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Career orientation of first-year students in STEM education: a Q methodology study

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Abstract
A shift has occurred in career attitudes and aspirations of university students within science, technology, engineering, and mathematics (STEM) disciplines, highlighting the importance of investigating students' strategies for early career planning. This study explores the career orientation of 27 first-year STEM students by utilizing Q methodology, which integrates qualitative and quantitative approaches. The findings provide valuable insights into the career orientation of first-year students in STEM disciplines in the aftermath of the coronavirus disease 2019 (COVID-19) pandemic; their focus includes a goal-oriented mindset, work–life balance, workplace conditions, and physical surroundings. The findings of this study carry practical implications for enhancing career support programs.

Keywords Protean career orientation · Q methodology · STEM

Résumé
Un changement s'est produit dans les attitudes et aspirations professionnelles des étudiants universitaires dans les disciplines des sciences, de la technologie, de l'ingénierie et des mathématiques (STEM), soulignant l'importance d'examiner les stratégies des étudiants pour la planification précoce de leur carrière. Cette étude explore l'orientation professionnelle de 27 étudiants de première année en STEM en utilisant la méthodologie Q, qui intègre des approches qualitatives et quantitatives. Les résultats fournissent des informations précieuses sur l'orientation professionnelle des étudiants de première année dans les disciplines STEM à la suite de la pandémie de COVID-19 ; leur focus comprend un état d'esprit orienté vers les objectifs, l'équilibre entre le travail et la vie personnelle, les conditions de travail et

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l'environnement physique. Les résultats de cette étude ont des implications pratiques pour améliorer les programmes de soutien à la carrière.

Resumen

Ha ocurrido un cambio en las actitudes y aspiraciones profesionales de los estudiantes universitarios dentro de las disciplinas de ciencia, tecnología, ingeniería y matemáticas (STEM), destacando la importancia de investigar las estrategias de los estudiantes para la planificación temprana de su carrera. Este estudio explora la orientación profesional de 27 estudiantes de primer año de STEM utilizando la metodología Q, que integra enfoques cualitativos y cuantitativos. Los hallazgos proporcionan valiosos conocimientos sobre la orientación profesional de los estudiantes de primer año en disciplinas STEM en las secuelas de la pandemia de COVID-19; su enfoque incluye una mentalidad orientada a objetivos, equilibrio entre la vida laboral y personal, condiciones de trabajo y entorno físico. Los hallazgos de este estudio tienen implicaciones prácticas para mejorar los programas de apoyo profesional.

Zusammenfassung

Es hat sich eine Verschiebung in den Berufseinstellungen und -zielen von Universitätsstudierenden in den Disziplinen Naturwissenschaften, Technologie, Ingenieurwesen und Mathematik (MINT) ergeben, was die Bedeutung der Untersuchung der Strategien der Studierenden für die frühe Karriereplanung hervorhebt. Diese Studie untersucht die Berufsorientierung von 27 Erstsemester-MINT-Studierenden unter Verwendung der Q-Methodologie, die qualitative und quantitative Ansätze integriert. Die Ergebnisse liefern wertvolle Einblicke in die Berufsorientierung von Erstsemester-Studierenden in MINT-Disziplinen in der Folge der COVID-19-Pandemie; ihr Fokus beinhaltet eine zielorientierte Denkweise, Wwork–Life-Balance, Arbeitsplatzbedingungen und physische Umgebung. Die Ergebnisse dieser Studie haben praktische Auswirkungen auf die Verbesserung von Programmen zur Berufsunterstützung.

The twenty-first century has borne witness to profound changes in the landscape of work and employment, primarily catalyzed by emerging global challenges and technological advancements (Gander, 2022). In turn, these changes have naturally influenced individuals' career choice practices (Badmus and Jita, 2023; Kettunen, 2023). This progression has given rise to a notable shift in the academic discourse surrounding careers, with increased emphasis on the significance of agency and self-directed career management in achieving career success (Akkermans and Kubasch, 2017). While a "career" is commonly accepted as an individual's sequence of employment-related experiences and practices, it is also universally acknowledged that developing a career is a lifelong process (Super, 1980). Although career development has traditionally been associated with the later stages of higher education, contemporary literature argues that adolescence constitutes a pivotal phase during which individuals form beliefs about themselves as lifelong learners and establish academic and career-related aspirations (Atkins et al., 2020; Badmus and Jita, 2023;

Murcia et al., 2020). The process of career development includes the establishment of consistent vocational preferences, the refinement of occupational choices, the formulation of career objectives, and the engagement in long-term career planning (Luo et al., 2021; Pascariati and Ali, 2022; Skorikov, 2007). A substantial body of research has examined various factors of career perspectives within science, technology, engineering, and mathematics (STEM) fields. These studies have delved into topics such as the development of STEM interests (Kier et al., 2014; Luo et al, 2021), STEM career aspirations (Chiu and So, 2022), the factors influencing students' choices in STEM careers (Kaleva et al., 2019; Murcia et al., 2020; Woo et al., 2023), and the means by which students in STEM fields can be effectively supported in relation to their career development (Martin-Hansen, 2018).

The term "career orientation" concerns the perspectives and strategies individuals employ when planning and pursuing their vocational endeavors (Hirschi and Koen, 2021). In traditional career orientations, workplaces have historically played a dominant role in shaping individuals' career paths, whereas contemporary career orientations place greater emphasis on the workplace accommodating the aspirations and objectives of individual employees (Baruch, 2014). Over the past decades, changes in the workplace have spurred a growth in research into contemporary career types. This has resulted in the emergence of various contemporary career concepts in literature while highlighting the increasing mobility and self-directed nature of individuals in their careers (Gubler et al., 2014; Herrmann et al., 2015). Moreover, the COVID-19 pandemic has had a profound influence on the professional values, interests, and preferences of employees (Cao and Hamori, 2022). This has underscored the imperative to reassess individuals' career orientations in the postpandemic landscape. Among the multitude of concepts involving contemporary careers, the protean career and the boundaryless career, which overlap in certain aspects, have gained widespread recognition. This study focuses on the protean career, as the concept predominantly addresses individuals' motivations for pursuing a particular career path, while the boundaryless career is more concerned with various forms of career mobility (Gubler et al., 2014). The protean career orientation (PCO) was initially introduced by Hall (1976, 1996) as a novel career orientation expected to dominate the twenty-first century, where careers were projected to be primarily driven by individual rather than organizational factors. The term "protean" draws inspiration from the Greek god Proteus, who possessed the ability to change shape as will (Baruch, 2014). This term aptly reflects the highly adaptive and dynamic nature of this career orientation. According to this perspective, individuals' personal career success is more likely to be influenced by their vision and core values: "The new career contract is not a pact with the organization; it is an agreement with one's self and one's work. The path to the top has been replaced by the path with a heart" (Hall, 1996).

The consistent rise in the number of women pursuing higher education in Denmark has resulted in a noticeable difference between male and female enrollment rates, yet STEM education maintains a strong retention rate for both male and female students (DST, 2022). Notably, there was a 5% decline in the number of students enrolling in STEM educations at Danish universities in 2022 compared with 2019 (Uddannelses- og Forskningsstyrelsen, 2022). The demand for skilled

professionals in engineering, technology, and IT fields is projected to increase significantly in the upcoming decade (IRIS Group and HBS Economics, 2021). The primary objective of this study is to explore students' subjective views concerning what they consider important in the context of their career orientation during the initial stages of their STEM curricula. Herrmann et al. (2015) underscore the necessity for extended research into the PCO, which, despite its significant recognition, lacks rigorous empirical assessments of the theoretical concepts. Specifically, this study was guided by the following research question: What do students in STEM fields value as important during their early university experience when developing a PCO? A notable gap exists in the understanding of how students embarking on STEM educational pathways cultivate their PCO during the early stages of their university journeys. It is crucial to understand how students perceive their career orientations, as this can inform educators, institutions, and policymakers on how better to prepare students for STEM careers. Moreover, STEM education is central to driving technological advancements and addressing global challenges and understanding how students early in their STEM education perceive and shape their career orientations has implications for how STEM education can better prepare individuals for the workforce of the future. Q methodology (henceforth Q) was employed to explore both individual and collective subjectivity. The unique aspect of Q lies in its ability to combine qualitative and quantitative elements in data collection and analysis. The study's data pool comprised 27 first-year students enrolled in a STEM program, where problem-based learning (PBL) served as the primary pedagogical methodology. This approach led to insights into the multifaceted and nuanced perceptions of these early-stage learners, shedding light on the evolving dynamics of their preferences in the context of twenty-first century education and the STEM workforce.

Career studies in STEM

Prior research has to a great extent investigated factors influencing the career choices of students in STEM fields, and numerous studies emphasize the pivotal role of student interest in influencing career choices (e.g., Gómez et al., 2022; Mau and Li, 2018; Nyamwange, 2016). Similar to Denmark, the USA is challenged by the shortage of STEM graduates that is needed to meet labor market demands (Falco, 2017). Jelks and Crain (2020) conducted a study highlighting the significance of early exposure to STEM-related jobs matching individuals' long-term career interests. They found a positive association between such exposure and a higher likelihood of persisting in STEM careers. Dabney et al. (2013) and Habig et al. (2020) further supported this notion, revealing that long-term engagement in voluntary, out-of-school STEM learning experiences fostered persistence in STEM fields. These findings underscore the role of early and consistent engagement in shaping STEM career interest and long-term commitment. Additionally, certain initiatives incorporate career planning classes aimed at recruitment and retention. These classes have been demonstrated to significantly reduce the prevalence of negative career thoughts among students (Belser et al., 2018).

Wiebe et al. (2018) contend that students as young as elementary school age begin to form attitudinal connections between their academic experiences, life events, and their approaching STEM career choices. According to Chen et al. (2023), STEM-related media, such as video content and video games, is a significant factor that has influenced students' shaping of interests in STEM careers. Their research underscores the importance of mindful communication through various media platforms, which may communicate nuanced and diverse messages regarding STEM career opportunities. Notably, for female students, it is essential to explore the extent to which they feel a sense of belonging in the STEM community, as this can significantly impact their STEM interests (Xu and Lastrapes, 2021). The parental role in students' STEM career interests has also been researched. Several studies have shown that parents' supportive behaviors in STEM fields play a significant role and have long-lasting effects (Dabney et al., 2013; Gottfried et al., 2016; Šimunović and Babarović, 2020). Numerous studies have demonstrated that individuals' career choices and aspirations are significantly influenced by their self-efficacy (e.g., Mau and Li, 2018; Rivera and Li, 2020; Santos et al., 2018; Wright et al., 2014). Murcia et al. (2020) found that during their lower secondary schooling years, participants actively engaged in career conversations with their parents and career counselors, which contributed to the development of their self-efficacy. School counselors' understanding of factors that influence students' academic and career choices in STEM is necessary to provide effective interventions and responsive services to positively impact students' future career outcomes (Falco, 2017). A study by Rivera and Li (2020) explored factors influencing high school students' STEM college learning and career orientation. Their findings underscored the importance of support from teachers and parents in shaping students' positive attitudes toward their future education and careers, particularly in STEM fields. Additionally, the physical context of the workplace emerged as another influential factor, suggesting that the environment in which individuals work plays a role in shaping their career orientation.

Beier et al. (2018) conducted a study revealing that active learning activities have a positive impact on student engagement and career interest within the domains of STEM. In particular, their research established that students who enroll in at least one project-based learning course during their initial four college semesters exhibited heightened aspirations toward STEM careers, enhanced proficiency in STEM-related skills, and a higher perception of the utility of STEM courses (Beier et al., 2018). Similarly, Peterson's (2020) research centered on active learning methodologies with the goal of enhancing student engagement. While the findings of this research showed no significant difference in STEM career interest between traditional science coursework and units utilizing inquiry-based or design-based learning, they demonstrated a noteworthy pattern of score elevation when a career area was addressed in an active learning unit. De Vos et al. (2011) conducted a study showing that employees valued competence development initiatives, recognizing a positive association with their perceptions of employability. This finding aligns with research conducted by Blokker et al. (2019), in which career success emerged as a mediating factor in the relationship between career competences and individuals' perceived employability.

Conceptualizing PCO

PCO can be conceptualized as being closely intertwined with various behavioral and attitudinal variables, including identity clarity, proactivity, flexibility, and adaptability (Hall, 1996; Hirschi et al., 2017). These characteristics imply that individuals exhibiting a PCO tend to experience heightened self-efficacy, as they demonstrate a stronger belief in their ability to make informed vocational decisions (Bandura, 1997; Li et al., 2019). Building upon this foundation, Hackett (1995) suggests that self-efficacy occupies a fundamental role in the development of vocational choice predictors, such as interests, values, and goals. Consequently, individuals' internal motivation is driven by intrinsic values and a highly individualistic and goal-oriented mindset, which serves as the foundation for agentic sources and as a metric for measuring career success (Baruch, 2014; Briscoe and Hall, 2006; Hall et al., 2018). Additionally, Sen and Hooja (2015) argue that the PCO is associated with psychological capital, including elements such as self-efficacy, confidence, hope, optimism, and resilience. Career success is best defined as the culmination of positive psychological and work-related outcomes and achievements resulting from one's work experiences (Seibert et al., 1999). In this regard, the motivation of individuals exhibiting a PCO is deeply rooted in their personal psychological success in their career pursuits (Redondo et al., 2021). Having a specific career goal that guides their career path is crucial for individuals with a PCO, in contrast to individuals lacking a PCO, who may conform to organizational or externally assigned goals for their development and performance (Rahim and Siti-Rohaida, 2015). Furthermore, research focusing on students' motivation reveals that students place a high value on securing a job that is both meaningful and enjoyable (Kirchmayer and Fratričová, 2018). The PCO not only impacts self-efficacy and intrinsic motivation but also fosters a deep-seated desire to find meaning and fulfillment in one's chosen career path.

A fundamental aspect of the PCO is linked to proactivity, such that individuals with a proactive personality demonstrate a strong desire to use initiative and actively seek out opportunities to transform their circumstances (Seibert et al., 1999). Li et al. (2019) suggest that those students in higher education with a high level of PCO are more likely to demonstrate a strong intention to proactively seek additional career-related information and resources independently. Thus, a PCO is characterized by a self-directed approach, signifying a mindset that values freedom and autonomy in career decision-making with a strong emphasis on aligning choices with personal values. In contrast, individuals who lack these values-driven and self-directed characteristics find it challenging to prioritize and manage their careers independently (Briscoe and Hall, 2006). They are more likely to follow externally prescribed paths or conform to organizational expectations (Baruch, 2014).

While the PCO has previously been associated with employees lacking a strong connection to their workplace, making them more prone to mobility (Briscoe et al., 2006), a study by Redondo et al. (2021) presents a counter narrative. Their research highlights that highly protean-talented individuals exhibit higher levels of organizational commitment and job satisfaction, indicating that these individuals value a stable work environment and job situation. In the study conducted by Kirchmayer and

Fratričová (2018), the notion of job security was mentioned minimally, with greater emphasis placed on financial security. Furthermore, Direnzo et al. (2015) found a positive relationship between PCO and work–life balance, which can be attributed to the connection between PCO and career planning. Engaging in career planning activities provides opportunities for individuals with a PCO to assess themselves and their work environment, leading to a more harmonious balance between work and personal life (Direnzo et al., 2015).

The social cognitive career theory (SCCT) aligns with the PCO by recognizing the dynamic and constantly evolving nature of career development, while also serving as the foundational framework for cultivating protean career competences. Developed by Lent et al. (1994), the SCCT draws from Albert Bandura's general social cognitive theory to provide a comprehensive theoretical framework through which to understand career and academic behavior, taking into account contextual and individual factors in career decision-making (Lent et al., 1994, 2006). The SCCT clarifies three closely interrelated dimensions of career development: (1) the development of fundamental academic and career interests, (2) the decision-making processes that underlie educational and career choices, and (3) the means by which academic and career success is achieved (Lent et al., 2006). In the context of career development, goal setting serves as a vital indicator of an individual's self-efficacy, outcome expectations, and interests (Lent et al., 1994). Their self-efficacy is significantly influenced by prior learning experiences, behaviors, and the environment (Bandura, 1997). People tend to develop an interest in activities for which they possess and are confident in the required skills (Lent et al., 2006). Unlike traditional career theories that have previously neglected the role of social and environmental factors in career development, the SCCT offers a more adaptable framework. It underscores the importance of individual and environmental changes and views career choice as a dynamic system that evolves over time (Wang et al., 2022). This adaptive perspective aligns closely with the PCO's emphasis on proactive, self-directed career development and the pursuit of goals in alignment with personal values and interests.

Research design

The aim of this study is to investigate the perspectives held by students pursuing STEM disciplines concerning their current career orientation. A subjective approach was adopted to facilitate an examination of the associations between predetermined statements related to students' future careers and workplaces. This method enables a comprehensive analysis of the data both qualitatively and quantitatively. Prior research has utilized Q, including Genissen et al.'s (2021) study on medical students' career orientations aimed at bridging the gap between students' career choices and the needs of society, and Kajfez et al.'s (2014) investigation of engineering education career opportunities and graduates' job search processes. Nonetheless, career research studies have predominantly relied on questionnaire-based surveys to collect data from a large number of respondents to measure various aspects (e.g., Direnzo et al., 2015; Kier et al., 2014; Li et al., 2019). Q combines a data collection

technique and statistical analysis method; hence, integrating qualitative and quantitative aspects and aiming at empirically grouping individuals based on their shared perspectives (Brown, 2019; Ramlo, 2016). Participants engage in a reflective ranking process of a set of items, allowing the researcher to explore the significance of these items for each participant (Ramlo, 2016). Consequently, Q provides a platform for individuals to express their subjective and personal viewpoints on a given topic and assign meaning to each item while placing them within a grid (Brown, 2019; Watts and Stenner, 2012). Lundberg et al. (2020) emphasize the utility of Q in collecting empirical and systematic evidence of subjectivity, which can inform and enhance educational practices. In the data collection of this study, the data collection and analysis followed a Q methodological procedure, as outlined by Lundberg et al. (2020). It consists of six key steps: (1) development of a concourse, (2) construction of the Q set, (3) participation of individuals in the Q sorting, (4) postsorting activities, (5) Q factor analysis, and (6) factor interpretation.

The current study was carried out in a first-year mandatory course within a PBL environment in which students were given the option to voluntarily participate in the Q study. PBL involves collaborative efforts of students organized in teams to tackle complex problems (Holgaard et al., 2021). Prior to their involvement in the study, all students received a consent form outlining the objectives and ethical principles established by the university's ethical regulations. A total of 27 students, comprising 19 males and 8 females, out of the 32 students enrolled in the course agreed to participate in the Q study. The participants' ages ranged from 20 to 29 years. The study was conducted in English; however, the introduction, support, and postsorting activities were conducted in Danish, which is the primary language of the study program.

Concourse development and Q set construction

The first step is crucial in Q and involves the construction of statements that serve as the data collection instrument (Lundberg et al., 2020). The Q set must be broadly representative of all possible opinions within the research focus (Watts and Stenner, 2012). To develop the Q set, the authors investigated previous studies on career orientation and career development and created the concourse, which is a collection of what can be said about the subject matter (Brown, 2019). In the second step, statements were developed as interrelated intrapersonal and external dimensions related to the PCO, as presented in Table 1. To gain deeper insights, the participants were asked to anonymously answer a question in advance of the Q sorting on important aspects when choosing their future career, and aspects that were not included in the initial Q set were added. To ensure the statements were formulated clearly and understandably, two experienced Q researchers provided valuable feedback, and adjustments were made accordingly, leading to the creation of a 34-item Q set. Subsequently, the first author facilitated an inductive process with research colleagues to provide additional feedback and validate the Q set by sorting the items. Adjustments were made to clarify certain statements, and one item was added, culminating in a final 35-item Q set, as presented in Table 2.

Table 1 The development of concourse and Q set

Dimensions of PCO	Statement number
Intrapersonal (Baruch, 2014; Briscoe and Hall, 2006; Briscoe et al., 2006; Hackett, 1995; Hall, 1996; Hall et al., 2018; Hirschi et al., 2017; Kirchmayer and Fratričová, 2018; Li et al., 2019; Rahim and Siti-Rohaida, 2015; Redondo et al., 2021; Seibert et al., 1999; Sen and Hooja, 2015)	19 statements: 1, 2, 3, 4, 5, 10, 11, 12, 13, 14, 19, 20, 21, 22, 23, 28, 29, 31, 32
External (Direnzo et al., 2015; Gómez et al., 2022; Kirchmayer and Fratričová, 2018; Lent et al., 1994; Redondo et al., 2021; Rivera and Li, 2020)	16 statements: 6, 7, 8, 9, 15, 16, 17, 18, 24, 25, 26, 27, 30, 33, 34, 35

Participant Q sorting and postsorting activities

The data collection process involved physical presence, and the first author and a colleague who were familiar with Q provided assistance when required. According to Watts and Stenner (2012), participants must be able to respond in an effective manner, and therefore, the instructions were simplified to make the assignment as clear as possible. The participants were instructed to provide demographic information, including age and gender, and to rank order the 35 statements based on their perceived importance with regard to their future career choice. Each participant was provided a consent form to sign, 35 statement cards, a piece of paper containing a table, and sticky notes for demographic information and the postsorting activity. Each statement was assigned a hierarchical position on a forced-choice symmetrical distribution grid (Figures 1, 2, 3), ranging from "most unimportant" (−4) to "most important" (+4), requiring the participants to consistently compare and reflect upon the relative positions of the statements. Following completion of the Q sorting activity, participants were asked to elaborate upon the statements they had sorted as being the most important and most unimportant. It is recommended that participants elaborate on the extremes of their sorted items to enrich the qualitative description of factor arrays (Lundberg et al., 2020).

Q factor analysis and interpretation

For the data analysis, the participants' statement-sort grids were analyzed using a specialized software for Q data analysis, KADE (Banasick, 2019). The centroid method of factor analysis was employed to condense the data, facilitate a thorough exploration of it, and extract the appropriate number of factors. This was followed by the application of a varimax rotation to achieve a mathematically favorable solution (Watts and Stenner, 2012). Based on an inductive approach to Q analysis, the most suitable solution consisted of three factors. With three factors, 25 participants significantly loaded on one of the three factors and could be

Table 2 Final Q set and factors

Nm	Statement	Factor 1	Factor 2	Factor 3	*z* score variance
22	Developing interpersonal skills during my studies	0	0	0	0.006
27	Being employed in the public sector	−4	−4	−4	0.006
8	My workplace making my work agenda	−2	−2	−2	0.008
32	Developing problem-solving skills during my studies	1	0	1	0.011
34	Being employed in a large-scale company	−2	−3	−2	0.011
19	Connecting theory to practice in my job	0	0	0	0.016
21	Opportunities to challenge myself in my job	1	3	2	0.027
1	Feeling confident in my capabilities in relation to the job	1	2	2	0.029
2	Having a job where I use the knowledge and skills I have learned during my studies	0	1	1	0.032
14	Developing critical thinking during my studies	0	1	0	0.032
24	The workplace emphasizes collaboration	−1	−1	0	0.044
7	Diversity in relation to education and knowledge of colleagues	−1	0	−1	0.048
20	Having a job where I get the opportunity to learn new things	2	3	2	0.064
29	My work having a positive impact on the technological development of society	0	0	−1	0.082
13	Seeking possibilities and opportunities for career development	1	1	3	0.109
33	A good relationship with colleagues	3	2	3	0.113
16	Satisfactory condition of physical facilities at the workplace	1	−1	1	0.119
23	Developing entrepreneurial thinking during my studies	−1	−1	1	0.119
35	Being employed in a smaller-scale company	−3	−3	−1	0.15
6	Expectations from my family when choosing career path	−3	−2	−3	0.159
11	Feeling motivated for the job	3	4	4	0.164
3	Having a job that fits my interests	2	4	3	0.199
5	Developing structural competences during my studies	−2	1	−1	0.201
15	The perception of my friends in relation to my chosen career path	−4	−2	−−3	0.225
10	Having a sense of ownership in the workplace	−2	0	1	0.27

Table 2 (continued)

Nm	Statement	Factor 1	Factor 2	Factor 3	*z* score variance
17	Flexible working hours	2	−1	0	0.286
28	Having a work/life balance	4	1	2	0.364
26	Flexible working locations	−1	2	−2	0.372
31	Compliance between my time and workload	2	−1	−1	0.52
9	Being employed in the private sector	−3	−4	0	0.527
25	Getting a job close to my relatives and friends	0	−3	0	0.629
12	Having financial security	4	0	4	0.799
18	Diversity in relation to cultural backgrounds and gender of colleagues	−1	2	−4	0.855
4	Having a clear career goal	0	3	−2	0.941
30	Getting a job in close distance to my home	3	−2	−3	1.037

The *z* score reflects the level of consensus versus disagreement across the three factors.

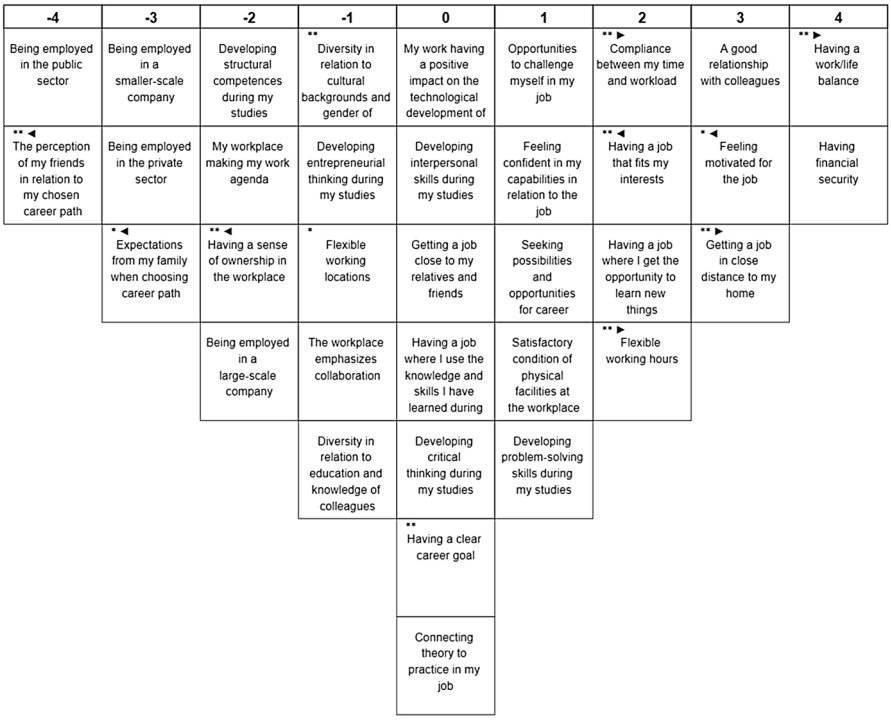

Figure 1 Factor 1: the three factors after a centroid factor analysis and varimax rotation. *Distinguishing statements at $p < 0.05$; **distinguishing statements at $p < 0.01$; ► z score for the statement is higher than in all other factors; ◄ z score for the statement is lower than in all other factors

included in the following factor analysis. The remaining two participants loaded nonsignificantly across all factors. Figs. 1, 2, 3 provide an overview of the factors. It is important that the interpretation of the factors is consistent and data driven. In addition, this interpretation can be seen as a holistic qualitative analysis (Lundberg et al., 2020).

Results

The following sections present an account of the three factors that surfaced from the Q analysis, namely: (1) work–life balance, (2) professional pursuits, and (3) personal satisfaction. The analysis incorporates demographic information and students' citations to contextualize the findings. The bracketed numbers in the text correspond to each statement number (as listed in Table 2), together with its assigned value ranging from −4 to +4 in the particular factor, e.g., (no. 28/4). The notation "*D*" signifies values that are "distinguishing statements" ($p < .05$),

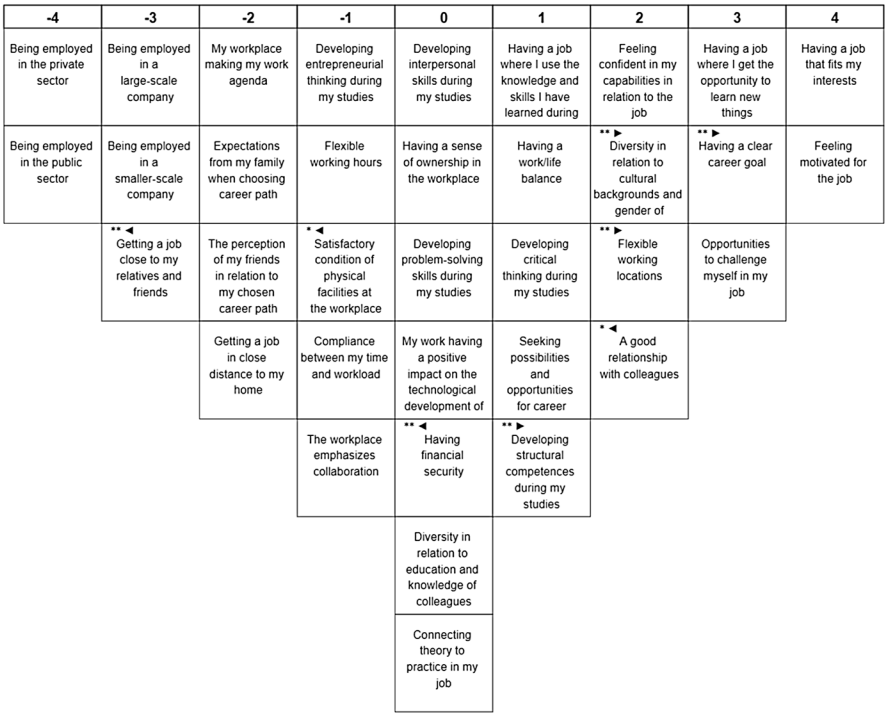

Figure 2 Factor 2: the three factors after a centroid factor analysis and varimax rotation. *Distinguishing statements at $p < 0.05$; **Distinguishing statements at $p < 0.01$; ► z score for the statement is higher than in all other factors; ◄ z score for the statement is lower than in all other factors

whereas *"D*"* indicates values that are "significantly distinguishing statements" ($p < .01$).

Factor 1: work–life balance

The first factor comprises 12 participants, of whom eight are male and four are female. Their age range is 21–29 years (predominantly 21–24 years). Commonly, these participants articulated their desire for a job that provides them with personal freedom beyond work, and therefore, they were not inclined toward a work environment with a high level of authority over employees. Overall, these participants anticipated a job that is accommodating and adjustable to their personal needs and preferences.

In concrete terms, participants categorized into factor 1 display a strong inclination toward job characteristics that enable a satisfactory balance between work and personal life (no. 28/4*D**), whereas those assigned to factor 2 and factor 3 ranked this feature as less significant. The prioritization of work–life balance by factor 1 participants was supported by statements that underscored their personal autonomy, such as the need for financial security (no. 12/4) and preferences for a

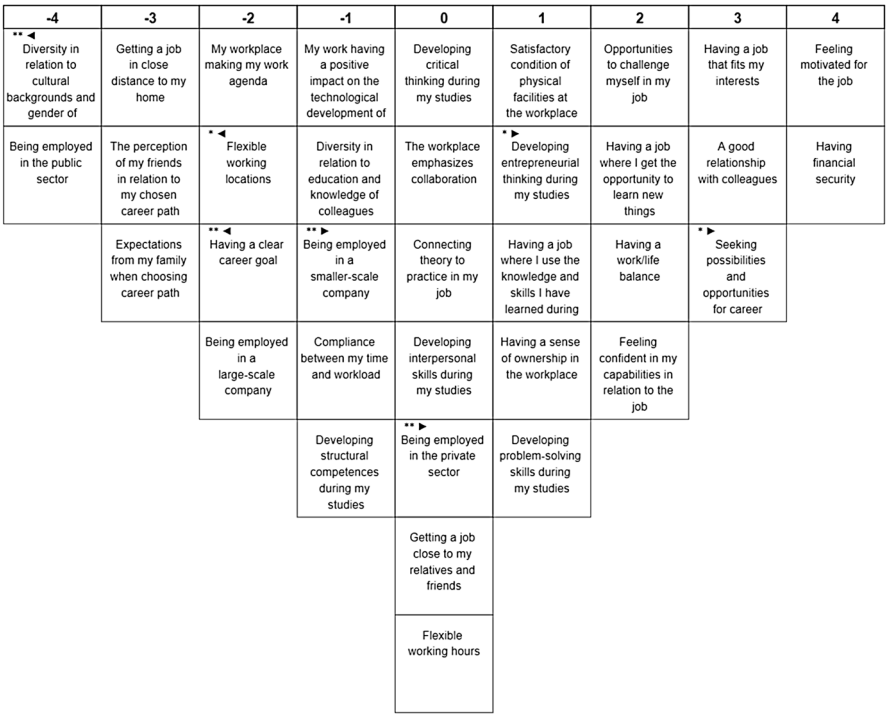

Figure 3 Factor 3: the three factors after a centroid factor analysis and varimax rotation. *Distinguishing statements at $p < 0.05$; **distinguishing statements at $p < 0.01$; ► z score for the statement is higher than in all other factors; ◄ z score for the statement is lower than in all other factors

job location in proximity to their home (no. 30/3*D**) and flexible work schedules (no. 17/2*D**). Conversely, participants in factor 2 and factor 3 ranked these statements as considerably less critical. One participant elaborated upon the highest rankings:

> I chose to place financial security and work–life balance as most important because I want to be able to have enough money to realize some of my dreams and just be sure to be independent. I want something where my whole life does not take place in the workplace.

Participants placed significant emphasis on the alignment between workload and time (no. 31/2*D**) and showed less interest in working in a workplace with a rigid work schedule that would limit their control over their work hours (no. 8/−2). However, participants also recognized the importance of workplace-specific factors, particularly the quality of relationships with colleagues (no. 33/3), aligning with factor 2 and factor 3. In terms of the need for individual autonomy, though, the study found that if the workplace prioritized collaboration, this aspect was deemed less important (no. 24/−1). The size of the company and whether it belongs to the public or private sector were also found to be of minor importance

(no. 35/−3 and no. 27/−4), as one participant stated: "I do not really care how big the company is or who owns it, the most important thing is that I like my job." While participants prioritized their own job satisfaction, they did not place significant importance on the impact of family and friends on their career choices. The expectations of family (no. 6/−3*D*) and the perception of friends (no. 15/−4*D**) in relation to their career path were categorized as least important, consistent with the rankings of factor 2 and factor 3 participants.

Factor 2: professional pursuits

Factor 2 includes four participants, two male and two female, aged 20–22 years. Generally, these participants value a job that allows them to pursue their interests and professional goals, irrespective of external and internal factors that might characterize the workplace.

The participants anticipated their future professional environment as a platform for personal growth, with a specific vocational objective in mind (no. 4/3*D**). Emphasis was placed on job alignment with their personal interests (no. 3/4), a factor of relatively lower significance in factors 1 and 3 but that served as a source of motivation for participants in factor 2 (no. 11/4). Moreover, acquisition of novel knowledge through learning opportunities was emphasized (no. 20/3) to facilitate self-improvement (no. 21/3). One participant provided further elaboration, stating that sustaining motivation is crucial in preventing exhaustion and that being challenged in the workplace is beneficial for personal and professional competence development:

> I think it is important to maintain a motivation, so you do not get exhausted, and besides that, I think it goes well with being challenged at your workplace, so you can unfold and develop your competences, both in a personal way but also in relation to colleagues.

The participants also deemed workplace values to be significant, including diversity in terms of cultural background and gender among colleagues (no. 18/2*D**).

Regarding the negative aspects, external factors associated with the workplace, such as the sector of employment (private or public; no. 9/−4 and no. 27/−4) and the size of the company (small or large; no. 35/−3 and no. 34/−3), were deemed unimportant. Similarly, certain workplace-specific factors related to organization were also considered to be of lesser importance. These included the workplace dictating employees' work schedules (no. 8/−2), offering flexible working hours (no. 17/−1), ensuring satisfactory physical facilities (no. 16/−1D), and ensuring an appropriate workload–time balance (no. 31/−1); participants in factor 1 considered the latter rather important. Additionally, participants did not consider it important to obtain employment in close proximity to friends and family (no. 25/−3), as one participant explained:

> The most important aspect for my future work life/job is not necessarily whether the company is small/large or in the public/private sector, I com-

pletely do not care about these factors. When viewed from a broader perspective, it is not about what I work with or how I work. That is why the location and work hours are not relevant to me. If I find a job that is cool and interesting to me, then I will organize my day routine accordingly.

Factor 3: personal satisfaction

Factor 3 comprises nine participants, eight male and one female, within the age range of 20–27 years (mainly 20–24 years). In essence, these participants emphasized the physical aspects of the workplace environment and the need to have a job that aligns with their mental comfort level. Consequently, they expect to work in a healthy environment.

More specifically, participants in factor 3 placed particular importance on financial security (no. 12/4) and motivation in relation to the job (no. 11/4), with the former being considered equally important in factor 1 and the latter in factor 2. They also valued aspects related to work conditions, such as having a good relationship with colleagues (no. 33/3) and a satisfactory physical environment (no. 16/1). This aligns with flexible working locations being given lower importance (no. 26/−2*D*). While participants in factor 3 considered having a good relationship with colleagues to be important, they did not place as much importance on diversity in terms of cultural background and gender (no. 18/−4*D**) or diversity in terms of education and knowledge (no. 7/−1). This is in contrast to factor 2, where cultural diversity was deemed important, but relationship with colleagues was not emphasized. One participant elaborated on the importance of the working environment, highlighting the relationship between feeling motivated and the physical working environment:

> My highest priority is to have a good relationship with my colleagues and feel passionate and driven about my work. In my opinion, a good and healthy working environment is a crucial factor for any workplace that wants to cultivate passionate employees.

The participants placed importance on feeling confident in their abilities (no. 1/2) and utilizing their acquired knowledge and skills (no. 2/1) in their future workplace, such as problem-solving skills and entrepreneurial thinking (no. 32/1 and no. 23/1*D*). They also valued the opportunity for career development (no. 13/3D) but did not emphasize the importance of having a clear career goal (no. 4/−2*D**), unlike those in factor 2 who viewed it as highly important. Additionally, external factors such as being employed in the public sector (no. 27/−4) and proximity to home (no. 30/−3) were considered less important. The expectations of family when choosing career path (no. 6/−3) were also not viewed as significant, in agreement with factors 1 and 2. Work-related factors such as work agenda (no. 8/−2) and alignment between time and workload (no. 31/−1) were also deemed less important, unlike factor 1, where compliance was more valued.

Consensus statements

The results of the Q methodological analysis revealed a number of individual statements that achieved statistically significant consensus across all viewpoints, as presented in Table 3. Notably, all factors' participants considered it important to have a job with opportunities to learn new things (20) and to feel confident in their own capabilities (1). All of them placed less importance on "my workplace making my work agenda" (no. 8), "being employed in the public sector" (no. 27), and "being employed in a large-scale company" (no. 34). Collectively, across factors, they did not highlight collaboration (24) or diversity (7).

Discussion

The present study investigates the career orientation of 27 first-year STEM students to gain insights into their values and priorities for their future careers. The research employed Q as the data collection method due to its emphasis on subjectivity, which allowed for a factor analysis by empirically grouping individuals based on shared viewpoints, utilizing both qualitative and quantitative approaches. The Q analysis revealed the presence of three statistically distinct factors, each representing different collective perspectives. These three factors underscore the complexity of SCCT by highlighting the interplay of individual and environmental factors and by positioning career choices as a dynamic system that evolves over time (Wang et al., 2022). This study centers on students' career orientation, recognizing that it may undergo changes throughout their academic journey. All three factors indicate a proactive attitude toward career anticipation, although in different ways, as seen in the consensus statements (Table 3). Participants within the identified factors generally feel confident in their capabilities, and they are generally positive toward having a job that challenges these. They exhibit a strong inclination toward value-driven and self-directed career pursuits, reflecting a pronounced sense of individualism. They shape their perception of career success based on their own criteria and priorities. Differences from previous studies can be seen in studies by Gómez et al. (2022) and Kazi and Akhlaq (2017), who reported that students' social contacts have a certain level of influence on their career choices. The present study indicates that the career preferences of first-year students are not significantly influenced by the perception of their friends and family. This may be related to Danish culture, which emphasizes the independence of young people when making personal choices (Thomsen et al., 2007).

Participants of the study addressed different aspects of the PCO, demonstrating diversity of their options at this stage. Factor 1 emerged as the most prominent factor, emphasizing the significance of achieving a balance between one's career and personal life, as well as achieving personal autonomy. Their conception of career success diverges from the other factors, with a particular emphasis on work–life balance. Research on work–life balance frequently centers around the idea that excessive working hours can lead to negative outcomes (such as compromised health and insufficient time allocated to familial, social, and communal engagements).

Table 3 Consensus statements

No.	Statement	State-ment Number	Factor 1 Q-SV	Factor 1 *z* score	Factor 2 Q-SV	Factor 2 *z* score	Factor 3 Q-SV	Factor 3 *z* score
1	Feeling confident in my capabilities in relation to the job	1	1	0.624	2	1.02	2	0.71
2	Having a job where I use the knowledge and skills I have learned during my studies	2	0	0.02	1	0.407	1	0.395
7	Diversity in relation to education and knowledge of colleagues	7	−1	−0.497	0	−0.052	−1	−0.538
8	My workplace making my work agenda	8	−2	−0.831	−2	−0.637	−2	−0.809
14	Developing critical thinking during my studies	14	0	−0.014	1	0.397	0	0.062
19	Connecting theory to practice in my job	19	0	−0.291	0	−0.055	0	0.002
20	Having a job where I get the opportunity to learn new things	20	2	0.9	3	1.49	2	1.026
21	Opportunities to challenge myself in my job	21	1	0.806	3	1.201	2	1.062
22	Developing interpersonal skills during my studies	22	0	0.155	0	0.045	0	−0.038
24	The workplace emphasizes collaboration	24	−1	−0.378	−1	−0.465	0	0.015
27	Being employed in the public sector	27	−4	−1.953	−4	−2.061	−4	−2.148
32	Developing problem-solving skills during my studies	32	1	0.227	0	-0.016	1	0.189
34	Being employed in a large-scale company	34	−2	−1.105	−3	−1.185	−2	−0.934

The concept of work–life balance also includes the notion of time-related stressors, wherein individuals feel pressured by the demands of their jobs (Warren, 2021). This emphasis on work–life balance could potentially influence students' career choices within the STEM field, depending on their perceptions, which are also influenced by media portrayals (Chen et al., 2023). Students may develop a belief that certain STEM careers might impede their ability to maintain their personal autonomy, as job autonomy and job control are generally seen as positively related to work–life balance (Haar and Brougham, 2022).

Conversely, the need for work–life balance was notably absent among factor 2 participants, who closely align with various aspects of the PCO reflecting an individualistic and goal-oriented mindset (Baruch, 2014). Their primary focus lies on their personal career development, rather than considering workplace relationships, the physical work environment, or other external dimensions. They also emphasize individual interest, which is in agreement with prior literature concerning factors that influence students' career choices, which has determined individual interest to be a significant component (e.g., Nyamwange, 2016). Such results are also in line with previous literature that suggests that the contemporary Generation Z cohort has distinct demands and motivations compared with previous generations (Lidija et al., 2017). With the individualistic Generation Z as the newest generation in the workplace, organizations are faced with the challenge of rising work-value conflicts and differences in learning styles, beliefs, and communication styles of four different generations at the same time (Barhate and Dirani, 2022). Previous research has found Generation Z to be the most achievement-oriented of the generations, while also seeking interesting and meaningful work (Barna Group, 2018; Kirchmayer and Fratričová, 2018; Schroth, 2019). These students may be challenged by certain STEM careers that emphasize collaborative research and team projects if their individualistic career orientation conflicts with the need for effective collaboration. Additionally, STEM fields often require resilience and adaptability in the face of rapidly changing technologies and research directions (Badmus and Jita, 2023). The students' individualistic and goal-oriented approach may influence their adaptability to industry trends and technological shifts. During the COVID-19 pandemic, students experienced barriers in their career pathways, including networking difficulties and lack of exploration in different fields. However, prior research established that students remained committed to career goals and their fields (Mahjoub et al., 2023; Torres et al., 2021), indicating a certain level of adaption to external circumstances.

Factor 3 participants expressed an expectation that the physical surroundings of the workplace and colleague relationships will have significant impact on their career-related decisions. While work–life balance relates to work-related stressors, "life satisfaction" is considered an important indicator of general well-being according to one's own criteria (Diener and Chan, 2011). This perspective underscores the significance of the physical environment and conditions in which an individual operates, which may bear direct relevance to these individuals' general well-being. The availability of personal resources is instrumental in shaping one's level of enthusiasm and the surplus of energy needed to effectively navigate and manage stressful situations (***Akkermans et al., 2018). Within factor 3 individuals, the physical environment emerges as a noteworthy factor contributing to the development

of these resources, facilitating the ability to confront and manage challenges both in the workplace and personal life. Among the most significant influences in factor 3, financial security was highlighted, consistent with the findings of Kirchmayer and Fratričová (2018). Financial well-being is considered a positive financial condition that is entirely subjective and made up of individuals' perceptions of their own financial situation (Iannello et al., 2021). Increased current money management stress is likely to put pressure on well-being levels (Ponchio et al., 2023), which is likely to contribute to the factor 3 participants' emphasis on financial security as a key item for their career perceptions.

Implications

The findings and discussion presented in this study give rise to several implications for future research and the development of educational and career support programs in higher education (HE). To support students with varying career orientations effectively, it is recommended to provide structured intervention activities in which early curriculum students can be guided to develop their career goals and plans. Clear goals may support students in better developing proactive career behaviors. Certain aspects of career orientations of first-year students may deserve further attention to expand this implication, including the pedagogical approach utilized by the university, which in turn might include collaboration, teamwork, and diversity-related differences. Follow-up studies are highly recommended to explore how career orientation develops throughout students' study and in different socioeconomic and cultural contexts, including gender, ethnic background, disciplines, and professional choices in the workplace.

Furthermore, the study highlights the potential differences in career strategies, wishes, and goals between the newer generation and those who came of age before COVID-19. It is highly important for educators and HE programs to develop an understanding of the distinct career aspirations of Generation Z students, as they are assumed to approach aspects of career development differently than previous generations (Kirchmayer and Fratričová, 2018). Investigating the impact of such programs on students' career development and decision-making can contribute to more informed decisions about their academic and career paths in STEM and such programs can be pivotal in shaping career development initiatives. Programs that align with students' career goals enhance university outcomes by improving student retention rates as students who feel that their institution understands and supports their career goals are more likely to stay and complete their education (Bass et al., 2016; Falco, 2017). Early-stage students can benefit from mentorship with senior students and early career professionals, as they are familiar with strategies for career development.

The notions of work–life balance and general well-being should be key considerations in career development, and future research could explore whether students are more likely to select or avoid STEM careers based on their beliefs about work–life balance. Understanding the roles of work–life balance and general well-being in career decision-making can guide educational programs and interventions.

Limitations

The study has a few limitations that could be addressed in future research. The study provided limited evidence due to the small sample size; however, ***Watts and Stenner (2008) argue that a smaller sample size can still be effective in Q studies, as the primary aim is to identify key viewpoints of a specific group of individuals regardless of sample size and rather than achieving generalizability. While the study provides insights into the career orientation of first-year students, such tendencies are expected to develop throughout their education. In a study by Kobicheva et al. (2022), it was evident that there was a difference in factors related to learning outcome and academic performance between undergraduate students and postgraduate students. The authors argue it to be because of the longer educational path and experience in obtaining knowledge. These differences may be visible in relation to career orientations. Furthermore, they may be particularly visible in a systemic PBL environment, where team-based work and projects play a major role in the provision of learning.

Conclusions

The primary objective of this study was to investigate the subjective perspectives of students regarding what they consider crucial in shaping their career orientation during the initial stages of their STEM curricula. The Q analysis revealed the presence of three statistically distinct factors, each representing different collective perspectives on the PCO. All three factors indicated a proactive attitude toward career development, and they exhibited a strong inclination toward values-driven and self-directed career pursuits, reflecting a pronounced sense of individualism. The findings and discussion presented in this study offer valuable implications for both practical applications and future research. This study underscores the diverse and multifaceted nature of students' values and perceptions concerning their future careers, revealing the importance of tailored interventions and mentorship programs that cater to individual needs and aspirations. By addressing these implications, we can foster students' career development, enhance their well-being, and ultimately contribute to their success and satisfaction in their chosen career paths within STEM.

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Declarations

Competing interests The authors declare that they have no competing interests.

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