goals, regular follow-ups, and industry-specific guidance. Informal mentorship, while mostly helpful, was described as discontinuous and relationship based. Some of the participants who had been in formal mentorship programmes said that although the programmes provided them with a format, success of the relationship would depend on compatibility between the mentor and mentee. When there were mismatches in mentorship assignments, participants got frustrated that advice they received was too vague or indiscriminate to their career aspiration.

3.3 Mentorship Challenges and Career Development

The survey also revealed that 85% of the respondents had experienced what they perceived to be gender-specific challenges in their careers. The focus groups gave details about these challenges, and the respondents talked about challenges they had with navigating company culture, career advancement, and having mentors who acknowledged their differences as women in design and engineering. Many of the women said that they felt isolated in their workplaces, particularly in engineering roles where they were typically the only woman in their team.

One respondent spoke of her experience working in a predominantly male team, reporting that although her male colleagues were supportive, there was an unspoken assumption that she had the same technical background and physical ability as the men. This assumption, although not always conscious, added pressure to her to demonstrate her ability in ways that her male colleagues did not have to. Others shared this same perspective, stating that their mentorship needs extended beyond technical growth to include workplace politics, confidence building, and advocating for their own career advancement.

One of the reoccurring themes in the focus group interviews was the difficulty of transitioning from mid-career to leadership roles. More experienced participants cited a lack of mentorship specifically targeting leadership development, one citing the observation that leadership training is heavily based on traditionally masculine strengths such as decisiveness and assertiveness. While desirable, she noted the need for mentoring affirming alternative leadership styles which validate her strengths instead of adopting the prevailing expectations.

3.4 Qualities and Areas of Focus for Effective Mentorship

When asked what they would most value in a mentor, 88% of respondents answered experience and expertise, followed closely by empathy and understanding (81%). Trust, advocacy, and communication skills were also considered desirable but to a lesser degree. This shows that technical and professional ability are highly valued, mentees also wish for mentors who can provide emotional support and a better understanding of the problems they are facing, highlighting the need for more women mentors.

The survey also asked participants to state areas of priority that they would like mentorship programmes to address. The most common responses were coping with workplace issues and building confidence (both 85%), followed by career exploration (73%), leadership development (58%), and technical skills development (42%). These findings affirm the perspective that mentorship should extend beyond traditional career guidance and encompass elements that will allow women to build resilience and self-advocacy in workplaces.

These interests were confirmed in the focus group discussions, with many of the participants noting the importance of mentorship that can be tailored to different career stages. Early-career professionals noted the necessity of mentoring to build confidence and define job roles, while mid-career professionals had an interest in career development and leadership abilities. Some of the executive-level respondents discussed how they felt isolated since there were no women mentors at the executive level, pointing to the need for mentorship programmes that guide women along their entire careers.

3.5 Challenges and Differences in Mentorship Needs at Early-Career and Leadership Levels

The findings of the questionnaire and focus groups indicate that mentorship needs transform significantly during a woman's design and engineering career. Early-career women predominantly need mentorship for skills development, workplace adaptation, and confidence-boosting, whereas those in leadership roles grapple with authentic leadership, strategic career progression, and the isolation of being one of the few minority women at senior levels.

For early-career professionals, mentorship is typically paired with acquiring technical skills and adapting to industry standards. One of the participants, a junior design engineer, explained that "my senior colleagues have been great at training me up, but mentorship outside of technical skills, such as career progression or leadership, hasn't really been discussed." Another participant echoed this, explaining that "when I started, I didn't have experience with certain manufacturing processes, and my mentors helped with that, but I would have liked more structured guidance on how to navigate the workplace as a woman in engineering." While skill acquisition was a high priority for early-career participants, there was also an emerging recognition of the gender gap in their industries. One young engineer described her first work experience, saying, "I was the sole female in my group, and while my colleagues were welcoming, I certainly felt I needed to try harder to prove myself than the men."

At the leadership level, the mentoring needs shift to learning workplace politics, and leadership expectations. Several more experienced participants reported a shortage of role models and mentorship as they progressed in their careers. One director-level participant stated, "When I got to senior leadership, I realised there were no women in front of me that I could look up to. At this level, the expectations around leadership are strongly geared toward traditionally masculine traits like assertiveness and decisiveness. I would have benefited from having a mentor who could show me how to lead in an authentic way instead of conforming to existing norms." Another participant, with a background of over 20 years in engineering, described the invisible obstacles for women in leadership, stating, "I've been in the industry for 20 years, and I've never had a female boss. Finding mentorship that is relevant to my experience has been really tough."

These disparate experiences highlight the necessity for mentorship programmes that cater to different career phases. While early-career women require structured skill-building and confidence boosting, women in leadership require mentorship that can support them in senior-level career progression, leadership authenticity, and the isolating experience of being underrepresented at the executive level. By reconciling these discrepancies through a human-centred mentorship framework, mentorship can remain pertinent and effective throughout a woman's design and engineering career.

4 CONCLUSIONS

The findings from this study highlight the need for a human-centred approach in developing mentorship programmes that support women in design and engineering. Traditional mentorship models often lack flexibility and fail to address the specific challenges women face at different career stages. A human-centred framework ensures mentorship is accessible, inclusive, and adaptive, evolving alongside the needs of mentees. This approach recognises that mentorship needs change over time. Early-career professionals' benefit from technical skill development and workplace adaptation, while mid-career and senior women require leadership development and strategic career progression support. A key challenge identified in the study was the limited availability of female mentors, with 68% of participants reporting that their mentor was not the same gender. Increasing access to female mentors can provide more relevant guidance on gender-specific challenges, workplace dynamics, and leadership pathways.

A successful human-centred mentorship framework should balance structured programmes with informal mentorship networks, ensuring flexibility in mentor-mentee relationships. Participants expressed frustration with rigid formal mentorship structures that lacked customisation and compatibility in mentor matching. Improving matching processes and offering adaptable mentorship models would enhance engagement and effectiveness. Additionally, fostering mentorship communities where mentees transition into mentor roles over time would create a continuous cycle of support and leadership development. This study reiterates the critical role of mentorship in advancing women's careers in design and engineering while identifying gaps in existing programmes. To be truly effective, mentorship initiatives should be structured yet adaptable, providing targeted support at different career stages.

Higher education in design and engineering has the ability to act as a critical foundation for shaping future professionals. Integrating a structured, human-centred mentorship resource within academic institutions can provide students with the necessary support to navigate career pathways effectively. By embedding mentorship initiatives into university, students can gain early exposure to industry expectations, develop essential skills, and build professional networks before entering the workforce. This approach will bring mentorship that is tailored to the needs of students about to transition into their early careers. By fostering mentorship communities within higher education, universities can help bridge the gender gap in design and engineering by encouraging the development of diverse role models

and peer-support networks, ultimately creating a more inclusive and equitable professional landscape. This study has some limitations that should be acknowledged. The relatively small sample size, with only 28 respondents completing the questionnaire and four participating in the focus group discussions, restricts the generalisability of the findings. A larger and more diverse participant pool would provide a broader understanding of mentorship needs across different backgrounds and career levels.

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