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The Experience Of Women In Engineering Apprenticeships | A Scoping Review

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The experience of women in engineering apprenticeships | A scoping review

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ABSTRACT

This scoping review aims to synthesise the existing literature on the experience of women in engineering and trade apprenticeships, discuss the common themes and highlight areas for future research. Apprenticeships are not only required to address the current skills shortage in the engineering profession which threatens to impede our ability to deliver on our sustainability goals and restrict economic growth they are also a proven pathway for women to enter engineering programmes. Despite growing social and political interest in increasing gender diversity in the workforce,

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data shows that women remain significantly underrepresented in engineering apprenticeship programs.

This review followed the methodological framework put forward by Arksey and O'Malley (2005) and the PRISMA-ScR extension checklist for scoping reviews (Tricco et al. 2018) and examines studies from the SCOPUS, JSTOR and web of science databases between 2012 and 2023. Results were analysed using a General Induction Approach (Thomas 2006) to produce high-order themes and key messages. The findings highlight several challenges faced by women in engineering apprenticeships including limited access to information and opportunities, poor recruitment practices, negative attitudes and beliefs, discrimination, and a lack of role models.

Despite the challenges, this analysis identifies several strategies that support the success of women in engineering apprenticeships notably mentorship, targeted recruitment and supportive policies and practices.

The results of this scoping review revealed that while there are a small number of studies on the experience of women in engineering apprenticeships it is currently limited to work completed in Australia (Simon and Clarke 2016), United States of America (Wagner and Gordon 2013) (Kelly et al. 2015) (Denissen and Saguy 2014), South Africa (English and Le Jeune 2012), and Chile (Sevilla et al. 2023).

1 INTRODUCTION

1.1 Aims

This scoping review aims to provide an overview of the existing literature researching the experience of women in engineering apprenticeships discuss the common themes and identify areas for further research.

1.2 Background

Apprenticeships are necessary to address the current skills shortage which threatens to hinder our ability to deliver on our sustainability goals and restrict economic growth (GOI 2021).

There is growing social and economic pressure to increase the number of skilled trades people in Ireland to support growth in several sectors. In Ireland, The Expert Group on Future Skills Needs has identified a shortage of skilled labour, which, if not provided, will result in constrained activity in the renewable energy sector (GOI 2021). One of the key recommendations of the report is the need to promote and improve the accessibility of apprenticeships to young people (GOI 2021). Ireland's Action Plan for Apprenticeship demonstrates the Government's commitment to promotion of apprenticeship routes in education (DFHERIS 2021). The Action Plan specifically recognises the importance of diversity and inclusion and offers targeted support to encourage women, to participate. Ireland's record in relation to the participation of women in apprenticeship schemes however is poor. In 2016, women made up only 4% of built environment occupations and only 1% of key trade apprenticeships in the sector (GOI 2021). To encourage more women, we first need to ascertain any challenges or barriers they face through this educational path, so we may work towards ameliorating them. This review aims to synthesise the existing literature on women's experiences in apprenticeships to highlight areas for future research.

2 METHODOLOGY

2.1 Framework

This review adopts a rigorous methodology that combines the PRISMA-SCR extension checklist for scoping reviews (Tricco et al. 2018) with the methodological framework proposed by Arksey and O'Malley (2005). By taking a pragmatic approach we aim to comprehensively identify, evaluate, and synthesise the existing literature on the experience of women in engineering apprenticeships.

Arksey and O'Malley identified 6 areas of focus for performing a scoping review:

1) Identifying the research question or topic.
2) Identifying relevant studies using a transparent and systematic approach.
3) Selecting the studies based on inclusion and exclusion criteria.
4) Charting the data using a standardized data extraction tool.
5) Collating, summarizing, and reporting the results.
6) Consulting with stakeholders to ensure that the review is relevant and useful.

The papers identified using the above method will then be analysed using Thomas' General Inductive Approach (2006). The General Inductive approach is a qualitative data analysis method that aims to derive meaningful themes, patterns, and insights from data without the need for preconceived categories. It allows for flexibility and open exploration of the data to generate concepts and theories directly from the empirical material and requires multiple iterations and closing readings of the material to refine the key concepts into overarching themes.

2.2 Inclusion and exclusion criteria

Included in this scoping review is (a) peer-reviewed journal papers (b) published between 2012 and 2023 (c) in English that (d) examines the experience of women in (e) engineering apprenticeships.

(a) To ensure the validity of the findings this review focuses only on peer-reviewed articles from reputable journals, which are subject to a rigorous process of review and evaluation. This helps to ensure that the findings included are reliable and trustworthy.
(b) A 10-year span is commonly used in scoping reviews. While in some cases it may be appropriate to consider all available literature regardless of age it was determined that research on women's experience in engineering apprenticeships is novel enough not to warrant a longer time span. As apprenticeships are currently undergoing a period of rapid change and revision in Ireland (DFHERIS 2021) it is also important to focus on the most recent available data so findings will be relevant and provide insights that are current and of interest to researchers in the field. A 10-year time span is also sufficient to identify trends and changes in the field over time.
(c) For practical reasons such as the researchers being English-speaking and English being the most prevalent language for academic and scientific communication, the decision was made to only include papers that have been published in English. This criterion reduces the workload on the researchers and ensures accessibility and consistency in the review process.
(d) Only papers that explicitly examine the experience of women will be included.
(e) This scoping review will include only papers that examine all apprenticeships related to engineering, construction, and trade, which are collectively referred to as "engineering apprenticeships"

This review excludes papers published before 2012 and those published in languages other than English. Additionally, any apprenticeships that do not fall under the category of 'engineering apprenticeships' and those that are commonly associated with women such as hairdresser or seamstress, are also excluded.

2.3 Search terms

The search terms were chosen by first defining three key areas of interest: Women, engineering apprenticeships and experiences. These were then expanded on with appropriate synonyms and 'wildcards' to include all variations of the words e.g., *'Wom**?**n' is* used to include both 'woman' and 'women' and 'apprentic*' is used to include 'Apprentice' 'apprentices' and 'apprenticeship' in the results. Initial search terms included "Irish" and 'Ireland." Including these terms resulted in no search results.

The search terms were then mapped to each database's controlled vocabulary using an iterative process to determine which arrangement produced the most relevant results.

The search terms used in each data base are included in Table 1. below.

Table 1. SCOPUS Search terms

Database	***Search terms***	***Search fields***
Web of Science	*((wom?n OR female OR gender OR tradeswom?n) AND (engineer*)AND(apprentic* OR trade) AND (experience OR barriers OR opportunities))*	*Abstract*
JSTOR	*(((((wom?n OR female OR gender)) AND ((engineer* AND apprentic*))) AND (Tradeswom?n)) AND ((Experience OR barriers OR opportunities)))*	*All fields*
SCOPUS	*TITLE-ABS-KEY ((wom?n OR female* OR gender* OR tradeswom?n) AND (engineer* AND apprentic* OR trade) AND (experience OR barriers OR opportunities)) AND (LIMIT-TO (DOCTYPE , "ar"))*	*TITLE-ABS-KEY*

After applying the exclusion criteria as described in section 2.2 the results were further reduced through a screening process following the PRISMA workflow (Tricco et al. 2018) illustrated below.

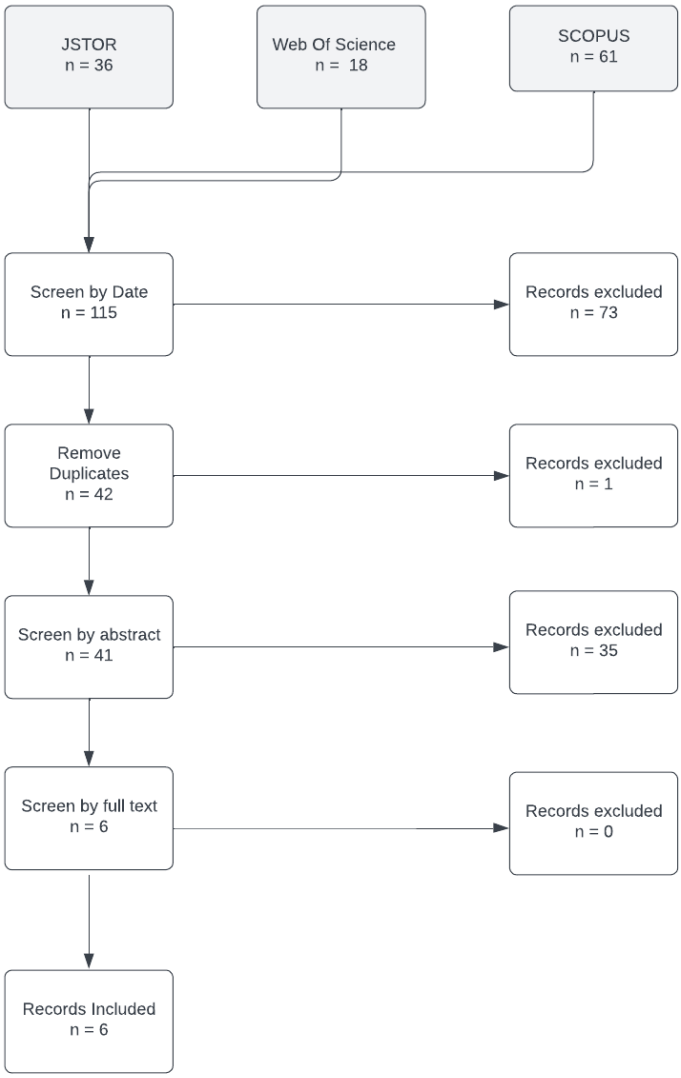

Figure 1. Flow of article search screening process adapted from the PRISMA flowchart

The initial search yielded a total of 115 potential papers. After applying the inclusion and exclusion criteria this was reduced to only 6 relevant papers. Many of the studies in the initial search (n=35) focused exclusively on women's experience within apprenticeships in Higher Education Institutions (HEI's), for example 'STEM research apprenticeships' and as such were excluded from this review.

3 FINDINGS

Using Thomas' General Induction approach for Qualitative Data Analysis 92006), a total of 28 codes were identified that capture the key ideas and concepts presented in the literature. These codes were generated through an iterative process of close reading and careful categorization. The relationships between the codes were then explored to identify overarching themes that encapsulated the main findings across the studies.

By grouping related codes together and comparing their content, higher-order themes emerged, providing a deeper understanding of the challenges faced by women in engineering apprenticeships. These themes include limited access to information and opportunities, poor recruitment practices, negative attitudes and beliefs, discrimination, and a lack of role models. Each theme encompassed multiple codes, for example the following 4 codes are combined into the theme ‘Unfavourable beliefs and attitudes’

1. *Poor self-efficacy*
2. *Parents or family expressing negative attitudes towards apprenticeships*
3. *Womens own poor perception of the industry*
4. *Harmful stereotypes pertaining to women's physical capabilities*

Some codes were present in more than one theme for example harmful stereotypes was classified in both ‘unfavourable attitudes and beliefs’ and in ‘discrimination and gender stereotypes’ illustrating the complexity and interconnectedness of the issues faced by women in apprenticeships.

3.1 Limited Access to Information and Opportunities

Limited access to information and opportunities stands out as a primary barrier. Young women often lack awareness of available apprenticeship programs, and even when they possess an awareness about apprenticeships, they frequently face obstacles in accessing the necessary information to make informed decisions about their career paths (Simon and Clarke 2016) (English and Le Jeune 2012) (Sevilla et al. 2023). This informational gap begins at school level, where boys typically receive information on apprenticeships as a career choice there is a dearth of information provided to young women students about apprenticeships as a career path. This disparity persists even as women enter apprenticeship programs, where research indicates that they are disproportionately affected by the absence of the informal network that benefits men in the workplace. Consequently, they may receive fewer opportunities and be less likely to be assigned tasks that are critical to their success as apprentices (Kelly et al. 2015)

3.2 Poor Recruitment and Employment Practices

Poor recruitment and employment practices also emerged as a significant barrier for women in male-dominated apprenticeships. It was found that women were subjected to discriminatory hiring practices (Kelly et al. 2015)(Sevilla et al. 2023)(English and Le Jeune 2012), excluded from the formal and informal interpersonal relationships that are essential for apprentices to succeed (Kelly et al. 2015), are disproportionately affected by layoffs (Kelly et al. 2015), often paid less than their male counterparts (English and Le Jeune 2012) and less likely to have a mentor. Furthermore, it was found that women often face a lack of appropriate personal protective equipment (PPE), workwear, and facilities and that this has a negative effect on women’s experience in apprenticeships (Wagner and Gordon 2013).

3.3 Unfavourable Attitudes and Beliefs

The research suggests that unfavourable attitudes and belief, both of women towards engineering apprenticeships and of others towards women in male-dominated industries contribute to low uptake and negative experiences of apprenticeships among women (Kelly et al. 2015) (Simon and Clarke 2016) (English and Le Jeune 2012) (Sevilla et al. 2023).

It was found that women often have a negative image of the industry (English and Le Jeune 2012), coupled with the lack of awareness of career opportunities, this can lead to an inadequate number of female applicants, which perpetuates the male-dominated culture of these industries. Simon and Clarke (2016) highlight the importance of the attitudes and beliefs of friends and family towards apprenticeships; Women whose parents have positive attitudes are more likely to enter an apprenticeship.

3.4 Discrimination and Negative Gender Stereotypes

It was noted that women must overcome a high cost imposed by the negative gender stereotypes they encounter when they enter male-dominated apprenticeship programmes (Sevilla et al. 2023). This cost may be emotional or professional, as they may feel unwelcome or excluded from the tasks and informal relationships that are important for apprentices to progress in their training.

These stereotypes are formed and reinforced in schools, where girls are often not encouraged to pursue careers in engineering and construction (Kelly et al. 2015). The review suggests that there is a lack of information and career guidance about careers in these fields which also aligns with the finding of limited access to information and opportunities (3.1).

It is worth noting that two of the included studies adopt an intersectional perspective that examines the experiences of women in relation to their gender intersecting with race and sexual orientation (Kelly et al. 2015) (Denissen and Saguy 2014). Their findings suggest that, in cases where discrimination intersects with race, gender tends to be a more reliable predictor of acceptance compared to race (Kelly et al. 2015).

3.5 Lack of Role Models

A lack of female role models in engineering apprenticeships was identified as a significant barrier for women (Simon and Clarke 2016) (Kelly et al. 2015) (English and Le Jeune 2012) (Sevilla et al. 2023). Women may struggle to envision themselves in these industries without seeing other women who have succeeded in these careers. The very nature of the apprenticeship model of vocational training and employment depends on both formal and informal mentoring partnerships for the success of the apprentices (Kelly et al. 2015) (English and Le Jeune 2012). A lack of female role models puts young women in apprenticeships at a disadvantage when compared to their male counterparts. Exposure to role models was the most frequently mentioned ‘enablers’ when educators, industry and community groups were surveyed by Simpson and Clarke (2016).

4 CONCLUSION

In conclusion, this scoping review finds that women in engineering apprenticeships face significant challenges. The barriers identified include limited access to information and opportunities, unfavourable attitudes and beliefs, negative gender stereotypes, discriminatory practices, and a lack of role models.

The implications of this study highlight the urgent need for addressing the barriers faced by women in engineering apprenticeships and improved dissemination of information to promote and enhance the representation and success of women in apprenticeships which in turn will lead to a more diverse and inclusive engineering workforce.

A comprehensive approach is needed to ameliorate these barriers which includes both ‘top down’ government policies and grassroots initiatives. Targeted outreach programs to schools and encouraging women role models can increase uptake and retention of women apprentices.

It is crucial that recruitment and employment practices are gender inclusive and provide the appropriate PPE and facilities. It is also necessary to address the negative attitudes and beliefs not only within the industry but also at a community and family level to encourage the full participation of women in the workforce and create an environment where women can thrive.

While the Irish Government has made commitments to ensure equity of access to apprenticeships programs so that underrepresented groups are able to avail of apprenticeships (DFHERIS 2021) it is important to note that this scoping review failed to find any research on the experience of women in apprenticeship programs in the Irish context thus identifying a key area for future research.

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