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Exploring Engineering Students' Perception Of Their Career Preparedness In A Systemic PBL Context In Denmark

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EXPLORING ENGINEERING STUDENTS' PERCEPTION OF THEIR CAREER PREPAREDNESS IN A SYSTEMIC PBL CONTEXT IN DENMARK

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ABSTRACT

The demand for graduates who are well-prepared for employment remains a persistent concern. This study aims to examine the perceptions of career preparedness among engineering students in a systemic problem-based learning environment, employing a gender perspective. The data for this study was collected through two focus group interviews conducted with engineering students in their eighth semester. The collected data was then coded, resulting in the identification of three main categories: (1) professional competence development, (2) career anticipation, and (3) gender role. The findings of the study reveal that collaboration with external companies and the provision of practical support play a vital role in enhancing career preparedness among engineering students. However, the students demonstrated limited considerations regarding their future career plans. Furthermore, notable differences were observed between male and female students in terms of their perceptions of their acquired technical-profesional skills. Based on the study's outcomes, recommendations are provided for the engineering programme. These

recommendations emphasize the importance of offering adequate support to female students, with a particular focus on recognizing their strengths.

1   INTRODUCTION

From a career development perspective, the period of time spent at university is recognized as a crucial phase, particularly during the final years where students face the transition from school to work. This increases the importance of engaging in proactive career behaviors (Jaensch et al. 2016; Hirschi et al. 2014). The concept of career preparedness has become an increasingly relevant topic that requires intensified attention from both educational practice and research. Specifically, within the field of engineering education, the shift towards Industry 5 has placed significant demand on engineers' general competences, pressuring educational institutions to undertake the challenge of integrating specific competences required by the industry (Isaeva and Grigorash 2023). Within literature examining career preparedness, efforts have been made in a list of research topics including identification of competences associated with career readiness (e.g., Anastasio and Morehouse 2019; Isaeva and Grigorash 2023) and interventions to it (e.g., Hanafit et al. 2022). Despite the increasing attention to career preparedness in higher education practice research, Marciniak et al. (2022) argue that research within career preparedness is fragmented, resulting in a lack of consensus on how to describe different constructs and thus what support students' career preparedness. Therefore, there is a need for further research on career preparedness in engineering education that addresses the complexity of various interactive factors, including employability skills development, intervention strategies, and career exploration. The demand for graduates who are well-prepared for employment is persistent, especially with the changing demographics of countries that generally impose more diversity (Kendricks et al. 2019).

The aim of this study is to investigate the perceptions of career preparedness among engineering students in a systemic Problem-Based Learning (PBL) environment in Denmark, in which students work in semester-long team projects collaboratively solving real-life and complex problems (Holgaard et al. 2021). Moreover, it employs a gender perspective, as previous research has highlighted the important role of gender in students' career pursuits (Ghofur et al., 2020). Particularly, this study was guided by the research question: How do engineering students perceive their career preparedness and the role of gender in their career choices? To address this question, a qualitative study was conducted using focus groups as the primary data source.

1.1 Career preparedness

Despite a multitude of research into career preparedness, there remains a notable shortage of a shared conceptualization surrounding the topic. There has been a tendency to use different labels to describe the same underlying constructs, such as career readiness and career maturity. Lent (2013) describes career preparedness in the context of post-entry employment, characterizing it as a state of vigilance that involves recognizing threats to one's career well-being and identifying opportunities and resources that can be utilized. Similarly, Marciniak et al. (2022) defines career preparedness as a combination of attitudes, knowledge, competences, and behaviors necessary to navigate expected and unexpected career transitions and changes. Readiness is often considered a direct synonym for maturity, as it is included in the definition of maturity as well (Marciniak et al. 2022). Super (1955) was one of the early

scholars who introduced the concept of career maturity as a crucial attribute that students must possess to manage developmental tasks at different stages, indicating their readiness for making age-appropriate decisions (Marciniak et al. 2022). Career maturity comprises two distinct stages, namely (1) attitudes towards and (2) competences for developing a career (Super 1955; Super et al. 1996). Prior literature has proposed that female adolescents may engage in career exploration and decision-making earlier than their male counterparts, although this difference tends to diminish with age (Patton and Creed 2002). Conversely, other research advocates that there is a minimal to no difference in terms of career maturity between male and female adolescents (Jawarneh 2016; Ghofur et al. 2020). According to Amelink and Creamer (2010), specifically female engineering students' perception of their academic ability may be adversely affected by an absence of respect and support from their peers.

Lent (2013) suggests that life preparedness should not be equated with career preparedness, as individuals may be well-prepared to enter a particular field of work but may not be adequately equipped to deal with the various obstacles they may encounter. Also highlighted by Lent's (2013) work, preparedness may involve two general types of activities: (1) routine career renewal and (2) preparation to cope with particular events. While the former relates to job-specific activities, the latter is more broadly focused on activities such as maintaining a professional network, exploring job opportunities, and envisioning different scenarios. Preparedness can lead individuals to be more likely to adapt proactive strategies for managing obstacles, building support networks, and advocating for their own career and life aspirations (ibid.). This, in turn, can facilitate the realization of one's potential, particularly in relation to the development of planful competences in career development (Savickas et al. 2002). This perspective serves as a foundational conceptual framework for examining career preparedness in the present study's research design and data analysis.

2 METHODOLOGY

2.1 Context

The study was conducted within the context of a Danish university that has embraced a systemic Problem-Based Learning (PBL) methodology as its primary approach to learning and teaching. Within engineering programmes, students engage in collaborative project groups on a semester basis to address identified problems within their respective domains (Holgaard et al. 2021). To explore students' experiences and opinions, two interviews were conducted with two distinct project groups in the eight semester of a Master's degree programme, although with varying specializations but centred on the theme of sustainability. The first group, henceforth referred to as Group 1, included one female and three male students, whose ages ranged from 23 to 25. The second group, henceforth referred to as Group 2, consisted of three female and one male students, whose ages ranged from 24 to 28. Notably, the students within each project group possessed familiarity with one another, having worked together for a duration of three months prior to the interviews. Within Group 1, all members possessed a Bachelor's degree from the Bachelor Programme. Contrarily, Group 2 comprised two female students who possessed a Bachelor's degree from a foreign institution, one female student who had earned her Bachelor's degree from a different university within the same nation, and one male student who was an international exchange student for this semester.

2.2 Data collection and coding

In qualitative interviews, the emphasis is placed on capturing interviewees' perceptions and perspectives, rather than seeking quantified answers or establishing causal effects (Brinkmann 2022), rendering it as the most suitable approach for the present study. The use of focus group is aimed at generating diverse viewpoints on the topic, rather than arriving at definite solutions to the issue (ibid.). Prior to conducting the interviews, an interview guide was developed, serving as a script that enabled the interviewer to follow up on interviewees' responses, indicating a semi-structured interview approach (Kvale 2007; Brinkmann 2022). The interview guide consisted of seven questions relating to students' actions on career preparedness, challenges and institutional support, future perspectives, and gender role on career development.

The coding process applied in this study followed an open coding, or data-driven, approach, whereby the codes were generated through a qualitative analysis that involved examining the relationships between the codes and their context (Kvale 2007; Gibbs 2007). The process generally involves the identification of passages containing similar ideas and assigning a name, or code, to each idea (Gibbs 2007). Prior to the coding process, the two interviews were transcribed, and subsequently coded independently by the first two authors, followed by a comparison of the coded transcripts. Initially, an inductive approach was employed, wherein themes emerged from the data itself, and subsequently following a deductive approach, wherein the identified themes were organized and categorized into three overarching categories that captured the major findings.

3 RESULTS

In the following subsections, the results from the two focus groups with engineering students are presented. Three major categories were identified from the thematic analysis, highlighting students' emphasized views regarding their career preparedness, namely: (1) Professional competence development in a PBL environment, (2) Career anticipation, and (3) Gender role. Fig. 1 presents an overview of the categories including themes that are reflected within each category.
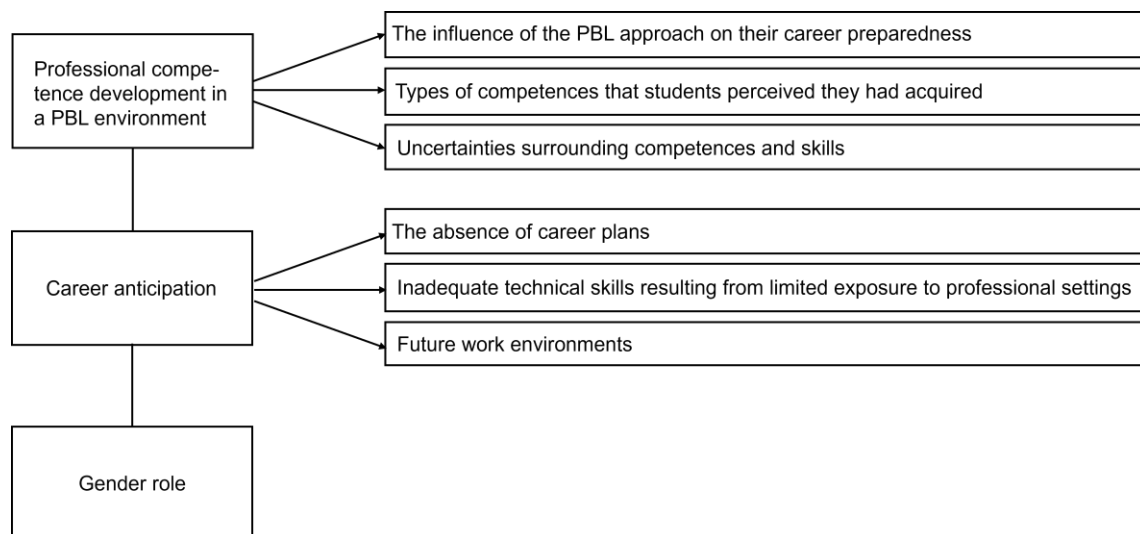

Fig. 1. Categories identified in the thematic analysis

3.1 Professional competence development in a PBL environment

The first category covered three themes associated with: (1) The influence of the PBL approach on their career preparedness, (2) Types of competences that students perceived they had acquired, and (3) Uncertainties surrounding competences and skills.

All students emphasized PBL as supportive for their career preparation, especially with regards to opportunities of having access to professional practice through collaborating with external companies, for example, "*We get used to communicating and collaborating with people in the work-life and gain knowledge on how to do so*" (A1), and additionally, "*It's the PBL mindset. We become adept to identifying and formulating problems, and we don't just receive knowledge from lectures that we don't know how to apply in practice*" (B1). Moreover, all students cited generic competences such as working autonomously, structuring one's own time, communication, learning to work with diverse individuals, and project management. The opportunity to experience how work-life is structured through PBL was similarly highlighted, "*Even though it's stressful, I think that's more like how you work in real life. I have a friend in another university where it's all assessments. I like that you have a project you can go in depth with*" (B2). The students generally emphasized that working with external partners provides valuable insights into the tasks of other employees, thus also increasing their confidence in their own knowledge, "*Right now, we are working with [a company] in [a particular African country], where what we are producing will actually be used. The project won't just be put away afterwards*" (B1).

The majority of the interviewed students expressed a desire for easily accessible opportunities to upgrade their skills and knowledge. Specifically, they expressed a general wish for more elective courses, "*Then you'll also have the opportunity to specialize in different aspects of your field depending on what you need. If someone wants more technical skills, then go do that*" (D1). Following this, it was emphasized that such courses need not necessarily be credit-bearing but could instead take the form of workshops where students can acquire different skills within relevant software, "*Without this scramble for higher marks. Where you just get the opportunity to play with the software*" (A1). Additionally, the potential benefit of obtaining a certificate that could be appended to one's curriculum vitae (CV) was emphasized, "*I can't draw, and the department hosted a graphics workshop for public facilitation, and we got a certificate in the end, something I can actually show*" (C2).

Most of the interviewed students also stressed the need for practical support, such as assistance in choices undertaken during one's education. For example, assistance in choosing their Master's degree, particularly when applying to institutions outside their current one, and support in finding internships during their Master's programme and gaining knowledge about potential career paths after graduation, "*More help for the internship search and more knowledge about where the alumni students went. It would be good to have more connections to the alumnis to get a better network and to find out what could be possible for me after university, like where did the other students go?*" (A2). The need for flexibility in their studies to explore different specialties and find their ideal path was specifically mentioned, "*Especially after Corona, because during Corona, your life was thrown up in the air, and you needed to find yourself in a new way, which I haven't tried before. Back then, during Corona, I felt like the university was more about keeping one's nose in the groove*" (D1).

3.2 Career anticipation

The second category comprised three themes of student perceptions including main concerns of: (1) The absence of career plans, (2) Inadequate technical skills resulting from limited exposure to professional settings, and (3) Future work environments.

All interviewed students reported lacking a clear career plan at this stage of their study. Nevertheless, they expressed different attitudes towards their forthcoming future as engineers. Group 1 students expressed optimistic views regarding their future career, "*I think the future for graduates within our specific education is very optimistic with low rates of unemployment, and those who're unemployed have chosen it themselves. So, it's a very open and optimistic future*" (B1). Conversely, Group 2 students expressed difficulties in predicting the prospects of their future career and highlighted the need for more experience, such as foreign company exposure and internships.

The interviews disclosed a collective apprehension among all students regarding their levels of technical skills; however, female students expressed a greater degree of concern compared to their male counterparts. The male students acknowledged the potential for skill development in the workplace, for example, "*Personally, I'm worried if my profile is technical enough, but that's also something you can develop over time, and it also depends a lot on the company, because they often have a specific way of working, specific software, and so on*" (D1). The male students also emphasized the value of other strengths and attributes that could be offered in place of lacking technical skills, for example, "*Sometimes you feel like you lack some competences, but if you list the ones you have, then you feel like you actually have plenty of competences*" (A1). Among female students, this concern was more pronounced, and the majority of female students expressed an apprehension in relation to their technical skills, "*I don't feel confident in my skills at all*" (A2) and "*I often feel like we are missing specific knowledge and that it's more about the soft skills*" (D2). A similar viewpoint relates to apprehension regarding fulfilling the required technical skills in their field of study. The uncertainties were elaborated upon, "*I'm afraid I won't have the skills that they're looking for. When I tell people I'm studying something in sustainability, they're usually like 'oh, you're probably going to find a job rather quickly', but I'm still unsure if that means a guaranteed job*" (B2).

Notably, the interviewed students underscored the significance of work formats, particularly teamwork within professional settings, placing greater emphasis on this aspect than on physical conditions. Such expressions also demonstrate the students' recognition and appreciation of the PBL environment throughout their studies. For example, "*I like the way we are working in semester projects, so therefore I would like to work in a team*" (A1), followed by highlighting the significant adjustment required to conform to structured work schedules in a professional environment, as opposed to the greater autonomy afforded in project work. Similarly, feeling comfortable was highlighted, "*I'm worried about if I find a position where I'm really comfortable and also like the team and feel like I can thrive there*" (D2).

3.3 Gender role

The third category concerns the viewpoints of both interviewed female and male individuals regarding gender disparities in the labour market, specifically focusing on general and stereotypical inequalities as well as self-efficacy.

All interviewed students demonstrated a comprehensive understanding of gender-related perceptions in the labour market. They expressed concerns regarding gender stereotypes prevalent in engineering workplaces, drawing primarily from knowledge acquired through familial influences, media sources, and their labour union. Notably, the students highlighted wage inequality between male and female employees occupying the same positions, as well as challenges faced by females in resuming their careers after maternity leave, among other related issues.

Personal concerns were particularly expressed by female students. For example, one female student noted her view that the gender differences regarding professional confidence which might be related to the observed inequalities. In her view, male employees could be more self-assured regarding their skill set, "*It can be discussed whether that is because men are better at saying 'here I come' when they get some leading positions*" (B1). Another female student theorized that the notion of females being less confident than males is a widely accepted perspective: "*I think the mainstream thought is that women are not that confident. In previous years it would have been hard for women to have an engineering career, but that should have changed now. But I think women are not that good at selling themselves for their skills*" (A2), indicating that females tend to demonstrate more humility in terms of their skills and knowledge. Moreover, gender stereotypes regarding the types of competences that are attributed to female and male employees appear to exert a considerable influence on contemporary society. Particularly, female students report feeling stigmatized and labelled as possessing primarily 'soft skills', "*In my work life outside of the field of my education, men have been calling me 'sweetheart' and I've got the comment 'oh we don't see a lot of women doing that task'. And I'm like 'okay'*" (B1). Another female student continues, "*This is a hypothesis, but because you are a woman, they might think that you might be better in your soft skills naturally. So, they might give you the positions where you have more communicative roles, and you talk more to people. Again, I haven't tried it, so I don't know if that is reality, but it's my perception of reality*" (B2).

The interviewed male students demonstrated their acknowledgment of prevalent gender stereotypes within professional environments, although expressing varying degrees of disagreement with them. For example, a male student argued that females might feel like they need to choose between having children and a career, "*Maybe it's a bit Hollywoodish, but sometimes you talk about real businesswomen who choose to have children by 40 and focus on their career. You know, that you don't have the possibility to have both, which it maybe sometimes isn't*" (D1). Another male student argued that the gender division within the field of engineering is influenced by societal norms. He further elaborated by stating that they as male students may not be able to accurately assess the frequency of such problems in the field, "*We are three white men, and you need to look at the problem from other angles, and not to choose what problems you think others might have*" (C1). Another male student discussed the idea of potential advantages of being a female in the field of engineering, citing new public reforms that prioritize the inclusion of women in the workplace, "*It is a positive progress that they're searching for more women, but I also don't think it should shift, so that you are chosen based on your gender*" (A1).

4   DISCUSSION AND CONCLUSION

The current study investigated the perceptions of engineering students regarding their career preparedness and the influence and role of gender on these perceptions. The research involved conducting two focus group interviews with engineering students in their eighth semester, and a coding process was employed which identified three distinct categories, namely: (1) Professional competence development in a PBL environment, (2) Career anticipation, and (3) Gender role.

Within the first category, labelled as "Professional competence development in a PBL environment", the students emphasized the pivotal role of PBL in preparing them for their entrance into the labour market. They underscored the value of acquiring generic competences and actively interacting with stakeholders as integral components of the PBL experience. This observation aligns with the findings of Anastasio and Morehouse (2019), who conducted a study investigating competences associated with career readiness among engineering students. Their study revealed that students exhibited the highest levels of confidence in critical thinking, teamwork, and professionalism, also aligning competences related to PBL. Additionally, the interviewed students expressed the need for enhanced practical support, including guidance in selecting an appropriate Master's programme, facilitating internship opportunities, and exploring possibilities relevant to their status as students. The second category, labelled as "Career anticipation", revealed that although the students held varying perspectives regarding the likelihood of securing immediate employment after graduation, a common finding was the absence of a specific career plan among the students. Their limited considerations about a future career plan can indicate a low level of preparedness, as according to Lent (2013). Nevertheless, despite having no clear career plan, the students were still concerned about their future career, but they maintained a desire to further develop their technical skills within their academic pursuits. Furthermore, both groups underscored the significance of acquiring practical experience and working in a beneficial environment. The third category, labelled as "Gender role", pertains to observations made regarding gender differences and societal positions. Despite the students having a shared understanding of inequalities between genders in various areas in the labour market, gender differences and differing perceptions regarding prospects were evident among male and female students. Specifically, female students expressed apprehensions regarding their technical skillset and perception of females in the labour market, relating to females' societal position within the job market. The male students generally acknowledged the presence of such, but also emphasized their disagreement with them.

For the purpose of enhancing the career preparedness of engineering students, outcomes of this study provide a few practical implications for future practice. Firstly, the engineering programme should provide more structured support to aid students in developing awareness of their career anticipation and rely on available resources to make a comprehensive career plan. Secondly, the programme needs to emphasize fostering external connections with relevant companies to facilitate practical industry exposure. Particularly, attention can be paid to support female students and others by providing increased opportunities for interaction with industry professionals and graduates who are already employed. Furthermore, it is essential to provide support to students, with particular attention to the needs of female students in recognizing and leveraging their strengths. This support should include the development of both

generic competences and technical-professional skills, as creating opportunities and offering comprehensive support and guidance throughout the career development process is vital in addressing these challenges effectively (McDonald and Waite 2014).

The present study has a few limitations. Despite not aiming at statistical representativeness, the results remain temperate due to the explorative nature of focus groups and minor sample size. Future studies may explore career preparedness in a PBL environment by employing diverse research methods, including mixed methods approaches. Furthermore, future studies can explore a larger scope of diversity perspectives, not limited to gender, as it is crucial to gain a deeper understanding of how engineering curricula can be designed to attract a more diverse population. This study seeks to provide valuable student-centered insights that can inform curriculum development efforts, with an emphasis on gender. Currently, the results are limited to the specific engineering programme and further studies are needed to expand the implications of the study.

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