

Understanding the Factors Influencing Upper Secondary School Students' STEM Career Aspirations

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ABSTRACT

This study examines factors influencing upper secondary school students' career aspirations and their conceptions about careers in science, technology, engineering, and mathematics (STEM)-related fields. The data were collected through semi-structured interviews among high-achieving, STEM-oriented students ($n = 10$). According to a qualitative content analysis, students described several factors influencing their career choices. These factors were categorized under four main themes, following the terminology of social cognitive career theory: Self-efficacy beliefs, interests and values, outcome expectations, and environmental supports and barriers. Furthermore, students described both negative and positive conceptions about STEM-related fields. The findings of this study have important implications for both upper secondary school science instruction and career counseling. Finally, recommendations for practice are introduced to (1) promote students' interest and self-efficacy in STEM subjects, (2) provide practical information on choices related to STEM careers, and (3) support the development of more realistic conceptions of STEM-related jobs and careers.

KEY WORDS: Career aspirations, science, technology, engineering, and mathematics careers, semi-structured interviews, upper secondary students

INTRODUCTION

The aim of this study is to examine high-achieving, STEM-oriented upper secondary school students' conceptions about careers in science, technology, engineering, and mathematics (STEM)-related fields, and to understand factors influencing their career choices. Understanding students' conceptions about science and STEM-related careers and the factors influencing their career aspirations is important since it can help teachers and other professionals to develop and implement better learning opportunities and targeted career guidance that enhance students' beliefs and understanding of STEM-related fields. There is a persistent decline in students' interest in STEM studies and careers, despite the global need for STEM professionals (OECD, 2016; Osborne and Dillon, 2008; Tytler and Ferguson, 2023). Enhancing students' engagement in sciences is crucial, as society will persistently require individuals capable of sustaining, advancing, and innovating key functions, including, for example, health care and technical infrastructure, in the future (Tytler and Ferguson, 2023). Delving especially into the experiences and reflections of high-achieving, STEM-oriented students, that is, the next generation of STEM professionals, can deepen our understanding of their unique motivational drivers and the challenges they face, offering insights critical for designing targeted educational strategies and tailored academic and career guidance.

Push and Pull Factors of STEM Careers

Motivation and interest in STEM studies among students have declined globally since the 1980s, and especially in Europe (OECD, 2016; Osborne and Dillon, 2008). Various factors, both intrinsic and extrinsic, contribute to this decline, including socioeconomic status, learning opportunities, attitudes toward science, and limited knowledge of STEM careers (e.g., Holmegaard et al., 2014). In addition to a lack of interest, there are other reasons why STEM professions may not be attractive to young people. For example, many young people find STEM subjects challenging, and low self-efficacy beliefs, high costs, and time barriers associated with STEM education can deter students from pursuing a career in STEM fields (e.g., Kaleva et al., 2019; Merayo and Ayuso, 2023). In addition, some students feel that STEM subjects are not relevant to their future careers (Kudenko et al., 2017). Furthermore, gender stereotypes can discourage young women from pursuing STEM careers. STEM fields are often perceived as male-dominated, which can make them less appealing to young women (e.g., Elmer et al., 2024). Recognizing the multifaceted nature of these challenges, efforts to address declining interest include specially designed instructional interventions with integrated career-based perspectives to enhance students' understanding of STEM careers and boost interest in science (Drymiotou et al., 2021; Hazelkorn et al., 2015; OECD, 2016).

Similarly, several reasons have been suggested why students choose a STEM career or educational path (Collegenp, 2024). For example, some students choose to pursue a career in STEM fields because they offer a wide range of career opportunities with high demand and competitive salaries. The job market for STEM graduates is robust, with many industries seeking skilled professionals. Furthermore, STEM fields offer possibilities to learn new competencies. STEM education equips students with critical thinking, problem-solving, and analytical skills, which are highly valued in the job market. Furthermore, many students tend to enjoy having possibilities for designing solutions, innovations, and using their own creativity (Lavonen et al., 2008; Vilhunen et al., 2025). STEM fields are known for their potential for innovation and creativity. Students who enjoy experimenting, building, and creating new things are often drawn to the hands-on learning experiences offered by STEM education. And finally, even though in general, students' interest in STEM has declined, many students still experience personal interest in subjects such as math, physics, and computer science. These interests often drive them to pursue careers in STEM (Blotnick et al., 2018).

Social Cognitive Career Theory and Science Career Aspirations

Social cognitive career theory (Lent et al., 1999) provides a framework for understanding how cognitive, social, and environmental factors interact to shape career choices and development over time. The theory emphasizes, for example, the role of self-efficacy beliefs, outcome expectations, interests and goals, environmental influences, performance and choice expectancies, and contextual supports and barriers in shaping an individual's career choices and actions. The career aspirations and clarifying of goals are affected by factors that are important to the student, such as the student's competence or knowledge and skills in science, compensation or salary and work conditions, and interest in science studies and careers. Furthermore, previous research has shown that, for example, other people's recognition and STEM identity (Ladachart et al., 2024; Simpson and Bouhafa, 2020), receiving career information (Kaleva et al., 2023), preconceptions and stereotypes about STEM careers (Holmegaard et al., 2014; Luo et al., 2021), and instructional activities in school (Drymiotou et al., 2021) can influence adolescents' STEM-related career choices.

In their review study, Reinhold et al. (2018) showed that schools often play an important role in students' orientation toward STEM studies and careers. Altogether 28 peer-reviewed journal articles, covering mainly Western countries, which used quantitative, qualitative, or mixed methods, were selected for the study. According to the systematic literature review, an overall positive school effect was recognized on the students' STEM orientation. However, schools' structure, location, school size, teacher-to-student ratio, use of education technology or lab tools, and, moreover, teachers' gender or academic capital did not have any effect on STEM orientation. From the home perspective, the proportion of college-educated

parents or immigrant background parents had no impact on STEM orientation. However, teachers' average years of teaching, school orientation to STEM or academic studies, and career counseling and STEM orientation in the curriculum had a positive effect on STEM orientation, highlighting the importance of school-related factors on students' career aspirations. Especially, secondary school experiences can significantly influence students' career aspirations, impacting their motivation and choices of science subjects and subsequent academic and career paths (Simpkins et al., 2006).

Besides the science education practices in classrooms, there are variables in the home environment, such as support available for homework and science studies, which influence students' science-related career aspirations. Parents and friends can play a crucial role in students' educational and career choices (Ikonen et al., 2017). In addition, career aspirations are also affected by society (such as media) and individual factors (such as performance in science, personal interests, values, experiences, and goals related to science) (Wang and Staver, 2001).

Finnish Education System

This research took place in the context of Finnish upper-secondary education, providing general education for students aged 16–19. The majority of students complete their studies in a 3-year timeframe. After the 9-year basic education, about half of the students choose general upper secondary school and another half vocational qualifications in the vocational institutions. Both educations are done in approximately 3 years. At the end of general upper secondary school, students have a national standardized test, the Matriculation Examination (ME). The results of the ME are also used as an entrance examination to higher education. After upper-secondary education, students typically continue their studies in tertiary education (Statistics Finland, 2021), that is, in the research universities or in the universities of applied sciences. In general, the most desired educational programs, especially the ones in STEM-related fields, are taught in research universities. Thus, in Finland, the most important decisions concerning educational and career-related choices are typically made at the end of the upper secondary school.

Career guidance in Finnish general upper secondary education is organized as a professionalized, school-based system with a long tradition of guidance counseling integrated both as a classroom subject and through individual support. According to the national curriculum (Finnish National Board of Education, 2016), a guidance counselor is responsible for organizing the guidance activities and for planning the overall guidance process. However, guidance in upper secondary school is viewed as a collaborative effort among all school professionals, with subject teachers bearing particular responsibility for supporting students' readiness for further studies and their understanding of working life within the context of their subject area (Finnish National Board of Education, 2016). This structure aims to equip young people not only with knowledge

and skills to manage future educational and career choices but also to actively engage in shaping their careers and lives.

Current Study and Research Questions

As described above, a number of previous studies have examined students' STEM-related career aspirations. However, there is a lack of research focusing on those students who actually are the potential future change-makers in STEM-related fields (Zhou and Shirazi, 2025). Examining the career aspirations of high-achieving STEM-oriented students is essential for understanding the motivational dynamics that drive engagement in STEM fields. These insights can help educators identify the kinds of experiences that foster students' interest development (Hidi and Renninger, 2006) in STEM, which can then, for example, be integrated into instructional design and career counseling. Moreover, understanding the pathways and barriers encountered by these students can inform targeted interventions to support a wider range of students. In line with this reasoning, in the present study, semi-structured interviews were conducted among high-achieving, STEM-oriented upper secondary school students.

Through directed qualitative content analysis, this study examines (1) what factors – recognized in the social cognitive career theory – students describe as influential for their career choices, and (2) whether themes beyond the social cognitive career theory emerge from the interview data. Given that the overall aim of this paper is to enhance career guidance practices in upper secondary education, we also (3) provide recommendations for practice based on the findings of this study and previous research.

METHODS

Participants and Context

The participants ($n = 10$; 5 females, 5 males) were 2nd- and 3rd-year students in a single upper secondary school located in southern Finland. To this particular upper secondary school, there has been significant competition for admission in recent years, and an average grade point average of over 9 (on a scale from 4 to 10) from compulsory school has been required to get in. Furthermore, the matriculation exam scores at this school have consistently ranked among the highest in Finland. Thus, in general, the students in this school can be considered high achieving, providing a suitable sample to address the research question. Before the interviews, descriptive background data from a larger sample of students ($n = 115$) were collected using a set of closed- and open-ended questions on career aspirations as well as subjective task values (e.g., Eccles and Wigfield, 2020) on science subjects. To choose the participants for the interview, the following open-ended items were considered: "If you think about your future, what is the highest degree you are going to attain? In what field?" and "In which job do you see yourself at 30?" Furthermore, subjective task values (STVs) for mathematics, physics, chemistry, biology, and geography, were inquired on a seven-point Likert scale (1 = Not at all, 7 = Very much) with the following dimensions: attainment value

("The subject is important to me"), interest value ("The subject is interesting"); utility value ("The subject is useful for me"), self-concept ("The subject is easy for me"), and cost ("The subject exhausts me"). In total, 26 students gave their consent for subsequent inquiries, and out of these, 10 students were chosen to participate in the interview study based on their indications of STEM-related career aspirations and STVs. Out of the 10 participants, 4 pursued a career in engineering and technology, 3 in medicine, 2 in environmental sciences, and 1 in aviation.

Data Collection and Ethical Considerations

The data collection took place in the school year 2022–2023. Face-to-face, semi-structured interviews were employed for data collection, with the aim of ensuring consistency while also allowing for spontaneous discussions. The interview questions were categorized into three sections: (1) Career aspirations in general ("In the background questionnaire you answered... Do you still think the same?," "How certain or strong is this aspiration?"), (2) Factors that have influenced the career decision ("How did you end up having this aspiration?," "What, if any, has been the role of home/school/peers in your career aspirations?"), and (3) Conceptions about desired profession ("What kind of conceptions do you have about this education/profession/job?"). The interviews lasted between 17 and 40 min (with an average of 28 min), but also included questions on well-being, which are outside the scope of this study, and reported in another study (Vilhunen et al., in press). The discussions on career aspirations typically took about half of the interview time. Participation in the research was voluntary, and informed consent was obtained from all the participants.

During the school year, the first author of this paper worked in the school as a science teacher and a guidance counselor and thus knew – at least to some extent – all the participants of the study. During the data collection, the first author's role with the participating students was solely that of a guidance counselor. The first author was also responsible for the data collection and analyses. Due to this dual role, special attention was paid to ethical issues during the interviews. That is, the discussions were allowed to go beyond the typical research interview format. For example, students could ask questions and seek advice during the interviews, which thus made the interaction more like a guidance discussion than a strict interview. The familiarity of the researcher and the participants can be considered both a limitation and an advantage. That is, some students may find it easier to discuss with someone they already know, whereas some students may feel the opposite.

Such practitioner research has long traditions in educational sciences (e.g., Menter et al., 2011; Rietz et al., 2021). Practitioner research has several advantages as well as potential pitfalls. For example, it can help to bridge the gap between theory and practice by generating knowledge that is both relevant and immediately applicable to specific educational contexts. Overall, it emphasizes teacher voice, contextual relevance, and practice-based evidence in educational research

and development (Menter et al., 2011). On the other hand, practitioner research can entail risks related to power relations, consent, and bias (Fleming, 2018). In the Finnish context, however, guidance counselors do not grade or formally assess students, which helps to reduce power-asymmetry concerns in the research setting. In addition, primary consent for the interviews was obtained via an anonymous survey, which reduced any pressure to participate. Nevertheless, we acknowledge that institutional status may still influence students' willingness to participate or shape their responses toward perceived expectations (Anyan, 2013). To reduce the risk of social desirability bias, students were informed that participation was voluntary and that their responses would be treated confidentially and would not affect their studies or guidance. During the interviews, participants were encouraged to discuss both positive and negative experiences, and open-ended follow-up questions were used to support elaboration of students' own perspectives. In addition, the interviewer avoided evaluative feedback and emphasized the research purpose of understanding students' views rather than assessing them.

Analysis

The interview data were first transcribed and then analyzed through directed content analysis (Assarroudi et al., 2018; Elo and Kyngäs, 2008; Hsieh and Shannon, 2005). More specifically, the social cognitive career theory (Lent et al., 1999) directed the analysis. As suggested by Hsieh and Shannon (2005), the analysis process started with reading the transcribed interview data and highlighting those parts of the text that appeared to be related to the factors recognized in the social cognitive career theory. In addition, excerpts that appeared to reflect themes related to students' career aspirations – though not directly derived from the guiding theory – were also highlighted. That is, new inductive categories were allowed to emerge from the data (Assarroudi et al., 2018). These text excerpts served as units of analysis, each accompanied by a note or a preliminary code. These units of analysis represented meaningful segments that ranged in length from parts of sentences to lengthy paragraphs. Following an iterative examination of the data, final codes were assigned to the units of analysis.

Directed qualitative analysis, while structured and theory-driven, carries the risk of overlooking data that falls outside the predefined framework (Fife and Gossner, 2024). That is, researchers may overlook data that does not align with the guiding theory or conceptual framework. This can lead to confirmation bias, limiting the depth and diversity of insights. In this study, to mitigate this, the authors acknowledged the issue and tried to remain open to unexpected findings. Initially, all the analyses were made by the first author. After this, to enhance the trustworthiness and credibility of the analysis, the process was discussed together with the second author. That is, the authors together reviewed and assessed selected transcripts, primary categories, and the final themes to ensure comprehensive coverage and balanced interpretation of the data (Janesick, 2015).

RESULTS

Based on the directed qualitative content analysis, the data aligned well with the social cognitive career theory, also supporting previous findings related to students' career aspirations. However, during the interviews, students also frequently discussed their conceptions of STEM-related careers. It was evident that these conceptions had influenced their career aspirations, thus representing a theme that extended beyond the scope of the guiding theory. In this section, we first present the findings that clearly correspond with social cognitive career theory, followed by an exploration of the emerging theme concerning students' conceptions of STEM fields.

Factors Influencing Students' Career Aspirations

According to the analysis of the semi-structured interviews, students described four main factors that had influenced their career choices. The factors were named following the terminology of social cognitive career theory that guided the qualitative analysis: Self-efficacy beliefs, interests and values, outcome expectations, and environmental supports and barriers. In our data, these four categories were not exclusive or clear-cut, but typically several factors were intertwined in students' answers.

Self-efficacy beliefs

Themes related to self-efficacy emerged as one of the most frequently discussed topics in the interviews, with students clearly indicating that these experiences had influenced their career aspirations. According to Lent et al. (1999), self-efficacy beliefs most strongly arise from objective performance skills and mastery experiences, but personal inputs (such as predispositions, gender or ethnicity) may play a significant role in the interplay of skills and efficacy beliefs. Furthermore, since efficacy beliefs are often subject-specific, they play an important role in students' career aspirations. In the interview data, self-efficacy beliefs were mostly presented as students' descriptions of their skills and abilities, for example:

Julian (Engineering and technology): *In middle school, everything was kind of easy, but in high school, I realized that I understand also physics, and it plays quite an important role in the world, it enables you to make an impact on the world. Like, for example, things to do with energy. Those are important topics.*

Julian's story was a very typical description of one's self-efficacy beliefs and career aspirations. In the interviews, the students often said that they are good at a certain subject and that's why they are planning to pursue a career in that field. Furthermore, Julian's quote implies the importance of values (i.e., making an impact on the world) in career decisions, as discussed next.

Interests and values

Alongside their self-efficacy beliefs, students often described how their interests and values had shaped their career aspirations. In the interview data of the present study, interests

and values were typically presented as detailed descriptions of personal interests and important values, for example:

Jack (Engineering and technology): *Well, I've liked math since kindergarten. I had these math workbooks that I enjoyed solving even in kindergarten. And it just continued from there; math has always been fascinating, and I've enjoyed calculating.*

As Jack explained, and also many other participants of the study, the interest in science, technology, or math had started already as a child. Furthermore, it was evident from the data that students' self-efficacy beliefs, interests, and values were often deeply intertwined in their thinking and experiences, highlighting their reciprocal nature.

Outcome expectations

Outcome expectations are the beliefs or predictions people have about the results or consequences that will occur based on their actions, for example, choices or performance (Lent et al., 1999). In the present interview data, outcome expectations included factors such as employment and the prestige of the profession. For example, Phoebe pursues a career in environmental sciences and mentions one of the reasons is the good employability in the field:

Phoebe (Environmental sciences): *In their own way, those in-depth natural sciences are pretty interesting when you get into them. At least there are jobs and demand in the field, and if you don't mind doing that kind of stuff yourself, then I probably wouldn't mind.*

Furthermore, Ethan, who pursues a career in aviation, considers the "glamour of the profession" to be one of the reasons for his career choice:

Ethan (Aviation): *Well, I've always been interested in technology and how it works. It was probably during some vacation, and then I'm into airplanes, all about how aerodynamics work and how a big metal cage can travel long distances. I think it just looks amazing, flying. And then it's also, the glamour of the profession, it does have that side to it too.*

Interestingly, even though many STEM-related jobs are generally considered prestigious, especially the fields related to engineering or health care and medicine (Rosenzweig and Chen, 2023), Ethan was the only student who explicitly mentioned it in the interviews. However, in some of the interviews, the prestigiousness was evident in more implicit ways, for example:

Jennifer (Medicine): *When I was a small kid, for a very long time I wanted to be a vet. Then I somehow forgot it, that no, I don't want to be a vet. Then there was law school, but I guess that more like a "wow, it would be cool to be a lawyer". But after all, I like sciences and all that, and it would be nice to work with people. So, since I had this dream of being a doctor, I thought what if I wasn't a doctor for animals but instead a doctor for people.*

Here, Jennifer does not explicitly say that she wants to have a prestigious profession, but considering her options between a

veterinarian, lawyer, and a medical doctor implies that the high status has some influence on her career aspirations.

Environmental supports and barriers

Furthermore, the social-cognitive career theory (Lent et al., 1999) recognizes contextual influences (environmental supports and barriers) to affect people's career-related goals and actions. Several participants of the present study recognized family-related factors influencing their career aspirations. Most typically, this was implicit or explicit support from the parents, as described for example by Mary and Max who both pursue a career in medicine, and Luca, pursuing a career in Engineering and technology:

Mary (Medicine): *We have three kids in the family, and school hasn't been that interesting for my older siblings. They didn't get the best grades. My parents were always like, since I got good grades, they were like, "You're going to be a doctor." --- And I've always had an interest, for example, in biology and people, and such. Of course, helping others is something I also find really enjoyable.*
Max (Medicine): *It's been since I was about 5 years old, as my dad is a doctor, so that's where it came. And it always sounded kind of fun, the job. Then in middle school, I did an internship at the hospital, watching surgeries, and it was quite nice, I liked it, so I thought, why not apply there. But now I'm not sure if I'll get in, so I have to consider other options as well.*

Luca (Engineering and technology): *Well, I don't think school had any influence [on career choices]. But then we have in the family... at least my dad has a Master of Science in Technology, and there are some others as well in the family.*

It is worth noting that in the data of the current study, Max was the only participant mentioning admission to the desired education as being a (potential) barrier for his career goals. This is probably due to the high achievement level of the participant students. That is, these students are expecting to have high enough grades from the matriculation examinations to be able to choose from any higher educational program they want. In Luca's case, it is interesting how he explicitly mentions that school had played no role in his career aspirations. However, some participants did describe how school-related factors had had an influence on their career goals or choices. Students explained, for example, how certain teaching approaches or elective courses had sparked their interest, or how the feedback from teachers or peers had reinforced their self-efficacy beliefs:

Alice (Environmental sciences): *Those teaching styles were something else compared to anything I had seen before, so it made even sometimes dull topics sound really interesting. And then it became like, "Oh, I'm actually interested in this."*

Jack (Engineering and technology): *Then, in middle school, when there was physics and chemistry, they were also like, immediately sparked my interest, and I've enjoyed studying them. --- And then, just recently, there was this programming course in high school, and I liked it.*

Julian (Engineering and technology): *Well, maybe people in a way, like when they say that you really understand and stuff. And, not directly from teachers, but of course, if you get almost full marks in a course exam, then it's like, of course, that reinforces it.*

Some students also described environmental barriers affecting their aspirations; these were typically factors related to admission to the desired education (as evident in Max's quote earlier) or the lack of knowledge about the different career options, for example:

Amanda (Engineering and technology): *Fields related to engineering and technology aren't something you hear about or immediately think of, like a doctor or a teacher. So, you probably learn more about them in school and guidance counseling in high school and so on.*

Here, Amanda explicitly notes that some professions (e.g., medical doctor or teacher) are more apparent to students than some more generalist degrees (e.g., fields in engineering and technology). Furthermore, she points out that schools in general, and guidance counseling specifically, play an important role in conveying career information about these fields.

Students' Conceptions about Science and STEM-related Fields

In addition to explicit factors described in the previous section, students also showed several general conceptions about STEM-related fields. Students described both negative and positive conceptions, and also changes in their conceptions that had affected their career aspirations. Positive conceptions were mostly related to and intertwined with the factors described earlier (e.g., interest or the prestige of the profession). Instead, some of the negative conceptions were more ambiguous and not so clearly connected to any of the factors above. For example, Amanda told how she had had a rather negative conception about STEM-related jobs and scientists, but had later changed her thinking and now pursues a career in engineering and technology:

Amanda (Engineering and technology): *I thought it's quite boring and somehow distant from everything, like life and such. I was really interested in health and those kind of everyday things. So, then it always goes a bit like... somehow farther away or looks at things either really narrowly or, you know... And maybe in those technical fields, there's a bit of an image that everyone is a super nerd sitting on their computer for 12 h a day and all that.*

In addition, Alice and Ethan hold rather unrealistic – or at least narrow – views about certain professions. For example, in her interview, Alice described how she enjoys geography as a school subject but doesn't see it as a potential educational or career choice. This is because she thinks geographers can work only as teachers in schools or as researchers, and she doesn't find these professions interesting.

Alice (Environmental sciences): *But then, when I really started thinking about it, do I actually want to become a*

geographer? What does a geographer do? Well, they're either a researcher or a teacher. So, do I want to be a researcher or a teacher, well...

Furthermore, Ethan holds a rather negative conception about working as a researcher. In his interview, he explains how he enjoys mathematics and physics and finds aerodynamics fascinating. However, when asked if he could see himself working on scientific problems related to these subjects, he responds with a rather simplistic perception of what researchers do.

Ethan (Aviation): *Of course I respect researchers, but it's not really something I see myself doing, like writing some big report and studying the same topic for decades. I probably prefer being more of an ordinary worker, just getting to do things without having to publish all sorts of papers or anything like that. It's just not really my thing.*

In these data, students showed considerably more positive than negative conceptions about STEM-related careers. This was expected because the participants were high-achieving STEM-oriented students. However, quotes such as the above can provide valuable insights on how students' – sometimes unrealistic – preconceptions about certain fields or professions can be influential for their career goals and choices.

DISCUSSION

In this study, we examined the factors influencing the career aspirations of high-achieving, STEM-oriented upper secondary school students in Finland. Using semi-structured interviews and directed qualitative content analysis, we identified four overarching categories that describe the factors also presented in social cognitive career theory (Lent et al., 1999): Self-efficacy beliefs, interests and values, outcome expectations, and environmental supports and barriers. Overall, the categories were not clear-cut but closely interconnected. This finding is also in line with previous research suggesting that several factors affecting career decisions and aspirations are deeply intertwined (Luo et al., 2021; Wang and Degol, 2013). Thus, in general, our findings are well aligned with the social cognitive career theory and also support the findings in other prior studies. For example, the strong association between self-efficacy beliefs, interests and values, and career aspirations has also been demonstrated in previous research (e.g., Blotnicky et al., 2018). In line with this, prior research shows that a reciprocal relationship with mastery experiences, the interest or “STEM identity,” tends to grow over time (Simpson and Bouhafa, 2020). Furthermore, the role of environmental supports and barriers, especially that of parents and friends, has been recognized in prior studies (e.g., Ikonen et al., 2017). Instead, research on outcome expectations related to career choices remains limited. Therefore, further investigation into this topic is needed.

While the findings that reflect factors already described in the social cognitive career theory can be considered a replication of previous research, they also point to the more specific

factors that play a role in these students' lives. For example, it is noteworthy that, in this specific context, the environmental factors were mainly related to family support or to a lack of knowledge, which was seen as a barrier to making informed career decisions. That is, factors more closely associated with inequality – such as money, gender, or race – were not mentioned at all. However, this finding may be expected in this specific Finnish context, where tertiary education is free, gender equality is high, and all the participants of the study were native Finnish. Further, it should be noted that the factors that were mentioned (e.g., social support or lack of knowledge) are such that can be effectively addressed through informed guidance practices.

In our data, we also recognized the theme of students' conceptions about science and STEM-related fields that was not clearly related to social cognitive career theory. We acknowledge that these conceptions are deeply intertwined with the factors and concepts of the social cognitive career theory but still consider this as an independent dimension in terms of students' career aspirations. That is, conceptions are not some explicit factors affecting career aspiration that students can name. Instead, they emerge more implicitly from students' speech related to specific careers or jobs. In our data, many students seemed to have – at least to some extent – unrealistic conceptions about science and STEM-related fields. Previous research shows that adolescents often have education- and career-related discussions with their friends, but not so with their teachers (Ikonen et al., 2017). This may lead to the prevalence of sometimes unrealistic conceptions about certain professions. Overall, it is evident that this issue should be addressed better in secondary education.

Recommendations for Practice

The findings of this study have important implications for both upper secondary school science instruction and career counseling. The empirical findings highlighted three key issues that can be addressed in educational contexts to promote students' aspirations in STEM careers: (1) Students' interest and self-efficacy in STEM subjects need to be promoted; (2) students need more practical information on choices related to STEM careers; and (3) students need a more realistic perception of STEM-related jobs and careers.

How can interest and self-efficacy in STEM subjects be promoted?

Based on the findings of the present study and previous literature (e.g., Lent et al., 1999), interest and self-efficacy beliefs are one of the most important factors behind students' career aspirations. Thus, promoting interest and self-efficacy in STEM subjects could lead to more young people pursuing a career in these fields. There are several factors that science teachers should emphasize to support the development of interest and motivation in science learning, like the topic or content to be learned, the perceived relevance of science, interest and enjoyment in an activity type, or the teaching methods. For example, teachers' encouragement and support

for students' empowerment in the context of STEM education could support the development of STEM orientation. Overall, science teaching and learning could not only impact the learning of scientific knowledge and skills but also nurture knowledge about science and science careers and, moreover, in general, thinking skills, curiosity, and a passion for discovery, all of which are essential for shaping students' career aspirations in science. Previous literature shows that pedagogical strategies such as inquiry-based science education (Strat et al., 2024), project-based learning (Schneider et al., 2020), collaborative problem-solving (Vilhunen et al., 2025), and hands-on experiments can promote students' enjoyment, interest, and self-efficacy in science (Inkinen et al., 2020; Neito et al., 2023, 2025; Vilhunen et al., 2021, 2022). Furthermore, the European Commission report "Science Education for Responsible Citizenship" (Hazelkorn et al., 2015) emphasizes student-centered science education, and that school science should better represent real science practices and cater more effectively to the needs and interests of young people (Osborne and Dillon, 2008; Tytler, 2007).

How to provide more information to students on choices related to STEM careers?

Based on the findings of this study and previous literature (e.g., Ikonen et al., 2017), it seems evident that students need more practical information about STEM-related careers. As emphasized also in previous research, the quality and quantity of this information can influence adolescents' STEM-related career choices (Kaleva et al., 2023). Typically, especially in the Finnish context, such career information is often provided by the guidance counselor. However, the curriculum also encourages science teachers to adopt a career guidance role. That is, supporting students in recognizing career possibilities in science, developing science- and technology-related ambitions and interests, and identifying potential directions for their future career paths in these fields (e.g., Finnish National Board of Education, 2016). Supporting career aspirations involves providing resources, guidance, encouragement, and opportunities for individuals to explore and pursue their desired career paths. Inspirational and supportive teachers, and teachers who are interested in their students' career goals, can support students' STEM orientation. Furthermore, science education, which supports students in becoming familiar with various scientific disciplines, including new disciplines, such as biotechnology and nanoscience, and occupations in these fields, could trigger students' interest in different domains of science and careers in these fields.

Furthermore, closer collaboration between guidance counselors and science teachers could help in achieving this goal. Such collaboration can take many forms depending on the local educational context. Subject teachers and guidance counselors may jointly integrate information about STEM study pathways, emerging disciplines, labor-market opportunities, and educational requirements into everyday science instruction. Approaches such as mentoring, alumni engagement, and reflective career-planning activities can

further help students connect their interests and strengths with future STEM opportunities. Rather than requiring extensive new programs, these activities can often be incorporated into existing school practices and classroom activities.

How to support the development of more realistic conceptions of STEM-related careers?

The findings of this study revealed that many students hold rather unrealistic conceptions of STEM-related jobs and careers. This issue should be addressed by both science teachers and guidance counselors. According to previous literature, teaching methods that explicitly introduce and emphasize STEM careers and types of working and thinking in these careers could influence STEM orientation (e.g., Reinhold et al., 2018). Furthermore, several educational approaches based on work-education integration could support the development of more realistic conceptions. Experiencing the day-to-day activities of professionals in different scientific fields can help students to make informed decisions about their careers. For example, job shadowing, classroom visitors, and site visits can help students explore various career paths within sciences and develop a realistic conception of STEM-related careers.

Job shadowing, or externships, allows students to spend time observing a professional on the job (Gardner and Bartkus, 2014). In the Finnish education system, job shadowing is implemented as a work practice program included in the lower secondary school curriculum. In practice, Finnish secondary school students spend a week or two each year in a chosen job. Typically, the work practice program is organized by the guidance counselor, and students are encouraged to find the jobs themselves. A closer collaboration between school counselors and science teachers could open up new possibilities for students to get insights into potential career paths in science, within the work practice program. Furthermore, having a scientist visit the classroom can increase students' knowledge and interest in science-related careers (Beattie et al., 2020; Vilhunen and Turkkila, 2024). Furthermore, through classroom visits, it is possible to get familiar with several scientific fields and scientists. Finally, field trips and site visits can deepen students' engagement with science, scientific and engineering practices, and careers if the careers are explicitly connected to the activities. These methods can also simulate real-world scientific or engineering research environments, preparing students for future careers in academia, industry, or government.

Overall, closer collaboration between subject teachers and guidance counselors should be emphasized and encouraged to support students' understanding of STEM-related educational and career pathways (Loukomies et al., 2016). We acknowledge this is challenging, especially within the traditionally subject-based structure of Finnish secondary education. Promoting interdisciplinary approaches and fostering communication among different educational professionals – for example through timetable planning – is essential to support more holistic career guidance and learning experiences. The specific forms of collaboration are likely to depend on local curricula, school structures, available resources,

and national traditions of career guidance. Rather than advocating particular activities, we emphasize the importance of creating opportunities for communication and shared responsibility among educational professionals. Such collaboration may help students develop broader and more realistic conceptions of STEM careers while allowing schools to design approaches that are appropriate to their own contexts.

CONCLUSION

In this study, we aimed to shed light on the factors influencing upper secondary school students' career aspirations and their conceptions about careers in STEM-related fields. According to the findings from the semi-structured interviews among high-achieving, STEM-oriented students, we recognized four main factors affecting students' career aspirations, that is, self-efficacy beliefs, interests and values, outcome expectations, and environmental supports and barriers. Furthermore, we found that students' – sometimes unrealistic – conceptions of STEM-related careers have an impact on their career aspirations. The empirical findings underlined three main issues that should be addressed in educational contexts, and the following recommendations for practice were made:

1. *Students' interest and self-efficacy in STEM subjects need to be promoted.* This can be done, for example, through inquiry-based science education (including especially scientific and engineering practices and designing solutions), which enables students to get involved in active and collaborative knowledge-generation (e.g., Anderson, 2007; Schneider et al., 2020).
2. *Students need more practical information on choices related to STEM careers.* This can be addressed through providing more resources, guidance, encouragement, and opportunities for individuals to explore and pursue possible paths (e.g., Kaleva et al., 2023), in collaboration between science teachers and guidance counselors.
3. *Students need more realistic conceptions of STEM-related jobs and careers.* This can be promoted through educational approaches that are based on work-education integration, such as job shadowing opportunities, classroom visitors, site visits, or career counseling approaches (e.g., Gardner and Bartkus, 2014).

Understanding students' conceptions about STEM fields and the factors influencing their career aspirations is important since it can help teachers and other professionals to develop and implement better learning opportunities for high-achieving, STEM-oriented students. Overall, the findings of this study provide valuable insights on how to attract potential future change makers to STEM-related careers.

ETHICS STATEMENT

The University of Helsinki Ethical Review Board in Humanities and Social and Behavioural Sciences has reviewed the research plan of this study. The review board found that the study follows the ethical principles of research in the

humanities and social and behavioral sciences issued by the Finnish Advisory Board on Research Integrity. Thus, the review board stated that the mentioned study is ethically acceptable (Statement 44/2021).

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