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Gender-Related Differences for Subject Interest and Academic Emotions for STEM Subjects among Swedish Upper Secondary School Students

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Abstract: It is hard to attract young persons to engineering and other science, technology, engineering, and mathematics (STEM) fields of education in Sweden. Factors, such as interest and ability, are affecting the educational orientation of students, and many studies suggest that there are gender related differences in students' perceptions regarding different subject areas. Nevertheless, it is not fully evident why students' make their educational choices. In this paper, Swedish upper secondary school students' perceptions of interest and self-efficacy are studied in the form of a questionnaire survey to gain deeper understanding on the choices that are made. Open-ended questions regarding subject interest, as well as questions connecting STEM-related situations with perceived emotions were included, in addition to direct questions regarding interest and self-efficacy. Differences were seen both with respect to educational orientation and to gender, which confirms previous studies. Male students were interested in subjects that are accurate, logical, and scientific, while the female students emphasized the analytical and challenging aspects, in the sense that the subjects forced them to think. Interest and future opportunities affected the choice of program, while the student's own perceived ability seemed less important. Results with respect to emotions showed that the female students in this study felt insecure and scared in STEM-related situations to higher degree than male students did. Students on the social science program were bored and uninterested, while natural science and technology program students were more interested and confident in STEM-related scenarios. These findings help us to understand how students approach STEM situations, and how to take necessary measures to equalize these situations using a norm-critical approach.

Keywords: STEM subjects; interest and self-efficacy; subject interest; academic emotions; upper secondary school; questionnaire study

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1. Introduction

Sweden shares the following important challenge with many other countries [1–4]: how can we supply people with an engineering degree or university degrees in science, technology, engineering, and mathematics (STEM) disciplines to our society? Statistics show that Sweden already has a substantial shortage of technicians and engineers [5], at the same time as the level of competence needed in the technology-related sector is steadily increasing. The Swedish school system comprises 10 years of compulsory education followed by 3 years of non-compulsory education on an upper secondary level that gives eligibility to higher education on the university level. Upper secondary school offers a selection of 18 national programs. Twelve of these are vocational, while six are preparatory for higher education, namely the natural science program, the technology program, the social science program, the humanities program, the arts program, and business studies. The natural science program is the broadest national program in terms of preparing for further studies, especially in natural sciences, engineering, and medicine, and the focus is on mathematics and natural science subjects (chemistry, physics, and biology). The technology program has a focus on mathematics, physics, and technology, and is essential in preparing the student for a career within engineering, data science, and technology. The social science program has a strong focus in social science subjects (geography, history, religion, and civics), modern languages, philosophy and psychology; this prepares the students for a career mainly within behavioral sciences, media and information sciences, and pedagogics. The humanities program focuses on modern languages and philosophy, the arts program on arts and communication, and business studies on business administration, law, modern languages, and psychology. As the curricula differs between programs, the future competence profile for the students is mainly determined at upper secondary school level.

The STEM education field plays a significant role for the competence supply, as the majority of the students in engineering and STEM subjects at a university level come from the natural science (N) or technical (T) programs. Unfortunately, we can observe a clear downward trend in young people's interest in STEM-related education, and especially that children and youths' interest in technology is decreasing with age [6]. At upper secondary school level, only 12% of students are enrolled in N programs, while 8% are enrolled in T programs. At university level, we struggle with low throughput. Even if approximately 39,500 students in total are enrolled in university engineering programs, the finishing rate is low, as only around half of the enrolled students receive an engineering degree [7]. Research shows that equal recruitment and staffing contribute to positive business results [8]. Statistically gender-integrated is a business model that gathers between 40 and 60 percent of either women or men, as in [9]. Engineering is an occupational category that is currently not gender-integrated, but which is gradually becoming more equal; Sweden's engineers report a membership distribution of 26% women and 74% men, but in the age group 26–30 the proportion of women is about 33% [10]. In other words, there is a great potential in recruiting more women into the engineering profession.

The gender distribution in the upper secondary school's N program is rather equal; 53% of the students are female, but the proportion of female students in the T program is just under 18% [11]. One reason may be that we are still wrestling with mental images of industrial work as "something dirty" and that engineers are typically "male" [12]. Even in areas where technology interest and use seem equal, such as in the use of mobile phones, a closer examination could reveal inequality [13], as while boys engage in self-assertive activities, such as gambling, girls use their mobile phones mainly for social activities. Girls are, thus, exposed to higher risks and are more closely controlled by their parents. Therefore, allowing young people the same access to technology does not automatically solve gender equality problems. Another reason for the skewed recruitment to the upper secondary school's technology program may be gender patterns and gender-based self-images. For example, [14] argues that gender patterns guide students' choice of education, and a study in [15] demonstrated that girls showed lower self-esteem than boys did when it comes to STEM education. Furthermore, [16] found that girls who made gender-typical upper secondary school choices discontinued studies to a higher extent than girls who did not make gender-typical choices. In other words, there is a link between gender and throughput. To gain deeper understanding of the reasons behind this, we must understand the perceptions of STEM-related education amongst students. How do students in upper secondary school relate to STEM-related subjects and areas? Can one see a difference in perceived self-efficacy between male and female students, and does the perception vary between students who choose a STEM oriented education and other students?

The students' approach to STEM has been investigated in a number of studies and with different approaches. A common survey tool is PATT, which stands for pupils' attitudes towards technology, see for instance [6,12,17–19]. The PATT tool was developed in the 1980s, and has subsequently undergone modifications to maintain timeliness [19]. The latest version contains a total of 100 closed questions and an open question capturing the students' attitude and understanding of technology, and efforts have been made to reduce questions, such as in [12], where the number of attitude questions decreased from 53 to 25 without reducing the internal validity. The PATT and similar survey tools have been the object of discussion, for instance regarding the validity of the questionnaire constructs [6]. Problems with how the questions are formulated were raised in [19]. The interpretation could for example be influenced by culture and language, especially when the questionnaire is used in non-English speaking countries and, therefore, it requires appropriate translations. An example is the word technology, which has a dual meaning in the Swedish language (an apparatus and a skill).

Gender is the demographic variable most often used to describe differences between student groups, such as in [20]. Other variables are socio-economic background and parents' occupation [6]. The educational context itself can also be used as a variable. Indeed, ref. [17] investigated whether specific technology education efforts affected students' attitudes to technology, and whether any educational design was better for increasing students' technology competence. Unfortunately, the study results showed that the students' interest in technology did not increase after the educational effort, and their understanding of technology as well as technical competence remained unchanged. In [21], enjoyment, interest, ability, and future usability were factors that determined students' subject choices, while [22] highlighted the importance of the teacher's role in creating interest for STEM subjects. Additionally, ref. [15] studied perceived self-efficacy and social belongingness among students in STEM-oriented and health/education-oriented (HEED) higher education, and how these vary with gender. Female students perceived their self-efficacy to be higher for HEED education than for STEM education, while men showed high self-efficacy for both education categories. Social belongingness seems to be an influencing factor for both male and female students in terms of education category; female students felt more resident in HEED, and men in STEM.

The purpose of this study is to gain increased knowledge about the Swedish upper secondary school students' approach to STEM, both as a school subject and as a real-life phenomenon. We assume that there are variances in the perception both directly with respect to gender, and indirectly as a socialization process, with respect to educational orientation. Therefore, gender and educational orientation will be used as the main background variables when exploring whether significant differences exist between Swedish upper secondary school students with respect to interests and self-efficacy for STEM-related subjects.

2. Materials and Methods

To achieve the purpose and answer the research questions, a questionnaire survey study was performed. Survey studies are suitable for mapping patterns and detecting relationships between different variables [23], especially using close questions and statistical analysis. In this study, however, the patterns refer both to statistically inferred quantitative results as well as qualitative results derived from free text results using content analysis, i.e., a mixed methods approach. In this section, the theoretical foundation and research questions are presented, followed by descriptions of the study design.

2.1. Theoretical Foundation and Research Questions

The term interest describes engagement, or the willingness to reengage in something, such as a school subject [24]. Interest is, thus, to be seen as a motivational construct and has, according to [25], a strong correlation with study results; interest was the factor that best explained the complement of a STEM major in the study of US students. Students who early expressed interest in a STEM career and found it useful were more likely to major in a STEM subject. Indeed, ref. [26] believes that it is important to not only let female students be exposed to STEM early in life, but they should also be actively engaged in it. Furthermore, ref. [24] note that research findings indicate that female students, even though they have an aptitude to succeed in STEM subjects, are less likely to show interest or chose a STEM career, and they suggest problem-based learning (PBL) to overcome this. In their study conducted in 20 inclusive STEM schools in the US, PBL showed a direct effect on interest in a future STEM career. Other researchers propose the use of advanced education technology for increasing the interest in STEM [27–29]. The evidence that different interventions would lead to increased interest in STEM subjects and careers is, however, not uniform. For instance, ref. [17] found no correlation between educational design and increased interest and competence, and ref. [30] found no clear correlation between participation in advanced placement courses and students' STEM career choices.

As early interest is an indication of future careers, the first research question is formulated as follows: *Do significant differences exist between Swedish upper secondary school students regarding interest in school subjects and program selection?*

Self-efficacy describes the personal perception of competence and is often used as a variable for explaining gender differences [15,20,31]. The term is a subpart of the social cognitive theory, which describes learning as a process that happens in a social context where person, environment, and behavior interact [32]. According to [32], self-efficacy affects the motivational aspects of an individual as well as their choice processes. Furthermore, ref. [33] explain student behavior as affected by self-efficacy and group efficacy, which in turn are affected by motivation, ability, and opportunity. There is a clear link between motivation and opportunities of action, as a student with high self-efficacy has the feeling of control and is likely more motivated and able to find more opportunities to affect the choice process. Female students typically show lower self-efficacy for STEM subjects and occupations than men [15,20,31]. While this is known, the intervention actions are less well-researched [34]. In a study performed in [35], emotions and well-being correlated with self-efficacy and achievement goals in STEM, especially for female students. Additionally, ref. [36] propose that academic emotions predict performance. It was also found that the relationship was reciprocal, in that achievement could also predict emotions. According to [34], negative emotions towards STEM subjects might form early. Few studies have been found addressing academic emotions, especially focusing on positive emotions. When viewing emotions as an expression of the motivational beliefs of students' [35,37], emotions could be a means to measure self-efficacy.

The second research question is formulated as follows: *Do significant differences exist between Swedish upper secondary school students regarding self-efficacy and academic emotions towards STEM subjects?*

Gender could be seen as a biological or social/cultural construct, but also as an identity [38]. Gender affiliation is not as binary as biological or legal gender, but a variety of classification systems exist for perceived gender affiliation. Therefore, it could be argued that the typical binary response to sex in survey tools, such as PATT, is insufficient, especially when designing questionnaires for students in upper secondary school or higher.

According to [39], identity is a bridge between the personal and the collective sphere and, thus, between gender identity and social gender. Gender describes the expectations that the environment, either consciously or unconsciously, imposes on an individual, i.e., determines what is considered male or female [40], and is, thus, linked to the term norm. However, ref. [39] argues that normativity is not about the average or ordinary but about what is desirable, i.e., a recommended character that defines what to do or be. Norms could be represented by the physical, i.e., linked to places or pursuits, or the psychic, being linked to traits [40]. Examples of physical affirmations of norms are the word engineer, which is associated with a male person, or the trait strong, which is also primarily a male trait. The norms are represented as constructs, as institutions, artifacts, and divisions of labor, or as direct learning (socialization). Taking full account of these aspects on gender and normativity is of course impossible in a survey study, but they should permeate the way the questions are selected and formulated. In this study, the questions are deliberately expressed as gender neutral.

2.2. Study Design

A questionnaire survey was designed for upper secondary school students regarding subject preferences, program choices, views on technology, self-efficacy towards STEM subjects, and feelings connected to STEM-related situations. The survey included 13 questions, see Table 1.

Table 1. Questions included in the survey.

Question	Application in this Article
Questions regarding yourself and your studies.	
1. I am [Girl/Boy/Other]	Background variable
2. What school are you attending?	-
3. What program are you enrolled in?	Background variable
4. Why did you choose this program?	Variable describing interest
5. If you chose between different programs and/or schools, what made you finally choose your school and your program?	Variable describing interest
6. My favorite subjects in school were (you can choose more than one alternative). [Art, Biology, English, Physics, Geography, Home and Consumer studies, History, Physical Education and Health, Chemistry, Mathematics, Modern Languages, Music, Religion, Civics, Crafts, Swedish, Technology]	Variable describing interest
7. Why did you find these subjects interesting?	Variable describing interest
STEM-related questions.	
8. The word technology can have different meanings. It can also mean different things to different people. What is technology for you?	-
9. I am interested in STEM subjects. [Completely true (4)—Not true at all (1)]	Variable describing interest
10. I am good at STEM subjects. [Completely true (4)—Not true at all (1)]	Variable describing self-efficacy
Describe the emotions you get in the following situations. [Irritated, Happy, Bored, Interested, Wary, Scared, Expectant, Unsure, Uninterested]	
11. You will work with new technology/technique that you do not master.	Variable describing self-efficacy
12. You will work with other students within a new STEM area.	Variable describing self-efficacy
13. You must explain something technical or mathematical to others.	Variable describing self-efficacy

Note: In Table 1, the questions occur in English. In the survey, the questions were asked in the native language.

Six of these were free text questions, i.e., open questions, while the others were closed questions, with either multiple or single-choice options. Two questions were attitude questions, where a 4-point Likert scale was used. The last three questions were asking about attitudes, but instead of using the Likert scale, we used a multiple choice question where the students were asked to describe the emotions they connected with different scenarios. This article presents results for questions 4, 6–7, and 9–13, while questions 1 and 3 were used as background variables.

Gender and educational program orientation were used as background variables. To address the issue of binary response for gender, a third choice, "other", was added to the gender-related question, see Question 1 in Table 1. For answering our own initial research question, we included questions regarding choice of upper secondary school program (ages 15–18), as in Questions 4–5 in Table 1, as well as questions regarding subject interest at lower school level (ages 6–15), as in Questions 6–7 in Table 1. Using predefined factors, such as in [20] or [41], allows for multivariate analysis and hypotheses testing. In this study, however, open questions were chosen for capturing subject interest and motivational factors, as we strived for deepened understanding of the motivational and influential factors that create subject interest. Question 6 includes a list of the 17 subjects that comprise the curriculum for the Swedish compulsory school. In addition, a question regarding interest in STEM subjects was used, as in Question 9 in Table 1.

In order to answer our second research question, the students were asked to rate their perceived STEM skills, as in Question 10 in Table 1, as well as their emotions regarding three STEM-related scenarios, as in Questions 11–13 in Table 1, in the questionnaire. The scenarios were selected to represent classroom situations that might be perceived as problematic from a norm-critical perspective, especially situations that assume that the student is interacting with technology and/or persons. There exist few studies of academic emotions in relation to STEM, and most of them focus on negative emotions [34], even if [35] and [36] included both positive and negative emotions in their studies. A comprehensive list of 21 academic emotions is presented in [36], of which 11 are positive and 10 negative emotions. Positive emotions represent enjoyment, both with respect to anticipation and success, pride, satisfaction, and gratitude, as well as empathy, admiration, and love, while negative emotions represent boredom and hopelessness, anxiety, shame and disappointment, sadness, as well as anger, envy, and hate. In this study, positive as well as negative emotions are used. The positive emotions (happy, interested, expectant) represent enjoyment and anticipatory enjoyment, which is suitable for the formulation of questions 11–13. Emotions expressing pride or satisfaction are better suited for measuring emotions of academic success, while admiration and love are better suited for measuring, for example, subject interest. The negative emotions (irritated, bored, wary, scared, unsure, uninterested) were selected to represent boredom, hopelessness, and anxiety, while anger, sadness, envy, and hate were seen as inappropriate emotions for the study purpose. The sample schools are here denoted as School_1, School_2 and School_3. All classes in the second year of the natural science (N) program, technology (T) program, and social science (S) program were invited to participate in the study. In addition, students in the Lingua program (a humanistic program) at School_3 were also invited, because they share classes with the S program and, consequently, were present in class at the time when the questionnaire was handed out. The survey was created as an online form that participants could access via a web link. None of the questions were compulsory, but the participant could choose not to answer one or more questions. Missing answers did not prevent the participant from answering the next question. The online questionnaire was distributed through the program managers and was carried out during school hours in the classroom or via the program's learning platform during non-school hours. The students had, in total, one week to finish the questionnaire. Table 2 summarizes the participants in the study. The total amount of students in the selected schools and programs was 1927 students, 640 of which were enrolled in Year 2. The questionnaire was answered by 165 students, which gives an overall response rate of 26%.

Table 2. Study participants.

	Students Enrolled in Total	Of These Female (%)	Students in Year 2	Study Participants			Response Rate (%)
				Male	Female	Other	
T program, School_1	217	10	79	53	7	3	80
N program, School_2	358	52	127	10	18	0	22
S program, School_2	358	63	102	-	-	-	-
N program, School_3	551	51	142	10	8	0	13
S program, School_3	402	63	182	13	35	1	27
Lingua, School_3	41	88	8	1	5	0	75
Program/school N/A				1	0	0	
Total per gender				88	73	4	
Total	1927		640			165	26

As can be seen in Table 2, no student from the social sciences program at School_2 answered the questionnaire, and this program was, therefore, excluded from the study. The number of students in the Lingua program is low and, therefore, this program will not be included in analysis regarding educational orientation but will be included in analysis regarding gender. When reviewing the material, three respondents were found to give incomplete answers (one fully incomplete, one in which only first question was answered and one in which the responses clearly indicated that the participant did not provide relevant answers). These cases were, therefore, excluded.

Variance analysis in the form of t-tests and Anova at the 95% significance level was conducted, including post hoc tests with Tukey's method, on a total of six questions, namely question 6 and questions 9–13. A T-test was utilized for analyzing the variance for the variable *gender*, while Anova was utilized for analyzing variance for the variable *study program*. In addition, three free-text questions (questions 4, 5, and 7) were processed using content analysis, in which categories were inductively derived from the responses [42].

3. Results

The number of female and male students who answered the questionnaire is quite even, at 73 and 89, respectively. However, the gender distribution is skewed in relation to educational programs. Most of the males are found in the T and N programs, while most females are enrolled in the S or N programs. This reflects the distribution that exists for the programs, as in Table 2. The distribution of responses based on programs is 63 from T programs, 46 from N programs, 49 from S programs, and 6 from the humanistic program Lingua, i.e., the group of T students is slightly larger than the remaining groups.

3.1. Gender-Related Differences in Interest and Self-Efficacy

For female students in the study, the favorite subjects were *Mathematics, English, Civics, and Art*, while the favorite subjects for male students were *Mathematics, Physics, Technology,* and *Physical Education and Health*, as shown in Table 3.

Table 3. Favorite subjects by gender and program.

Subject	Female (%)	Male (%)	T Program (%)	N Program (%)	S Program (%)
Art	28	17	15	13	13
Biology	21	11	8	16	8
English	30	29	28	13	19
Physics	9	33	24	15	2
Geography	13	16	13	9	9
Home and Consumer studies	24	16	12	8	17
History	21	24	11	9	23
Physical Education and Health	26	30	17	19	19
Chemistry	15	15	10	13	7
Mathematics	30	45	33	34	7
Modern Languages	17	7	3	7	9
Music	15	16	11	10	10
Religion	19	7	4	5	17
Civics	29	16	9	8	27
Crafts	13	16	14	6	9
Swedish	27	6	4	8	19
Technology	8	31	31	9	1

The variance analysis showed that there were significant differences between the genders for several subjects (see Appendix A, Table A1). Female students were more positive than males towards the subjects of *Art, Biology, Home and Consumer studies, Modern Languages, Religion, Civics,* and *Swedish*. Male students were more positive than females towards the subjects of *Physics* and *Technology*.

The open-ended question "Why do you find these subjects interesting?" was answered by 67 female and 85 male students, a total of 152 responses. Table 4 reports on the frequency of responses based on identified categories. Four different categories were found. The first concerns interest in the subject (keywords, such as "fun", "interesting", "like", and "enjoy", were recorded). Both male and female students largely chose a favorite subject based on interest; this justification is found in half of the open-ended responses. The second category concerns the student's ability in a specific subject (keywords, such as "easy to understand", "simple", "best at", and "understand", were recorded). Indeed, 37% of the female and 26% of the male students indicated this as motivation for a particular favorite subject. The influence of the teacher was also mentioned by several students and forms the third category (keywords, such as "good teachers", "dedicated teachers", and "fun teachers", were recorded). The last category regards the subjects and their characteristics, and there was a great variation in the students' motivation for the subject being a favorite one. The most common ones were that the subject is practical, that the subject is theoretical, that the subject provides an understanding of how the world works, that it is useful, that it is analytical, and that the subject is creative. Male students appreciated subjects that are *theoretical, logical, structured, scientific*, and which *have exact answers*. Future *usability* was also positive according to the male students, as well as that the subject *creates an understanding* of how the world works, as well as about humanity and our surroundings. They also liked subjects where they can do *practical work*, for example cooking, but also solving a mathematical problem. Practical work also attracted female students. The *practical* subjects were described by some females as *relaxing* and as brain rest. They also mentioned *creativity* as a motive for choosing a favorite subject. While male students were attracted to theoretical and logical subjects, *challenging* and *analytical* aspects were important for female students, indicated by answers, such as “one must think”, “be challenged”, “problem solving”, and that the subjects are not “black and white”.

Table 4. Results of the content analysis, in terms of motivation for favorite subject.

Category	Female in % (Total 67)	Male in % (Total 84)	T Program in % (Total 57)	N Program in % (Total 41)	S Program in % (Total 48)
Interest	52.2	50.2	42.1	48.8	64.6
Ability	37.3	26.2	24.6	34.1	33.3
Teacher	19.4	13.1	15.8	14.6	16.7
Subject					
Practical	14.9	5.9	7.0	12.2	12.5
Theoretical	1.5	5.9	3.5	9.8	-
Understanding	4.5	4.8	-	4.9	10.4
Useful	3.0	3.6	3.5	2.4	4.2
Creative	6.0	1.2	1.8	-	4.2
Analytical	4.5	-	-	2.4	4.2
Challenging	6.0	-	-	4.9	4.2

The open-ended questions “Why did you choose this program?” and “If you chose between different programs and/or schools, what made you finally choose your school and your program?” show that the choice of program is usually related to interest and opportunities for further studies. Female students in the T program indicated general interest in technology, or specific interests, such as game development and programming, as a reason for the program choice. The breadth of the program and its preparatory nature were also motivating reasons. One female student mentioned that she wanted to work with technology in the future. Most of the male students stated the same reasons as the females, i.e., a general interest in technology, a programming interest, program breadth, university preparatory education, and that they see a future in technology. However, the male students’ answers deepened the reasons in many cases. For example, two male students specifically mentioned that they want to become engineers. Others expressed that they opted out of the N and S programs because they did not think they would be able to pass these programs. In terms of interest, some of the male students were particularly interested in specific school subjects, such as mathematics, physics, or technology. One male student mentioned friends as reason, i.e., a reason not connected to interest, program character, or future prospects.

Most of the students were both interested and perceived themselves as having good ability in STEM subjects. Low values (1 and 2) were indicated by 64 and 66 respondents, respectively, while high values (3 and 4) were indicated by 102 and 100 respondents, respectively. Looking at the distribution by gender in Figure 1, male students seem to be both more interested and consider themselves more able in STEM subjects. The analysis of variance confirmed *significant differences* regarding interest for male (M = 2.94, SD = 0.98) and female students (M = 2.40, SD = 1.04); t (160) = 3.40, $p = 0.001$. *Significant differences* were also seen in perceived ability for male (M = 2.93, SD = 0.85) and female students (M = 2.40, SD = 0.90); t (160) = 3.86, $p = 0.000$.

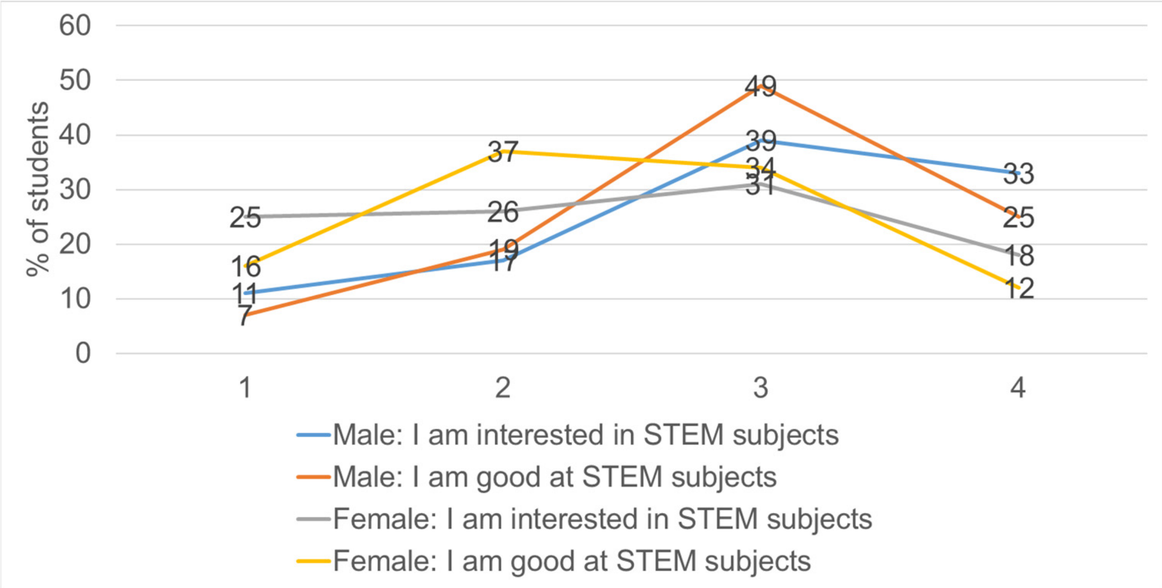

Figure 1. Interest and perceived self-efficacy for STEM subjects.

Results for questions 11 to 13, in which emotions regarding specific STEM-related scenarios were asked for, are presented in Figure 2. Noteworthy is that female and male students expressed different types of emotions in the three scenarios, where males were generally interested in all the scenarios, while females, in addition to being interested, also felt insecure or afraid. The analysis of variance confirmed these results (see Appendix A, Table A2).

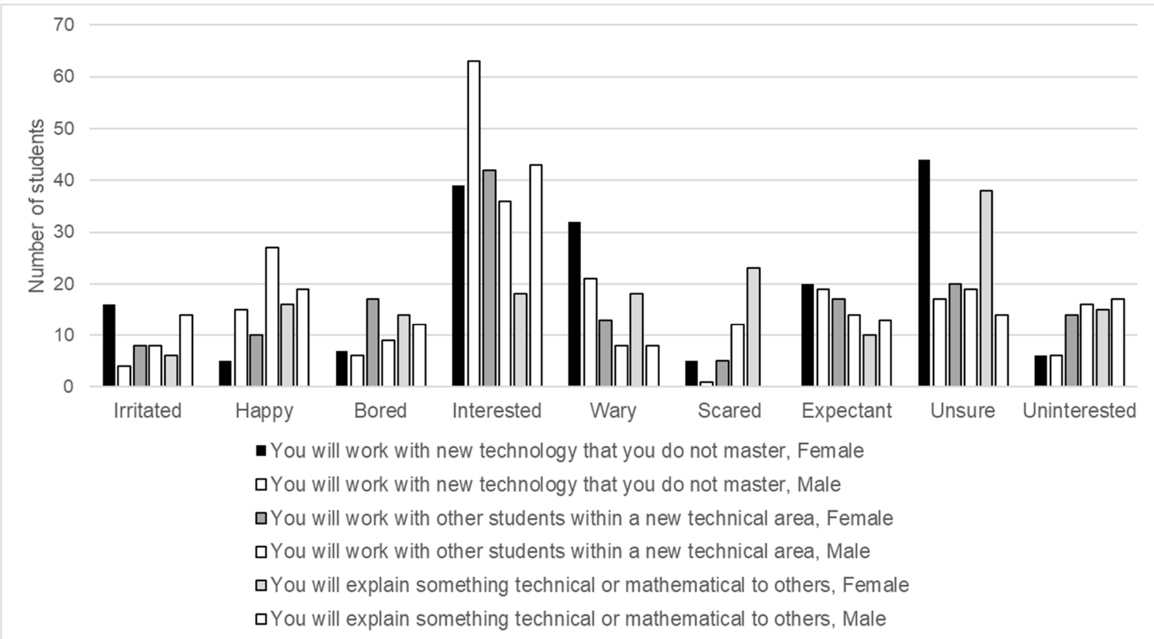

Figure 2. Emotions regarding STEM-related scenarios.

For the scenario "You will work with new technology that you do not master", significant differences were seen in the Anova for the emotions irritated, happy, interested, wary, and unsure. Male students, to a greater extent, stated that they were *happy* and *interested*, while female students were more *irritated*, *wary*, and *unsure*. For the scenario "You will work with other students within a new technical area", significant differences between the genders were shown only for the emotion scared. Female students were more scared than male students were. Regarding the third scenario, "You must explain something technical or mathematical to others", significant differences were shown in the statistical analysis for the emotions interested, wary, scared, and unsure. Female students indicated that they were wary, scared, and unsure to a greater extent than male students, while the males were more interested than the females.

3.2. Education Oriented Differences in Interest and Self-Efficacy

Favorite subjects for students in the S program were *Civics, History, Swedish, English*, as well as *Physical Education and Health*. Students in the N program had *Mathematics* as their favorite subject, and the T students liked *Mathematics, Technology*, and *English* the best, as shown in Table 3. Results from the Anova analysis (see Appendix A, Table A3) showed significant differences between the groups for following subjects: *Biology, Physics, History, Mathematics, Religion, Civics, Swedish*, and *Technology*. The between group variance was analyzed using Tukey's method. The largest difference between groups was found for students in the S program, as these students were more positive towards *History, Religion, Civics*, and *Swedish*, and more negative towards *Physics* and *Mathematics*, than other program students were. Frequency wise, there were no major differences between the programs for the open-ended question "Why do you find these subjects interesting?", but differences are seen in motivation for favorite subject based on subject characteristics. Students studying in T or N programs preferred theoretical subjects, while students in the S program emphasized understanding and analysis.

Results from the open-ended questions regarding program choice showed that female students in N programs motivated their choice of programs, in general, with an interest in science subjects and mathematics (i.e., STEM subjects), but the possibilities to choose study direction after the upper secondary school was the most mentioned reason. Most of the female students expressed that they do not know what to study after upper secondary school and, therefore, the breadth and opportunity for further university studies were attractive features of the program. Two female students mentioned future professional choices (doctor and architect) as reasons for the program choice. Interest in STEM subjects, program breadth, and opportunities for further studies were also common reasons for the program choice for male students in N programs. Several additional reasons were stated; five mentioned that they had enough credit points/were qualified, one mentioned that the program has the best teachers, one mentioned the opportunity to study Japanese, and two linked program choices with career choices (one wants to become an engineer and the other work in astronomy). In addition, one student saw the program as a way to enter a prestigious university.

Female students in the S program indicated interest in civics subjects or civic-related problems as the reason for their program choice. Interest in behavioral science and psychology was also mentioned by many female students, as well as the breadth of the program. Some of the female students stated that they did not like mathematics, and one was not accepted to the N program and, therefore, chose S instead. The male students in the S program commonly made the choice because of interest, but also for the opportunities for higher studies. One male student mentioned that this was a choice of impulse, and one that it was the only program he could be admitted into. One wanted to work with people in the future, and one chose the program because he did not know what he wanted to do in the future.

For questions 9 and 10, regarding perceived interest and self-efficacy in STEM subjects, the statistical analysis revealed differences between programs. According to the Anova, there was a significant difference in interest, as $F(2, 156) = 46.18$, $p < 0.001$, as well as a significant difference in perceived ability, as $F(2, 156) = 21.10$, $p < 0.001$. The post hoc test showed that students in the *N program* were more interested and perceived themselves more able in these subjects than other students, while *S students* were less interested and rated their ability lower for these subjects.

The results for questions 11 to 13 are presented in Appendix A, Table A4. Between programs, the emotions irritated, interested, and unsure showed significant differences for the scenario "You will work with new technology that you do not master". The post hoc analysis showed that students in the *S program* were *more irritated* than those in the *T program*. Students in the *N program* were *more interested* than students in the *S program*. Additionally, *T program students* were *less unsure* than other students were.

For the scenario "You will work with other students within a new technical area", significant differences in emotions were seen for the emotions bored, interested, and uninterested. Students in the *S program were more bored* than other students, while students in the *N program were more interested* than other students were. No statistically significant differences between the programs were found for the emotion uninterested. Regarding the third scenario, "You must explain something technical or mathematical to others", significant differences between programs appeared for a variety of emotions, such as bored, wary, scared, expectant, unsure, and uninterested. According to the post hoc test, students in the *S program* were more *bored* and *scared* than those in the *N program*, as well as more *uninterested* than other students. They were also more *wary* than T program students were. Students in the *N program* were *expectant* to a higher degree than the other students were. The *T program students* were *less unsure* than other students.

4. Discussion

The results show clear differences between genders regarding favorite subject. The female students in the study preferred "soft" subjects, such as language, civics, biology, and religion, while the male students preferred "hard" subjects, such as physics and technology. Interest, ability, teacher, and the characteristics of the subject were factors that influenced the choice for both groups. These results are in line with the findings of, for instance, [21,22]. Male and female students alike appreciated practical subjects, but unlike the female students who linked practical subjects with creativity and relaxation (from more theoretical and demanding subjects) and the opportunity to be active, male students linked practical subjects primarily with usability. This is an indication that open-ended questions might be better for capturing motivational variables than predetermined questions, as used, for instance, in [31]. Male students often described their favorite subjects as accurate, logical, and scientific, while the female students emphasized the analytical and challenging aspects, in the sense that the subjects had them to think. An explanatory model for these results could be biological [43], as girls mature more quickly and can take on more challenging subjects, namely subjects that require multiple reasoning, while boys need more structure to succeed in studies, which is found in the traditional natural sciences. Another explanation could be found in the construction of social norms, where men are assumed to be strong and more practical, and oriented towards a future typical male labor market in the engineering and technology profession [40]. It is notable that there were no differences in the interest for the subject of mathematics.

Moreover, the statistical analysis showed significant differences between programs in terms of subject interest, e.g., for mathematics and physics. Students in the S program appreciated the social science subjects, such as civics, history, and religion, while students in the N program mainly favored mathematics and other STEM subjects. The T students' favorite subjects were mathematics, physics, and technology. In other words, the choice of educational program and favorite subject in primary school correlates. Interest also gave a strong correlation regarding program choice in [15], where program choices at university level were studied. In the same study, it was found that perceived self-efficacy and social belongingness played a role, especially when it came to STEM education. In this study, interest and future opportunities played a role in choosing a program, while the student's own perceived ability seemed less important, even if some respondents stated that the program was chosen because he/she was not admitted to another, more attractive, program. In the answers, more male than female students indicated such reasons, but since the sample size in this study is relatively small, we cannot draw any general conclusions.

Male students motivated program choices to a greater extent than girls with concrete career choices, such as becoming an engineer or astronomer, or working with people, which can be interpreted as perceiving themselves as belonging to a certain social context but, again, the small sample size makes it hard to draw general conclusions. Therefore, it would be interesting to conduct further deepened studies of upper secondary students' program choices based on social belongingness.

The statistical analysis showed differences between gender with respect to perceived self-efficacy in STEM subjects, as well as differences between programs. Students in the S program rated their ability lower compared to other students, and students in the N program perceived themselves more able than other students. These results support the findings of [20,31]. Furthermore, the S students felt bored, uninterested, or wary when facing the STEM scenarios, while T and N students expressed confidence and interest, and especially N students showed more interest than S students did in the STEM-related situations. These results seem reasonable, especially if the assumption is that selection of programs is largely based on subject interest. However, questions 9 and 10 contain some ambiguity. Had the questions only focused on interest and ability in technology, i.e., excluding natural sciences, the gender differences might have been greater. Natural science subjects are inhomogeneous in that they include logical and structured subjects, such as physics and certain fields of chemistry, while other subjects, such as biology and other fields of chemistry, are more analytical in nature. This may be the reason why we see an even gender distribution in N programs compared to T programs (53% and 18% female students, respectively) in Sweden. The questions 11 to 13 were formulated more specifically and linked to emotions and, therefore, might reflect the students' self-efficacy more correctly than the generally formulated question.

According to the results, male students expressed positive feelings towards new technology while female students expressed feelings of insecurity and irritation. This is an important observation, as it describes different approaches towards technology that requires different pedagogic strategies. Thus, equal access to technology does not necessarily mean an equal utilization, as highlighted in [13]. An insecure student might, for instance, require detailed instructions and time to familiarize themselves with the technology before being able to utilize it efficiently. In addition, female students often felt unsure in the STEM-related scenarios and were more likely to be scared or insecure in situations where they should interact with others or explain something in a STEM context than male students, who mainly expressed interest and excitement. Thus, students approach STEM situations where interaction with others is required differently, and consequently different pedagogic strategies are required for equalizing the situations, especially as we know that the speech distribution in the school is not equal; females are not given the same opportunities to share their voices as males [39]. In the next section, some practical implications and suggestions for interventions are given to overcome these didactic issues.

5. Conclusions

This study shows differences between gender as well as educational orientation regarding Swedish high school students' interest in STEM and perceived self-efficacy. Previous studies have concluded that differences in perceived self-efficacy between female and male students do exist, and the results from this study strengthen this statement as well as broaden the understanding by using content analysis for studying subject interest and scenarios connected to academic emotions for studying self-efficacy. The study results also confirms previous studies that show a correlation between choice of program and gender, such as [15]. The questionnaire design seems to have a major impact on the results; we can obtain a deepened understanding of the nature of perceived self-efficacy when the question concerns specific scenarios and emotions than we would with a more generally asked question about self-efficacy. Interest, self-efficacy, and social belongingness appear to be factors of influence in this study. We are socialized early into what is expected of a boy or girl, and perhaps it is these patterns that the study indirectly reveals. One conclusion is, therefore, that a norm-critical approach, where gender and gender differences are not seen as merely biological differences, but as gender-dependent differences that indirectly describe existing norms and power relations, are better suited for studies of students' approach to technology. This gives us a possible reason behind differences in perceived self-efficacy but, more importantly, indications on suitable interventions.

While using surveys to describe gender differences is common, several issues exist that need to be addressed. One is how gender-related questions are asked. In the original version of PATT, for example, 10 attitude questions exist where gender is mentioned in the question itself. What is striking is that questions referring to girls are negatively expressed, e.g., "Girls think technology is boring", or cover questions considering the practical use of technology, e.g., "A girl can become a car mechanic". In contrast, questions referring to boys mainly focus on ability, e.g., "Boys are able to do practical things better than girls". Therefore, ref. [6] recommend the use of dual formulations, i.e., using the question "Boys are more capable of doing technological jobs than girls" together with the question "Girls are more capable of doing technological jobs than boys". In this study, the attitude questions were instead formulated to be gender- neutral. Another problem is how participants perceive gender. In most surveys, only two categories are used to determine gender. Consequently, students who identify themselves as belonging to none of the genders (or both) find it difficult to answer the question, or must choose, for instance based on biological sex instead of perceived gender [38]. These problems were addressed in this study by using gender-neutral statements and questions, and by adding a third alternative, "other", to the demographic question of gender. While this group had to be excluded from the analysis due to insufficient respondents in the current study, the authors believe that the gender category question design should be considered in larger studies. Using the term "other" is not optimal, since it shows a norm difference where being male and female is the norm, while the rest is outside the norm, as in, for instance, [40]. However, the solution felt most neutral and the easiest to introduce in the current circumstances.

One of the most important didactic implication is that we, as educators and teachers, must understand that differences do exist, and find effective strategies to equalize them. Applying a norm-critical approach to the speech and action space in school is a way of working with the problem, but how this is made in practice can both improve and undermine the situation. For example, it is not enough to try to equalize the distribution of speech if it means that we put additional pressure on the groups that are silent today, such as female students. Indeed, ref. [44] suggest reviewing the curriculum, instruction material, and the classroom interactions with respect to language and gender stereotypes, and raise the awareness of gender biases in the classroom interaction, such as praising boys more than girls in STEM-related situations. At the same time, we should avoid "forcing" gender equality by controlling the distribution of voices. The consequences of forcing gender equality into the speech distribution could, for example, be that female students must share their "girl's perspective" on a particular subject, or be forced to say something, even if they feel afraid to appear stupid or deviant. Instead, ref. [39] suggests that we should adopt a student-centered perspective for understanding underlying mechanisms. A presentation occasion could, for instance, be used as a manifestation of status or for social positioning, as identity, language, and power relations interact in these contexts, maintaining or reinforcing given norms. To avoid this, we should change the educational context so that everyone feels safe, for example by raising the students' awareness of norms and gender inequities. A conscious norm-critical discussion from an early age, adapted to the maturity level of the student group, might be a way to change gender norms in the future. This could be performed either in gender-separated groups, such as in [45], by addressing norms and stereotypes regarding the female body, or in mixed gender groups, such as in [46], where an intergroup dialogue approach was used for reaching the cognitive, attitudinal, and behavioral shifts in students' perception. Tutorials and learning material have been developed for this purpose, such as [47].

Another way to overcome the problem is to gradually train unsure students in specific learning activities or by giving students enough preparation time. For STEM subjects, this could be achieved by online tutorials and remote laboratories that allow for training before and after physical laboratory sessions [48,49], by linking STEM subjects with emerging societal challenges, such as radiation risks [50], or by specific training programs aimed at developing generic skills related to STEM. One example is the spatial development program for the middle school level presented in [51].

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Appendix A

Table A1. Differences in favorite subject by gender [1].

	t	df	Sig. (2-Tailed)	Mean Diff.	Std. Error Diff.	95% Confidence Interval of Diff.	
						Lower	Upper
Art	−2626	135,059	0.010	−0.186	0.071	−0.326	−0.046
Biology	−2450	126,181	0.016	−0.156	0.063	−0.281	−0.030
Physics	4041	154,240	0.000	0.256	0.063	0.131	0.380
Home and Consumer Studies	−2252	135,335	0.026	−0.156	0.069	−0.292	−0.019
Modern Languages	−2737	114,040	0.007	−0.158	0.058	−0.273	−0.044
Religion	−3127	111,287	0.002	−0.186	0.060	−0.304	−0.068
Civics	−3172	131,811	0.002	−0.225	0.071	−0.365	−0.085
Swedish	−4875	100,657	0.000	−0.308	0.063	−0.434	−0.183
Technology	3723	154,957	0.000	0.233	0.063	0.110	0.357

[1] Only results for variables showing significance at the 0.05 level are included.

Table A2. Differences in emotions by gender [1].

	t	df	Sig. (2-Tailed)	Mean Diff.	Std. Error Diff.	95% Confidence Interval of Diff.	
						Lower	Upper
You will work with new technology/technique that you do not master.							
Irritated	−3295	98,542	0.001	−0.178	0.054	−0.285	−0.071
Happy	2317	150,847	0.022	0.111	0.048	0.016	0.206
Interested	2248	145,930	0.026	0.172	0.077	0.021	0.324
Wary	−2668	139,897	0.009	−0.197	0.074	−0.343	−0.051
Unsure	−5713	133,903	0.000	−0.408	0.071	−0.550	−0.267
Irritated	−3295	98,542	0.001	−0.178	0.054	−0.285	−0.071

Table A2. *Cont.*

	t	df	Sig. (2-Tailed)	Mean Diff.	Std. Error Diff.	95% Confidence Interval of Diff.	
						Lower	Upper
			You will work with other students within a new STEM area.				
Scared	−2302	71,000	0.024	−0.069	0.030	−0.130	−0.009
			You must explain something technical or mathematical to others.				
Interested	2265	158,901	0.025	0.164	0.072	0.021	0.307
Wary	−2704	117,254	0.008	−0.161	0.060	−0.279	−0.043
Scared	−2818	125,917	0.006	−0.186	0.066	−0.317	−0.055
Unsure	−4124	135,932	0.000	−0.303	0.073	−0.448	−0.158

[1] Only results for variables showing significance at the 0.05 level are included.

Table A3. Differences in favorite subject by program [1].

Subject		SS	df	MS	F	Sig.
Biology	Between Groups	1431	2	0.716	4626	0.011
	Within Groups	24,129	156	0.155		
	Total	25,560	158			
Physics	Between Groups	3401	2	1700	9814	0.000
	Within Groups	27,027	156	0.173		
	Total	30,428	158			
History	Between Groups	2818	2	1409	7700	0.001
	Within Groups	28,553	156	0.183		
	Total	31,371	158			
Mathematics	Between Groups	8706	2	4353	220.009	0.000
	Within Groups	30,854	156	0.198		
	Total	39,560	158			
Religion	Between Groups	2440	2	1220	9856	0.000
	Within Groups	19,309	156	0.124		
	Total	21,748	158			
Civics	Between Groups	5358	2	2679	150.792	0.000
	Within Groups	26,466	156	0.170		
	Total	31,824	158			
Swedish	Between Groups	2965	2	1482	100.515	0.000
	Within Groups	21,991	156	0.141		
	Total	24,956	158			
Technology	Between Groups	6225	2	3112	200.060	0.000
	Within Groups	24,203	156	0.155		
	Total	30,428	158			

[1] Only results for variables showing significance at the 0.05 level are included.

Table A4. Differences in emotions by program [1].

Subject		SS	df	MS	F	Sig.
		You will work with new technology that you do not master.				
Irritated	Between Groups	1274	2	0.637	6431	0.002
	Within Groups	15,455	156	0.099		
	Total	16,730	158			
Interested	Between Groups	1555	2	0.777	3412	0.035
	Within Groups	35,552	156	0.228		
	Total	37,107	158			
Wary	Between Groups	2934	2	1467	6749	0.002
	Within Groups	33,909	156	0.217		
	Total	36,843	158			

Table A4. *Cont.*

Subject		SS	df	MS	F	Sig.
	You will work with other students within a new technical area.					
Bored	Between Groups	2519	2	1259	9270	0.000
	Within Groups	21,192	156	0.136		
	Total	23,711	158			
Interested	Between Groups	2342	2	1171	4901	0.009
	Within Groups	37,280	156	0.239		
	Total	39,623	158			
Uninterested	Between Groups	0.980	2	0.490	3271	0.041
	Within Groups	23,360	156	0.150		
	Total	24,340	158			
	You must explain something technical or mathematical to others.					
Bored	Between Groups	1182	2	0.591	5188	0.007
	Within Groups	17,774	156	0.114		
	Total	18,956	158			
Wary	Between Groups	1094	2	0.547	4130	0.018
	Within Groups	20,655	156	0.132		
	Total	21,748	158			
Scared	Between Groups	1421	2	0.710	4379	0.014
	Within Groups	25,309	156	0.162		
	Total	26,730	158			
Expectant	Between Groups	2314	2	1157	100.848	0.000
	Within Groups	16,642	156	0.107		
	Total	18,956	158			
Unsure	Between Groups	3618	2	1809	8641	0.000
	Within Groups	32,659	156	0.209		
	Total	36,277	158			
Uninterested	Between Groups	2905	2	1452	100.001	0.000
	Within Groups	22,655	156	0.145		
	Total	25,560	158			

[1] Only results for variables showing significance at the 0.05 level are included.

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