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Students' Perceptions of Skills Expectations in Science-Related Careers

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Abstract

Secondary school students show limited socialization, interest and awareness in science careers. This study explores the students' perceptions of essential working life skills in science-related careers. Data were collected from 144 students through questionnaires and self-created job advertisements and applications and analysed with content analysis. Adopting a sociological lens, we interpret students' perceptions as identity work shaped by school, counselling, and local labour-market discourses. Results reveal that students perceive the most important skills in science-related careers to be Ways of working and Ways of thinking such as being careful, curious and precision. While students emphasized formal education and field experience in job ads, their understanding of required qualifications varied, with many applications showing over- or under-qualification. These mismatches suggest partial and status-oriented understandings of vocational pathways. We discuss implications for equitable guidance, teacher–counsellor collaboration, and context-rich career-related instruction in science education. To promote career awareness and interest in science, students need broader, more realistic information about science professions, which can be supported through interaction with professionals, but also with collaboration of science teachers and counsellors.

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Introduction

There is a growing global concern about the shortage of professionals in science, technology, engineering, and mathematics (STEM) (Bøe et al., 2011; OECD, 2016). Despite decades of educational reforms and initiatives, the gap between the supply of qualified science professionals and the demands of the work life persists (European Commission, 2010; Mendick et al., 2017). Limited awareness and interest among secondary school students in science-related careers maintains the problem (Salonen, 2020). In addition, students' STEM career aspirations are shaped by their awareness of career options, their confidence in mastering relevant skills, and their perceptions of the relevance of science to their lives (Han, Kelley, & Knowles, 2021; Zhou & Shirazi, 2025). Students' perceptions of science-related careers can be understood through a sociological lens. From this viewpoint, students' ideas about required skills and qualifications are shaped not only by individual interests or abilities, but also by *social structures, cultural expectations, and institutional practices***,** all contributing to how students come to understand what kinds of futures are possible or desirable for them (Marcionetti & Zammitti, 2025). For example, students' exposure to science-related role models, their familiarity with different types of work, and the visibility of local labour-market opportunities can all influence how they interpret the relevance of certain skills or qualifications (Kanzaki et al., 2025). Moreover, public discourses about "21st-century skills" and employability may encourage students to adopt generalised or idealised views of what is needed in working life, sometimes without a clear understanding of how specific career pathways actually function (Stephen & Fru, 2023). These social influences can lead **to** *fragmented or status-oriented perceptions* of science careers, where formal education is overemphasized and vocational routes are undervalued (Korpershoek et al., 2020). Drawing further on Bang & Medin's cultural-process perspective in science education, students' engagement with science is embedded in the communities, histories, and practices they inhabit. Learners routinely navigate multiple epistemologies; school science alongside local and everyday knowledge. This navigation is also sort of identity work: valuing diverse knowledge systems and practices fosters relevance, belonging, and sustained participation in science careers.

Students in middle school often lack awareness of potential career paths, particularly in science-related fields (Maltese & Tai, 2011). Similarly, Cleaves (2005) found that students have limited understanding of science careers and work. These misconceptions tend to persist throughout adolescence, with many students holding the belief that science careers are neither creative nor socially engaging (Masnick et al., 2010). Furthermore, Archer et al. (2014) and Salonen et al. (2018) emphasized the influence of stereotypical images of scientists on students' career choices, often portrayed as isolated, male, and intellectually elite. Offering students timely appropriate guidance, information, and advice about career possibilities and the educational paths required is essential for enhancing the perceived relevance of school science (Andersen & Ward, 2014). Without such interventions to counteract stereotypes and expand students' views of science-related professions, many may disengage from science early on (Archer et al., 2010; Holmegaard et al., 2014). Lower secondary STEM education plays a crucial role in addressing this issue by helping students imagine themselves as capable contributors to scientific work (Bang & Medin, 2010). Indeed, secondary schools have a significant influence on students' STEM orientation, and their role in shaping career aspirations has been well-documented in recent literature reviews (Reinhold et al., 2018; Zhou & Shirazi, 2025).

In the core of the career awareness is the competencies (knowledge, skills, values, attitudes and ethics) required in required in science-related careers is essential. These competencies, often referred to as 21st-century or transversal skills, are increasingly emphasized in both educational and work life contexts (OECD, 2018). European employers continue to value foundational skills such as teamwork, communication, and digital literacy, as highlighted in earlier reports (European Commission, 2010). However, recent policy documents show a shift toward more dynamic competencies. The need for upskilling and reskilling has intensified due to green and digital transitions (European Commission, 2023a). Employers now prioritize analytical thinking, emotional intelligence, and adaptability, with nearly half of current skills expected to become obsolete within a decade. Digital, AI, sustainability-related, and cross-cultural competencies are increasingly emphasized. The OECD Skills for 2030 agenda further reinforce this shift, highlighting the need for transformative skills, STEM readiness, and lifelong learning to ensure competitiveness and social inclusion across the Union (OECD, 2018).

Currently competence frameworks are under debate but considering the skills Binkley et al. (2012) found in reviewing different 21st century frameworks ten skills grouped in four categories. *Ways of Thinking* includes creativity, critical thinking, problem-solving, decision-making, and metacognition, skills that support cognitive flexibility and innovation. *Ways of Working* includes communication and collaboration, emphasizing interpersonal effectiveness and teamwork. *Tools for Working* refers to information literacy and ICT literacy, reflecting the importance of navigating digital environments and managing information. *Living in the World"* includes citizenship, life and career skills, and personal and social responsibility, highlighting the ethical, cultural, and societal dimensions of work. This framework provides a useful lens for analysing students' perceptions of the skills required in science-related careers and aligns with both latest educational and work life competence frameworks.

Han et al. (2021) emphasized that students' development understanding of the expectations is closely tied to their self-efficacy and outcome expectancy in STEM learning, which in turn influences their career awareness. Winarno et al. (2020) also noted that integrated science curricula that emphasize real-world applications and interdisciplinary learning are more effective in fostering these skills. Students' awareness of these working life skills is often limited, and their perceptions may not align with the expectations of employers or the realities of scientific work (Salonen et al., 2017). However, when students are exposed to real-world scientific problems and interact with professionals in STEM, they are more likely to develop informed and realistic views of science careers (Andersen et al., 2014; King & Glackin, 2010).

School counselling interventions focused on specific STEM subfields, along with educational efforts that highlight the connections between school subjects and career requirements, may support students in making informed choices and help reduce gender inequality in STEM fields (Conlon et al., 2023). However, a recent study by (Gearns et al., 2024) shows that counsellors often struggle to support students in STEM due to the influence of sociocultural factors on students' preparation and decision-making, and a frequent mismatch between students' career goals and their academic behaviours. Additionally, counsellors' own STEM-related knowledge and practices are shaped by their training and work environment, which may limit their ability to provide informed guidance without collaboration from teachers in STEM.

Aim of the Study and Research Questions

This study aims to explore secondary school students' awareness of science-related careers, with a particular focus on their understanding of the importance of working life skills required in these fields. By analysing students' responses to a questionnaire and their self-created job advertisements and applications, the study seeks to uncover how students conceptualize the competencies needed for science-related work. This study answers the following two research questions:

- What competencies do secondary school students perceive as most important in science-related careers?
- How do students reflect their understanding of science-related career requirements in self-made job advertisement and applications.

Method

This study employed mixed methods to examine secondary school students' perceptions of science-related careers and the working life skills associated with them. The research aimed to gain both breadth and depth of understanding by combining questionnaire data with student-generated job advertisements and job applications.

Participants

The participants were 144 students from three secondary schools located in Eastern Finland. The students were 9th grades, typically aged between 14–16 years. During secondary school, students begin to gather key information and identities that influences their future educational and career choices. They also start to write their first job applications to summer jobs. Therefore, this age group is under heavy influence of both STEM education and career counselling, making them interesting and relevant target group.

Data Collection

Data was collected through questionnaire (N=144), job-advertisements (N=27) and job-applications (N=13). All 144 students completed a questionnaire in which they ranked the importance of 41 working life skills in science-related careers. These 41 skills were identified from previous research of working life skills in science-related careers and they aligned with 21st-century skill framework (Salonen et al, 2017; Binkley et al., 2012). Each student had the opportunity to rank 10 most important skills with numbers 1-10. Next, two groups of students (n = 27) were asked to create fictional job advertisements for careers of their choice, in the field of electricity. The task was designed to elicit students' perceptions of employer expectations, required qualifications, and desirable skills in science-related occupations. They could search for information on local job market and advertisement, but teacher guided them to focus on the career they had chosen. Another group (n = 13) wrote job applications for one of four predefined careers in the metal-related industry: proto maker, laboratorian, equipment calibrator and task manager. This task was designed to reveal students' understanding of educational requirements, self-presentation strategies, and alignment with job expectations. Students filled out their job applications based on

authentic job advertisements of two local companies, but they had the opportunity to use their creativity to create an imaginary applicant. Students had no further instructions on how to complete their applications. All the groups had two 45-minute science classes to finish the tasks.

Data Analysis

The questionnaire responses were first coded to match four categories of 21st-century skills: Ways of Thinking, Ways of Working, Tools for Working, and Living in the World (Binkley et al., 2012). Then each student answers of the most important skills were calculated so that the most important (student ranked as number one) skill gets 10 points, second most important 9 etc. Thus, leading us to ranking points ranging from 0-110 points across all the 41 skills. The job advertisements and applications were analysed using deductive qualitative content analysis (Elo & Kyngäs, 2008). To ensure reliability of mentioned skills that were not yet categorised, two researchers independently analysed those parts of the data and discussed discrepancies until consensus was reached.

Validity, Reliability and Ethical Considerations

Science teachers were instructed to support students by clarifying unfamiliar or confusing aspects of the assignments, though they were not to discuss the specific skills or competencies required for the careers being explored. Even so, their guidance may have subtly influenced how students approached their assignments. To strengthen the reliability of the findings, we employed analysis triangulation (Patton, 1999), with two researchers independently analysing the data and arriving at similar categorizations of the identified skills. Participation was voluntary, and informed consent was obtained from all students and their guardians in accordance with ethical guidelines of the university and schools. The study was conducted in accordance with the ethical standards of University [blinded for review]. Students were assured of the confidentiality and anonymity of their responses, and participation had no impact on their academic evaluation.

Results

Important Skills in science-related careers

Students perceived that the most important skills in science-related careers includes mostly *Ways of working* and *Ways of thinking* (see Figure 1). Responsibility (*Living in the world*) and research skills (*Tools for working*) are the only top 20 skills from the other categories. Indeed, Tools for Working and Living in the World categories were notably underrepresented. Despite the increasing importance of digital literacy, ICT skills, and global citizenship in modern science careers, students did not rank these competencies as highly. This underrepresentation may reflect a limited understanding of the technological and societal dimensions of scientific work. In addition, more specific and context-dependent skills, such as, assembling, negotiation skills, sector-specific knowledge, and safety at work. received fewer points or were absent from the rankings altogether. Students also didn’t see social responsibilities such as organising, reliability, leadership or helping people highly important.

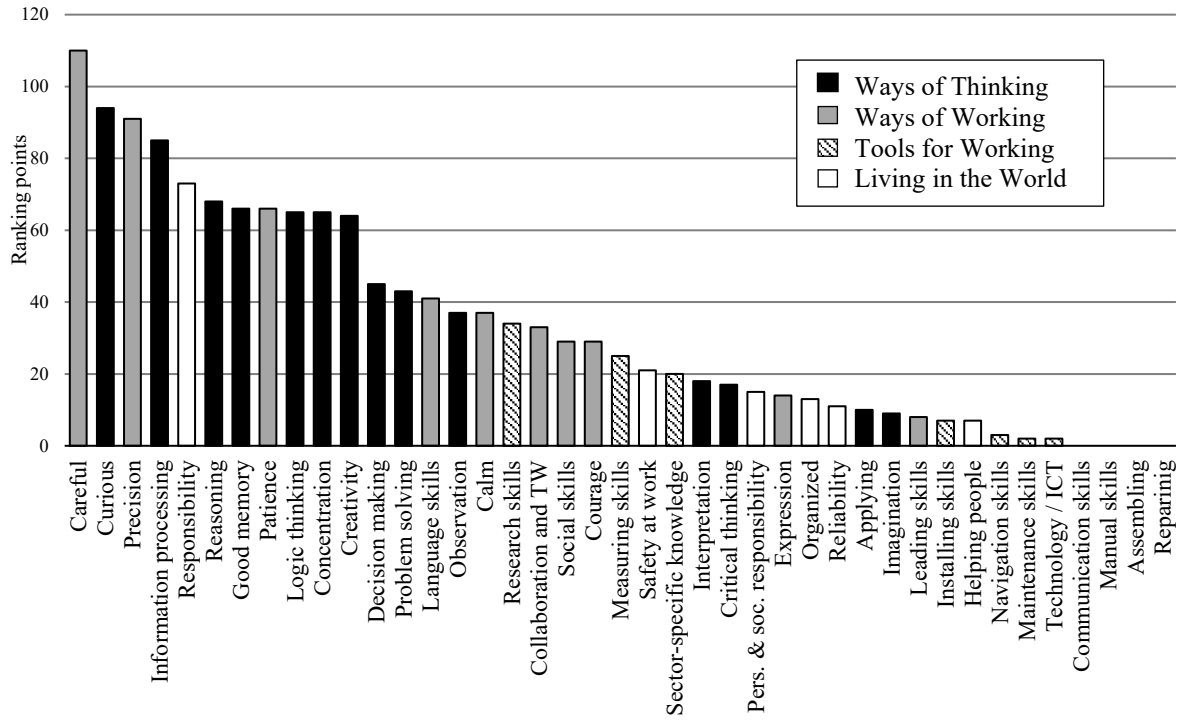


Figure 1. The Importance of Working Life Skills in Science-Related Careers according to the Students

While the questionnaire results highlight students' general perceptions of important skills in science-related careers, a deeper understanding emerges when examining how students apply this knowledge in more practical contexts when how students interpret and communicate career requirements when placed in the role of either an employer or a job applicant.

Insights from Students' Job Advertisements and Applications

Most of the students chose a familiar career to prepare their job advertisements (see Table 1) or job applications (see Table 2). The following tables present the students' perceptions of the required working life skills in these specific science-related careers. Students' job advertisements for careers in the electricity sector (Table 1) showed a balanced and broad range of skills. While Ways of Thinking skills such as eager to learn new and reasoning were mentioned, there was a notable emphasis on Ways of Working, including teamwork, customer-service orientation, and language skills. Tools for Working were also frequently referenced, particularly "sector-specific knowledge," "dexterity," and "ICT skills." Safety-related competencies under Living in the World were also present, especially in roles like electricians and electric officers. When students adopt the perspective of an employer, they recognized the importance of practical, interpersonal, and safety-related skills.

Table 1. Students' Perceptions of Working Life Skills in the Field of Electricity

	Electric engineer (n=3)	Network engineer (n=1)	Customer service (n=3)	Electrician (n=17)	Electrician in machinery (n=3)
Ways of	Learn		Eager to learn	Reasoning;	

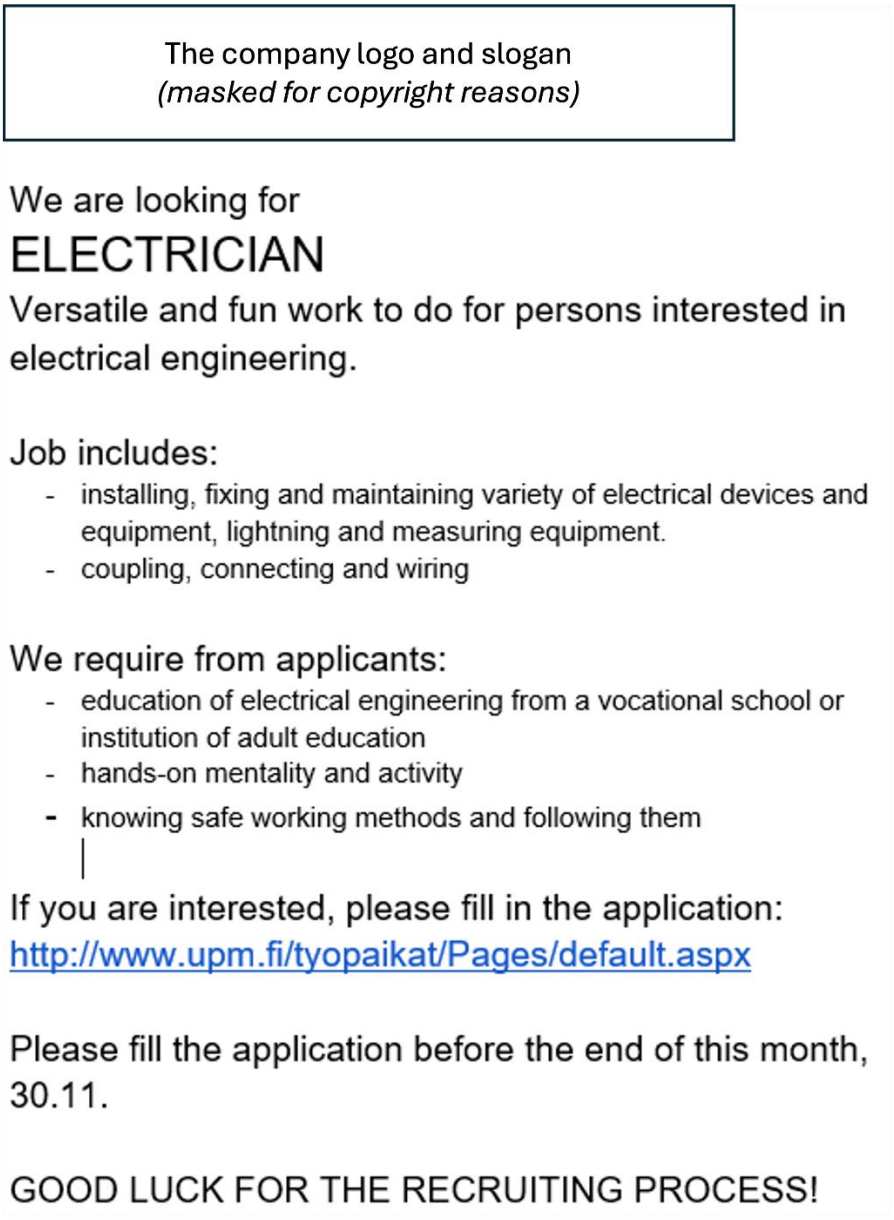
Thinking	quickly		new	Perceptive skills; Analysing; Eager to learn new; Persistence; Motivation	
Ways of Working	Quick		Social; Hard-working; Teamwork; Customer-service oriented; Language Skills	Precision; Social; Careful; Teamwork; Language skills	
Tools for Working	Sector-specific knowledge	Good hearing Good eyesight	Sector-specific knowledge; Negotiation skills	Dexterity; Sector-specific knowledge; Assembling; ICT	
Living in the world			Independent Own-initiative	Independent; Safety at work; Safety knowledge	Own-initiative; Safety at work; Safety knowledge

Table 2. Students' Perceptions of Working Life Skills in the Field of Metal-Related Industry.

	Proto maker (n=3)	Laboratorian (n=7)	Equipment calibrator (n=2)	Task organizer (n=1)
Ways of Thinking	Perceptive skills; Inventive	Concentration; Learn quickly; Eager to learn new; Clever; Persistence; Adapting	Persistence	
Ways of Working	Precision;	Precision; Social; Hard-working; Perfectionist; Patience;	Hard-working;	Social Quick
Tools for Working	Dexterity	Dexterity		Dexterity
Living in the world	Independent	Reliability; Independent	Own-initiative	Own-initiative

Students also had possibility to make the job advertisements visually appealing. Most of the students chose a logo for the company they invented. In addition, some job advertisements had contextual hints of the future working environment or tasks, but only three of the advertisements had competences included in the visual appearance. One with using tools for electricity assembling, one presenting collaboration with either clients or co-workers. Mostly the structure of the job advertisements was very traditional and formal as the example advertisement in Figure 2 shows, but some had humorous or even absurd details, like huge salaries or demands of work time. The

students had evaluated educational qualifications accurately to the advertisements.


The company logo and slogan
(masked for copyright reasons)

We are looking for

ELECTRICIAN

Versatile and fun work to do for persons interested in electrical engineering.

Job includes:

- installing, fixing and maintaining variety of electrical devices and equipment, lightning and measuring equipment.
- coupling, connecting and wiring

We require from applicants:

- education of electrical engineering from a vocational school or institution of adult education
- hands-on mentality and activity
- knowing safe working methods and following them

If you are interested, please fill in the application:
http://www.upm.fi/tyopaikat/Pages/default.aspx

Please fill the application before the end of this month, 30.11.

GOOD LUCK FOR THE RECRUITING PROCESS!

Figure 2. Example of One of the Student's Job Advertisement. (Translated by the first author)

In the job applications for metal-related industry roles (see Table 2), students highlighted Ways of Thinking skills such as perceptive, inventive, and eager to learn. Ways of Working were also prominent, with precision, hard-working, and social being frequently mentioned. Tools for Working were less varied but included dexterity across nearly all roles. Living in the World skills related to independence and personal reliability were also present in all applications.

Similarly to the job advertisements, students followed very traditional form when preparing their applications as seen in the example in Figure 3. When looking on the educational qualifications, many student "applicants" appeared to overstate their educational qualifications mismatching their understanding of job requirements and actual expectations.

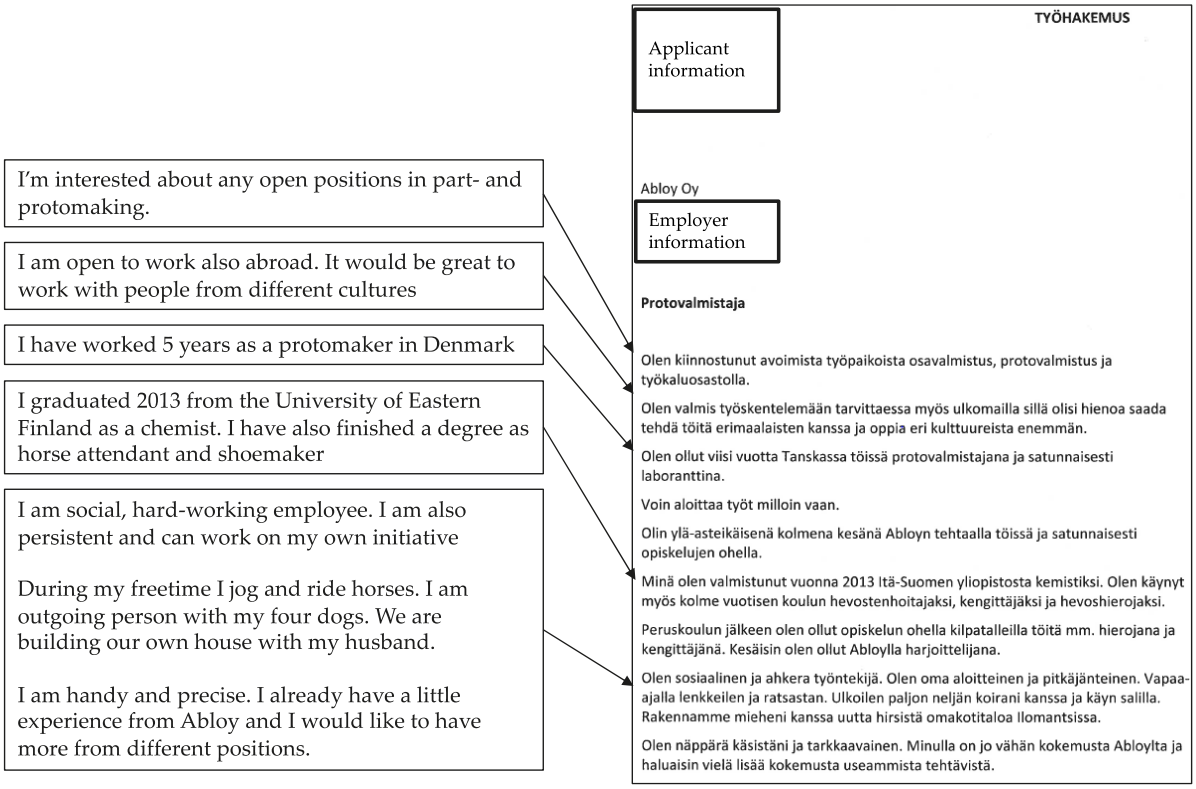


Figure 3. Example of Student's Job Application to Abloy Oy That Creates Locks, Keys and Other Metal Products (Translations in Squared Boxes Made by First Author)

Discussion

This study explored lower secondary school students' perceptions of working life skills in science-related careers, using both a skill-ranking questionnaire and student-generated job advertisements and applications. In response to the first research question, the results from the questionnaire indicate that students primarily associate science-related careers with broad cognitive traits. The most highly ranked skills, carefulness, curiosity and precision, reflect a traditional and somewhat stereotypical view of scientific work which align with previous research (Salonen et al, 2017). These skills fall within the Ways of Thinking category of Binkley et al.'s (2012) 21st-century skills framework, which includes creativity, problem-solving, and metacognition. While these traits are undoubtedly relevant, their dominance in the rankings suggests that students may have a limited understanding of the full range of competencies required in contemporary science careers. Skills categorized under Tools for Working and Living in the World were notably underrepresented in the rankings. For example, digital literacy, ICT skills, and global citizenship were rarely mentioned, despite their increasing relevance in science and technology fields (OECD, 2018; European Commission, 2023a). This finding is consistent with earlier research indicating that students' knowledge of science careers is often superficial and shaped by limited exposure to real-world professional contexts (Cleaves, 2005; Salonen et al., 2017). It also reflects the persistence of stereotypical images of scientists as solitary and intellectually focused, rather than as collaborative professionals engaged in socially embedded and technologically advanced work (Masnick et al., 2010; Archer et al., 2014).

The second research question focused on how students' perceptions differed when they were asked to create job

advertisements and applications. These tasks revealed a broader and more applied understanding of career requirements. In the job advertisements, students included new and wider range of skills, such as teamwork, customer service orientation, and safety awareness. These skills fall more under the Ways of Working and Living in the World than in the questionnaire data, suggesting that students can recognize the interpersonal and contextual demands of science-related jobs when placed in a practical scenario and linked to actual job positions and descriptions. Similarly, in the job applications, students highlighted traits such as being hard-working, independent, and eager to learn, indicating an awareness of employer expectations and workplace behaviour. However, these are again very general competencies rather than specific to science-related careers though they are different than the most important skills mentioned in the questionnaire data. Despite this broader perspective, several important competencies remained underemphasized. Skills such as adaptability, sector-specific knowledge, and ICT literacy were mentioned infrequently, even in the applied tasks. This finding is noteworthy, when compared to recent policy documents and employer surveys consistently identifying these skills as critical for future employment, particularly in the context of digitalisation (World Economic Forum, 2023; European Commission, 2023b). The limited attention to these competencies suggests that students may not fully understand the evolving nature of science-related work or the specific qualifications and experiences that different roles require.

Another important finding concerns students' perceptions of educational requirements. In the job applications, many students presented themselves as overqualified for the positions they were applying for. This may indicate a lack of understanding about vocational education pathways and the diversity of routes into science-related careers. Previous studies have shown that students often have limited knowledge of the structure and accessibility of STEM professions, which can lead to unrealistic or misinformed career aspirations (Maltese & Tai, 2011; Holmegaard et al., 2014).

Our findings can also be interpreted highlighting the sociological aspects of how students' perceptions are shaped by the broader social and institutional contexts in which they learn. The tendency to overemphasize formal education and underrecognize vocational routes may reflect dominant cultural narratives that associate academic pathways with higher status and success, while vocational education is often perceived as a second-tier option (Korpershoek et al., 2020). In this light, students' limited or fragmented understanding of science career pathways is not merely a matter of missing information, but also a reflection of how schools, families, and guidance systems frame what kinds of futures are visible, valued, and encouraged. Public discourses around "21st-century skills" and employability may further contribute to this by promoting generic skill ideals without clearly linking them to specific occupational contexts. As a result, students may adopt broad or idealized notions of what is required in science-related work, while lacking concrete knowledge of how different roles are accessed or developed. Recognizing these sociocultural influences is important for designing career education that not only informs but also challenges narrow or status-driven assumptions about science careers.

These findings reinforce the importance of integrating career education into science curricula. According to Cohen and Patterson (2012), students' career awareness and self-efficacy are key factors influencing their engagement with science. While the students in this study demonstrated awareness of relevant skills and a willingness to

engage with career-related tasks, their understanding was often fragmented and incomplete. This suggests a need for more explicit and structured opportunities for students to explore science careers, interact with professionals, and reflect on their own strengths and interests (Han et al., 2021; King & Glackin, 2010). Furthermore, the findings align with the OECD Skills for 2030 agenda, which emphasizes the development of transversal skills, digital competence, and lifelong learning as essential for employability and social inclusion (OECD, 2018). STEM education should therefore aim to bridge the gap between students' perceptions and the realities of the work life by embedding these competencies into everyday learning experiences.

Limitations

Several limitations should be acknowledged. First, the study was conducted with students from a limited number of schools in one country, which may affect the generalizability of the findings. Although the tasks were designed to elicit authentic responses, students' interpretations of the job advertisement and application tasks may have varied depending on their prior experiences and exposure to career-related content. At this point of their lives, the students have very little knowledge and skills to create professional job advertisement or applications. However, their teachers encouraged and guided, carefully not to lead in to mentioning any skills, but to think about different aspects. Additionally, the skill list used in the questionnaire is limited and thus vulnerable for misrepresentation of some critical skills or development of other competence frameworks.

Conclusions

Results show that secondary school students perceive the skills important in science-related as broad cognitive traits such as carefulness, curiosity, and precision. While these attributes are relevant, students often overlooked more specific and increasingly essential competencies such as digital literacy, adaptability, and sector-specific knowledge. The contrast between students' abstract skill rankings and their more applied thinking in job advertisements and applications suggests that their understanding of science careers is still developing and shaped by limited exposure to real-world professional contexts. It is worth noting, that science-related careers included many types and level of careers and it is difficult to make a statement what competencies are commonly important to all.

The results propose implications for both STEM education and career counselling. For science educators, there is a clear need to integrate career-related learning into classroom practice, not only by discussing scientific content but also by highlighting the diverse skills and pathways associated with various types and levels of science professions. This includes fostering students' awareness of transversal skills and connecting science learning to societal and technological challenges. For career counsellors, the results underscore the importance of systematic and informed guidance that begins early and continues throughout secondary education, helping students form realistic and informed views of the work life in STEM. Collaboration between educators, counsellors, and industry professionals can provide students with authentic insights into science careers, helping them to better align their interests, skills, and educational choices. By addressing these gaps, both education and guidance systems can play a more proactive role in preparing students for meaningful participation in the future workforce.

A broader implication of this study concerns the practical application of competence frameworks in STEM education. While frameworks such as Binkley et al. (2012) and the OECD Skills for 2030 (OECD, 2018) offer valuable guidance on the skills needed for the future workforce, they often remain abstract and distant from everyday classroom practice. As a result, both students and teachers may struggle to interpret what generalized competencies, such as living in the world or reconciling tensions and dilemmas mean in concrete terms. This can lead to vague or superficial understandings, limiting the effectiveness of competence-based education. To address this, STEM education and counselling must work together to contextualize these frameworks through real-life examples, workplace scenarios, and transdisciplinary collaboration. Only by making competencies visible, meaningful, and connected to real-life contexts young learners are equipped with the tools they need to navigate and shape the future.

Statements and Declarations

Authors' contributions: The manuscript was drafted and developed and finalised by the one author.

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Data availability: The data in this study cannot be made publicly available due to ethical and legal restrictions related to the protection of minor participants' privacy. According to the research plan and consents, data can only be accessed by the research team. De-identified data excerpts supporting the findings are contained within the manuscript. Additional anonymized data may be made available from the corresponding author upon reasonable request and with appropriate ethical approval.

Ethics Approval: Permissions to conduct the research were secured from the school administration and teachers. Ethical Council of University of Eastern Finland noted that no additional ethical review was needed.

Informed Consent: Informed consent was asked from the participating students and their guardians.

Conflict of interest: The authors declare no conflicts of interest or competing interest.

References

Andersen, H.M., Krogh, L.B. & Lykkegaard, E. (2014). Identity Matching to Scientists: Differences that Make a Difference? *Research in science Education,* 44, 439-460. https://doi.org/10.1007/s11165-013-9391-9

Andersen, L., & Ward, T. J. (2014). Expectancy-value models for the STEM persistence plans of ninth-grade, high-ability students: A comparison between black, Hispanic, and white students. *Science Education,* 98, 216–242. https://doi.org/10.1002/sce.21092

Archer, L., DeWitt, J., Osborne, J., Dillon, J., Willis, B., & Wong, B. (2010). 'Doing' science versus 'being' a scientist: Examining 10/11 year old school children's constructions of science through the lens of

identity. *Science Education*, 94(4), 617–639. https://doi.org/10.1080/09500693.2015.1071899

Archer, L., DeWitt, J. & Dillon, J. (2014). 'It didn't really change my opinion': exploring what works, what doesn't and why in a school science, technology, engineering and mathematics careers intervention. *Research in Science & Technological Education*, 32(1), 35-55. https://doi.org/10.1080/02635143.2013.865601

Bang, M. & Medin, D. (2010). Cultural processes in science education: Supporting the navigation of multiple epistemologies. *Science Education,* 94, 1008-1026. https://doi.org/10.1002/sce.20392

Binkley, M., Erstad, O., Herman, J., Raizen, S., Ripley, M., Miller-Ricci, M., & Rumble, M. (2012). Defining Twenty-First Century Skills. In P. Griffin, B. McGaw, & E. Care (Eds.). *Assessment and Teaching of 21st Century Skills* (pp. 17-66). Springer.

Bøe, M. V., Henriksen, E. K., Lyons, T., & Schreiner, C. (2011). Participation in science and technology: Young people's achievement-related choices in late-modern societies. *Studies in Science Education*, 47(1), 37–72. https://doi.org/10.1080/03057267.2011.549621

Cleaves, A. (2005). The formation of science choices in secondary school. *International Journal of Science Education,* 27, 471-486. https://doi.org/10.1080/0950069042000323746

Cohen, C. & Patterson, D. (2012). Teaching Strategies that Promote Science Career Awareness., https://www.nwabr.org/sites/default/files/pagefiles/science-careers-teaching-strategies-PRINT.pdf . Accessed 25 January 2017.

Conlon, R. A., Barroso, C., & Ganley, C. M. (2023). Young children's career aspirations: Gender differences, STEM ambitions, and expected skill use. *The Career Development Quarterly,* 71(1), 15-29.

Elo, S., & Kyngäs, H. (2008). The qualitative content analysis process. *Journal of Advanced Nursing*, 62(1), 107–115. https://doi.org/10.1111/j.1365-2648.2007.04569.x

European Commission. (2010). Employers' perception of graduate employability. Analytical report. http://ec.europa.eu/public_opinion/flash/fl_304_en.pdf. Accessed 17 November 2018

European Commission. (2023a). Employment and social developments in Europe 2023. https://employment-social-affairs.ec.europa.eu

European Commission. (2023b). European Skills Agenda: FutureSkills 2030. https://ec.europa.eu/social/main.jsp?catId=1223

Gearns, R., Kelly, A. M., & Bugallo, M. F. (2024). School counseling practices related to postsecondary STEM participation. The Career Development Quarterly, 72(1), 2-17.

Han, J., Kelley, T., & Knowles, J. G. (2021). Factors influencing student STEM learning: Self-efficacy and outcome expectancy, 21st century skills, and career awareness. *Journal for STEM Education Research,* 4, 117–137. https://doi.org/10.1007/s41979-021-00053-3

Holmegaard, H.T., Madsen, L.M. & Ulriksen L. (2014). To Choose or Not to Choose Science: Constructions of desirable identities among young people considering a STEM higher education programme. *International Journal of Science Education*, 36, 186-215. https://doi.org/10.1080/09500693.2012.749362

Kanzaki, M., Suzuki, H., Ouédraogo, A., Andrei, A., Bacanlı, F., Donnelly, H. K., ... & Zbróg, Z. (2025). Cultural translation of career decision-making: Understanding practitioners' perspectives from a multinational study on social and emotional learning. International Journal for Educational and Vocational Guidance.

https://doi.org/10.1007/s10775-025-09745-3

King, H., & Glackin, M. (2010). Supporting science learning in out-of-school contexts. In J. Osborne & J. Dillon (Eds.). *Good practice in science teaching: What research has to say* (pp. 259– 273). Maidenhead, UK: Open University Press.

Korpershoek, H., Canrinus, E. T., Fokkens-Bruinsma, M., & de Boer, H. (2020). The relationships between school belonging and students' motivational, social-emotional, behavioural, and academic outcomes in secondary education: A meta-analytic review. *Research Papers in Education, 35*(6), 641–680. https://doi.org/10.1080/02671522.2019.1615116

Maltese, A.V. & Tai, R.H., (2011), Pipeline Persistence: Examining the Association of Educational Experiences with Earned Degrees in STEM Among U.S. Students. *Science Education,* 95, 877-907, https://doi.org/10.1002/sce.20441

Marcionetti, J., & Zammitti, A. (2025). Perceived support and influences in adolescents' career choices: A mixed-methods study. *International Journal for Educational and Vocational Guidance, 25*, 423–446. https://doi.org/10.1007/s10775-023-09624-9

Masnick, A.M., Stavros Valenti, S., Cox, B.D. & Osman, C.J. (2010). A Multidimensional Scaling Analysis of Students' Attitudes about Science Careers. *International Journal of Science Education*, 32, 653-667. https://doi.org/10.1080/09500690902759053

Mendick, H., Berge, M., & Danielsson, A. (2017). A critique of the STEM pipeline: Young people's identities in Sweden and science education policy. *British Journal of Educational Studies*, 65(4), 481–497. https://doi.org/10.1080/00071005.2017.1300232

OECD. (2016). *PISA 2015 Results (Volume I): Excellence and Equity in Education*. Paris: PISA, OECD Publishing.

OECD. (2018). The future of education and skills: Education 2030 Position paper. OECD. https://www.oecd.org/content/dam/oecd/en/about/projects/edu/education-2040/position-paper/PositionPaper.pdf

Reinhold, S., Holzberger, D., & Seidel, T. (2018). Encouraging a career in science: A research review of secondary schools' effects on students' STEM orientation. Studies in Science Education, 54(1), 69–103. https://doi.org/10.1080/03057267.2018.1442900

Salonen, A. (2020). *Career-related science education: instructional framework promoting students' scientific career awareness and the attractiveness of science studies and careers*. (Doctoral dissertation, University of Eastern Finland).

Salonen, A., Kärkkäinen, S. & Keinonen, T. (2018). Career-related instruction promoting students' career awareness and interest towards science learning. *Chemistry Education Research and Practice*. https://doi.org/10.1039/c7rp00221a

Salonen, A., Hartikainen-Ahia, A., Hense, J., Scheersoi, A. & Keinonen, T. (2017). Secondary school students' perceptions of working life skills in science-related careers. *International Journal of Science Education*, 39, 1339-1352. https://doi.org/10.1080/09500693.2017.1330575

Stephen, J. S., & Fru, A. (2023). Cultivating student employability skills: Classroom to career preparedness and readiness. In *Global Perspectives on Higher Education* (pp. 321–334). Springer. https://doi.org/10.1007/978-3-031-31646-3_21

Winarno, N., Rusdiana, D., Riandi, R., Susilowati, E., & Afifah, R. M. A. (2020). Implementation of integrated science curriculum: A critical review of the literature. *Journal for the Education of Gifted Young Scientists*, 8(2), 795–817. https://doi.org/0.17478/jegys.675722

Zhou, Y., & Shirazi, S. (2025). Factors influencing young people's STEM career aspirations and career choices: A systematic literature review. *International Journal of Science and Mathematics Education.* https://doi.org/10.1007/s10763-025-10552-z