An argument for incorporating sociological approaches into phenomenological analyses in engineering education research

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ABSTRACT

Despite numerous research studies that have examined why women are underrepresented in engineering education programmes, the phenomenon is still not fully understood, and no effective general solutions have been found. In this context, analysing women's experiences in engineering education can provide insights regarding the evolution of the students' learning strategies and socialization processes as well as contextual factors that influence their choice to persist in or leave their courses. This paper explores the pertinence of enhancing phenomenological analyses conducted in engineering education research by incorporating sociological perspectives, drawing on sociological studies that explore the relationship between gender, STEM education and persistence in STEM courses. The aim is to contribute to building a conceptual framework that, on the one hand, captures lived experience in engineering education and, on the other hand, analyses the social settings around engineering itself, i.e., the objectively significant circumstances, that condition female students' attitudes, behaviours, and expectations towards persisting or not in engineering courses. Conclusions suggest the conceptual framework around *subjectively meaningful experiences,* proposed by Alfred Schutz, who followed the phenomenological school of thought initiated by Edmund Husserl, might be useful in understanding not only (a) the representations

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of the subjective social world for women in engineering education (that induces feelings of identification, security, symbolic values, and ultimately social actions), but also (b) the intersubjective social system that structures daily life, legitimizes behavioural patterns, assigns roles, and defines group membership along education in engineering. Expanding engineering education researchers' conceptions of phenomenology, to consider more of the structural issues that influence women's experiences and choices, can help generate increasingly meaningful research findings.

1   INTRODUCTION

Researchers have identified the social cultural masculinization construct in Science Technology, Engineering and Mathematics (STEM) fields as a prominent barrier, discouraging women from choosing any of these career paths [1, 2]. Although a variety of theoretical and methodological frameworks have been used to explore those factors and, of course, to elucidate how to reduce them [3, 4], enrolment data in STEM courses continue to reflect an unbalanced representation of women, particularly in engineering fields of study, where men represented 74% of new entrants in engineering, manufacturing and construction on average across OECD countries in 2019 [5][2].

Investigation about the underrepresentation of women in STEM fields has grown, to focus not only on factors or influences related to context and historical research of gender inequity in education (e.g., sexist institutional environments, gender imbalance in the profession, cultural barriers and lack of support), but also to study women's lived experiences throughout STEM education programmes [1, 6, 7].

In this context, the objective of this paper is to contribute toward eventually building a conceptual framework in engineering education research (EER) by now introducing the phenomenological sociology approach developed by Alfred Schutz. The Schultz approach can be helpful in the development of an analytical framework that captures the subjective interpretation of the students who elaborate a body of beliefs, values, and norms from their daily life experience in engineering education, as well as the social structural constraints reflected in such experiences. This means that together, they create and continually re-create a system of social values, and that structure, in turn, curtails their choices.

2   METHODOLOGY

Several researchers [2, 6, 8, 9] have encouraged increased use of theoretical frameworks in engineering education scholarship to foster a professional field that is more inclusive and diverse. In this sense, it is relevant to develop conceptual

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[2] Also retrieved from the publication's website with additional information
https://www.compareyourcountry.org/education-at-a-glance-2021/en/3//default/all/OAVG

approaches that address women's lived experiences in the male-dominated world of engineering [1,7–11].

Understanding how students experience their introduction to the world of engineering makes it necessary to build a conceptual framework that allows returning to the people who elaborate (enact and create) their social environment from daily life, attributing subjective meanings to it. In that sense, phenomenology as a research method explores the essence of a phenomenon by focusing on the perspective from those who have experienced it [12]. This approach is helpful to gain a deeper understanding of the meaning of everyday experiences of women in engineering education.

This paper uses a 'scholarship of integration' approach as defined by Boyer [17] to identify methodologies and prior research that can inform our upcoming study regarding the underrepresentation of women in STEM, a topic that has been researched from a broad variety of fields of knowledge, particularly psychology and education. Drawing on sociological studies that explore the relationship between gender, STEM education, and persistence in STEM courses, the aim is to explore the pertinence of enhancing phenomenological analyses in engineering education research by incorporating a sociological approach. Below, we review recent phenomenological studies conducted within EER; later we provide background on Alfred Schutz's sociological approach of phenomenology to, finally, explore some research performed with other methodologies, where Schutz's conceptual framework happens to be also helpful to interpret their findings and results.

3   DISCUSSION

Dryburgh [1] was a pioneer in conducting research on women's experiences in engineering who used a vast variety of qualitative methods. Based on Erving Goffman's theory of symbolic interactionism and the concepts of the presentation of self, Dryburgh's conclusions stated that women engineers must show competency in the field, in addition to enacting masculine norms of attitudes and interactions. Furthermore, the educational phase constitutes a learning path, through socialization processes to manage the masculine culture into which they are entering, a competence that requires extra effort beyond what is asked to men. Dryburgh concluded that women's adaptation to masculine culture includes denial of sexism, a condition that keep hiding obstacles for women may face in engineering.

Later, in 2012, Charity-Leeke [7] conducted research on women in engineering using phenomenological analysis to find meanings of the sociocultural systems that help women succeed or that challenge them as engineers. With a sample of nine participants, her analyses generated 5 categories: gender roles and sociocultural influences; context-based learning; gender relationships; work and family; essence of women as engineer. Her main findings, similar to Dryburgh's [1], show that women

in engineering seek to prove their knowledge and improve their self-confidence as part of their socialization process.

More recently, Rodriguez et al. [10] conducted phenomenological research, with a sample of 17 undergraduate students, exploring the role of religious beliefs in shaping STEM identity in Latina college students. Results show that both elements reinforce each other, but also that intersectionality of multiple "marginalized" identities may be essential to sustaining students' interest in STEM context as ways to examine and redefine their cultural values. Likewise, Morton and Parsons [9] explored the influence of a racial and gendered identity in STEM, using the Phenomenological Variant Ecological Systems Theory to better understand 10 undergraduate black women's perception of race and gender in STEM. Conclusions indicate that the identity as 'black women' is in fact a positive and protective factor for their STEM engagement and persistence.

Phenomenological research approaches have become more popular in EER, and methodological toolkits have been published to increase understanding and applied knowledge of the phenomenology. An example in 2022 has been provided by Tomko et al. [11] who developed a methodological roadmap for phenomenologically based interviewing in engineering education.

However, some of the main criticisms of phenomenology are that it tends to ignore the structural context where the phenomena happen (leading, erroneously, to an overestimation of individuals' agency) and that commonly results are based on small samples of participants (typically fewer than 30 people). To address such problems, we propose using the theoretical and methodological frameworks based on Schutz's postulates of an intersubjective social world. These frameworks are intend to help distil the subjective interpretation of social action, to better understand the meaning that individuals attribute to objectively significant circumstances and use to guide their behaviour and 'projects' [13,14].

With regard the sample size, it is worth mentioning that this paper is framed as part of a broader project, initiated at Technological University Dublin in 2014, by Professor Shannon Chance with the support of Professor Brian Bowe [8], which currently has a longitudinal data set, comprised of 72 interviews, that represents a valuable resource for phenomenological analysis helpful to generate an understanding of the lived experiences of women who chose to study engineering.

Main concepts of the social phenomenology of Alfred Schutz
In the mid 1940s the sociologist Alfred Schutz [13] revived the phenomenological tradition of Edmund Husserl [15] in an effort to incorporate social characteristics in the understanding of the meaning structure in the world of daily life. This daily reality is presented to individuals and groups as a shared world. Schutz's phenomenological sociology made possible the transition from Husserl's theory of a 'conscious individual' to a new theory about the subject acting in society [16]. Schutz provided new conceptual tools to define the social structure of the world of daily life

where we, as subjects, share a language, i.e., a series of signs, that help us understand others and be understood, emphasising the concept of the intersubjective world.

Using the concept of *subjectively meaningful experiences,* Schutz [13] argued that people elaborate a body of beliefs, values, and norms to help themselves understand their reality; these form a representation of their world and work together as a system of meanings that structure daily life, legitimize social relations, and help people assign roles. The system also induces feelings of identification, security, norms, and symbolic values within individuals, ultimately influencing their social actions. This postulate is helpful for understanding socialization processes that define the sign systems used by engineering students, conditioning their behavioural patterns and how they create membership groups.

In line with Schutz's concept, Eisenhart and Allen [19] reported that the socio-cultural system in STEM education, mainly in engineering and computing, constantly plays out in various types of exclusions that adversely affect many young women of colour. These include unequal opportunity structures, negative discourses and stereotypes, and interactions that marginalise certain groups of people. As a result, although a woman might have interest, ambitions, or the ability to pursue STEM fields, her socio-cultural system might carry expectancies that hinder her sustained engagement. Moreover, according to Dancy et al. [20], often members of privileged group of students in STEM education (white men) are unaware of how race and gender affect students' experiences as STEM majors. Exclusionary factors are frequently invisible to those not affected by them.

Increasing diversity in STEM education requires not only understanding how students experience membership but, also subjectively, how the group to which they belong plays a role in the formation of the sense of self held by individuals. This sense of self informs the adoption of behaviours of the group, demands certain norms to be respected and expectations to be fulfilled.

Schutz's system of meanings also explains how individuals make sense of and understand, organise, or order their experiences of time. Schutz [13] argues that 'memories' are established and shared by members of a group because the intersubjective world of everyday life was there before them, and it will continue to exist after they leave. The 'future' provides a common frame of reference for the projection of individual actions. Thus, the system of meanings links individuals to both the past and the future – linking them to their predecessors' and successors' sense of belonging to the group. In this way, the community transcends the finitude of its individual members.

That aspect surfaced in research by Smith et al. [18] who, referencing the concept of social capital (i.e., resources obtained from relationships), found that students' social networks are key factors influencing their persistence in engineering through the provision of support and information. Smith's team therefore suggested that women

and underrepresented and minoritized students should be encouraged to participate in sectorial organizations at very early stages of their majors. Likewise, Turnbull et al. [2] identified factors explaining why female students are underrepresented in physics (while in the life sciences women are more equally represented). They stated that "individuals who begin their life with more capital, be that through inheritance or immediate exposure to the dominant culture, will be more able to gain personal and social advantages" (p5).

4   CONCLUSIONS

A group's culture, represented as symbolic systems, can be characterised as a set of objectified values. These objectified values are continually defined and redefined by the group, as members work to make sense of their lives, so that they can apprehend and transmit ideas. The symbolic system does not represent a permanent and intact code, but rather a constantly changing construction reinterpreted by individuals who adjust concepts to reflect new daily life experiences. In this sense, Schutz's conceptual frame might be appropriate in the exploration that retrieves the voice of women who, during their time at university, have also experienced the metamorphosis of engineering education.

Although engineering education is the result of a cultural elaboration, it has a subjective meaning for those who experience it, and therefore phenomenology is a pertinent method to analyse and interpret qualitative data about the everyday experiences of women. Explanation of the social world demands understanding what the social world means to the people within it, and what meaning people assign to their actions within it. In that frame, phenomenology contributes with a useful methodology, but the approach used in EER can be further enhanced by incorporating more sociological perspectives in the lineage of Schutz [14] and Husserl [15]. Using sociological perspectives can expand the research produced within EER to consider structural aspects of the shared experience that using phenomenology alone has tended to overlook.

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