The gender difference in computer science: motivation strategies and reasons for pursuing a study in the field.

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16 March 2022

Abstract

The underrepresentation of women in computer science is a widely researched theme within the western world. In this mixed method descriptive study, a questionnaire and focus group interviews have been employed. The self-reported motivation for secondary school computer science of Dutch 11th & 12th grade preuniversity male and female secondary school students was measured and compared using the learning section of the Motivated Strategies for Learning Questionnaire (MSLQ). This questionnaire encompasses intrinsic & extrinsic goal orientation, self-efficacy, task value, test anxiety and control of learning. In the qualitative part, semi-structured focus group interviews were conducted with four groups of students, differentiated on gender and intention to pursue a study in computer science. The quantitative results show that female students report a significantly higher task value for secondary school computer science compared to male students. The other constructs in the MSLQ did not show any statistically significant gender differences. The focus group interviews revealed that stereotypes of people in the field of computer science to be the most reported deterrent among the factors which lead to the lower representation of women in computer science. This was the case in all four focus groups, indicating that stereotyping is present in both male and female students and does not depend on whether the students are actually planning to pursue a career in computer science.

Women are greatly underrepresented in computer science in the western world. Men outnumber women greatly in the field (Meijer, 2021) causing a male oriented image of the field. Because of the gender gap, computer science is missing out on potential contributions to the field by talented women who can bring creativity and gender diversity to the field. Also, women miss out on jobs in computer science which tend to be high paying, lucrative and flexible (Cheryan et al., 2015).

The underrepresentation of women in the computer science field is mostly a western problem. For instance, in Malaysia, computer science is considered to be a valid career path for women (Lagesen, 2008) and the number of women enrolled in bachelor studies often even exceeds the number of men (Othman & Latih, 2006). This balance is caused due to government policies and societal factors (e.g.: parents deciding which study their daughter should follow).

In Europe, the gender disparity problem in computer science is also present with women taking up 17% of the share of women attending computer science studies (Eurostat, 2020). Of all the countries in European Union, The Netherlands had the lowest share (8%) of female students in computer science in 2018 opposed to Belgium with the highest share (37%).

Luckily, the number of female employees in IT in the Netherlands grew with 6,5% in 2020 to 100.000, but the total share of female employees is still 18,5% of total share (Meijer, 2021). The Dutch Employee

Insurance Agency (UWV) reports a great labor shortage within the computer science industry with almost 57.000 open vacancies (UWV, 2019). These hard to fill jobs are mostly meant for university (of applied sciences) students. The UWV points out the that fulltime jobs tend to be the norm in IT and offering more parttime jobs could help attract female employees.

Literature states numerous reasons for the gender gap in computer science with the stereotypes of the field being the most prevalent (Cheryan et al., 2017). Stereotypes show to be such a detrimental deterrent that women who briefly interact with stereotypical female computer science students anticipate lower success belief in computer science compared to their male counterparts (Cheryan et al., 2011). A physical classroom environment in which stereotypical computer science features are not salient also leads to females, but not males, expressing more interest in opting for computer science (Master et al., 2016).

Dutch students also tend to have insufficient preuniversity computer science experience. If students are lucky, they have the chance to choose computer science as an elective in the 10^{th} grade of their preuniversity education. These students are lucky, because the percentage of Dutch secondary schools offering computer science as an elective has dropped from 60% in 2008 to 47% in 2018, as secondary schools are not obligated to offer computer science as a subject (TechniekPact, 2020). To some extent preuniversity computer science is still in its infancy. The teacher shortage contributes the problem and schools even take out computer science from their curriculum out of necessity.

Research shows that interventions can be successful to solve the gender disparities in computer science. For example, the Harvey Mudd College has managed to increase and retain the enrollment of female students from 12% to 14% by adapting their computer science curriculum to be more welcoming to female students (Alvarado et al., 2012). The Dutch organization VHTO, which is committed to increasing female participation in science, technology, engineering & mathematics (STEM) education, also employs activities (e.g.: gender inclusive programming, Girls' Day) to increase (female) participation in secondary school computer science in the Netherlands (VHTO, 2022).

This research aims to point the gender differences in self-efficacy by measuring the self-reported motivation strategies (which contains a self-efficacy scale) of Dutch secondary school students. Furthermore, this research also reports what Dutch pre-university students state on the in literature know reasons (for females) not to pursue computer science. The investigation into the reasons for students for (not) pursuing a computer science study, are limited to the three factors causing underrepresentation in computer science compared to other more gender balanced STEM fields as presented by Cheryan et al. (2017). These three factors include:

- the masculine culture of computer science
- insufficient early computer science experience
- the gender gaps in self-efficacy.

This leads to the following question to be answered within this study:

1. *To what extent does motivation strategies for computer science in secondary school differ for 11th & 12th grade Dutch preuniversity male and female students?*

2. *What do 11th & 12th grade Dutch preuniversity male and female students report on the reasons for pursuing or not pursuing a computer science study?*

Theoretical background

An interesting body of research exits on the topic of gender disparities in computer science education. A recent review of the most cited reasons explaining gender disparities in STEM participation (Cheryan et al., 2017) proposes a model (Figure 1) explaining the gender disparities in participation in physics, engineering & computer science compared to biology, chemistry, and mathematics. In the US, the latter fields show a more balanced picture in terms of gender than computer science. This model may also be applicable in STEM subfields so it is used in this study to categorize the reasons leading to underrepresentation of women in computer science in the Netherlands. It will therefore be discussed in some detail, below. The different elements of Figure 1 will be discussed successively.

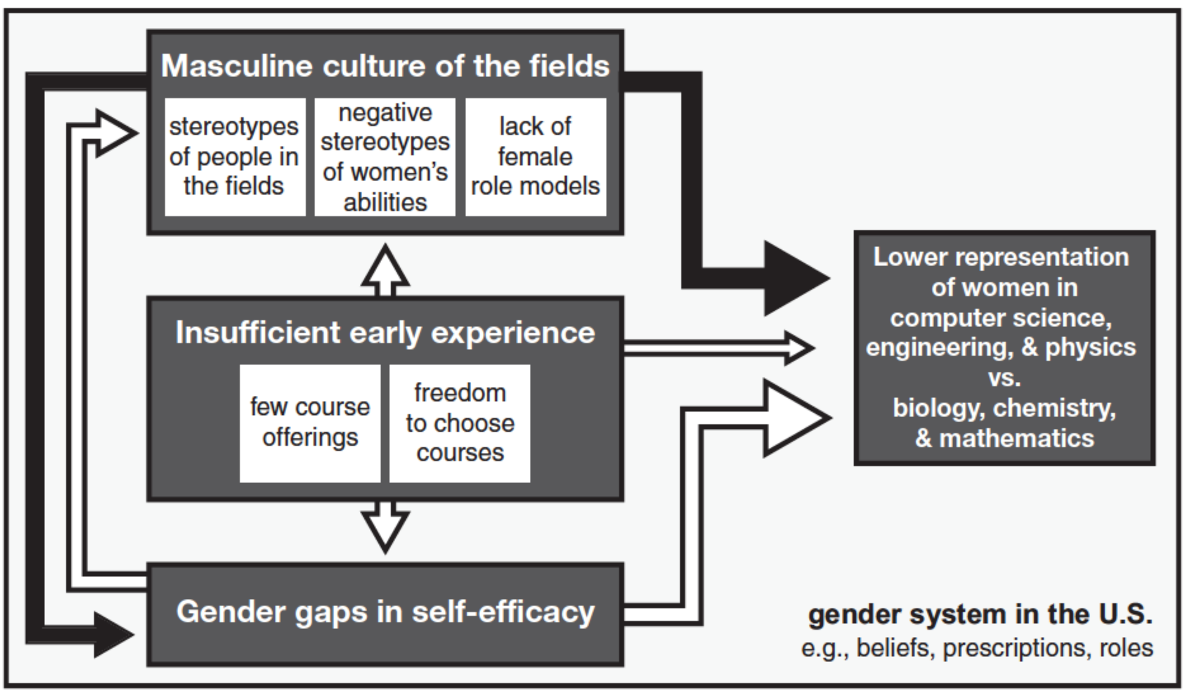

Figure 1 Masculine culture of the fields, insufficient early experience and gender gaps in self-efficacy explain the lower representation of women in computer science (Rijksoverheid, n.d.) (Rijksoverheid, n.d.) (Rijksoverheid, n.d.) (Rijksoverheid, n.d.) (Rijksoverheid, n.d.; Rijksoverheid, n.d.). The solid lines represent proof of sufficient experimental evidence. Figure by (Cheryan, Ziegler, Montoya, & Jiang, 2017)

Masculine culture in computer science

The gender imbalanced field of computer science (education) is renowned for its masculine culture. Cheryan et al. (2017) conceptualize masculine culture as features of a field (e.g.: the beliefs, norms, values, structures, interactions), which causes females to feel a lower sense of belonging which has been showed in female secondary school students (Master et al. , 2016). This masculine culture also causes females to be less successful than their male counterparts. As the solid arrows in the model of Cheryan et al. (2017) indicate, there is enough experimental evidence for the masculine culture of computer science leading to a gender gap in self-efficacy and to the lower female representation in computer science (Figure 1).

In the model, this area is subdivided into three categories that have been shown to decrease women's sense of belonging to computer science:

1. Stereotypes of people in the field of computer science

The stereotypes of people in computer science refer to the traits and characteristics the people in the field embody. Stereotypically people in computer science are described as white males who are singerly focused on technology, socially awkward, brilliant, and masculine (Cheryan et al., 2013). Exposure to males and females who embody these characteristics has a negative enduring effect on women's interest in computer science (Cheryan et al., 2012). Also, students' future course selection is connected to their values which in its turn is strongly influenced by stereotypes (Beyer S. , 2014).

2. Negative stereotypes of women's abilities in computer science

The model described here is originally used to state reasons for lowers representation in the math-intensive fields physics, engineering & computer science compared to biology, mathematics & chemistry. Negative stereotypes about women's abilities appear to more problematic in first fields compared to the latter (Cheryan et al., 2017). Female undergraduate students also report greater concerns for being negatively stereotyped in computer science compared to mathematics and even more than in biology (Matskewich & Cheryan, 2016). Although females are sometimes negatively stereotyped in STEM fields there is no innate gender difference in ability for STEM subjects (Wierenga & Crone, 2019).

3. Lack of female role models in computer science

Because there is a gender disparity in computer science, potential female role models are less salient than male role models. Women are more likely to enter the field of computer science when they are exposed to relatable female role models who do not embody the negative stereotypes of people in the field (Cheryan et al. 2011). Female role models contribute to the retention and sense of belonging of women in computer science (Drury et al., 2011).

Insufficient early computer science experience

The second overarching factor, insufficient early experience, comprises the few course offerings students get, and the freedom students have, to choose courses. Some STEM subjects are offered earlier than others and are mandatory (Cheryan et al., 2017). For example, mathematics is mandatory from the 7th grade, while computer science is offered as an elective in the 10th grade in the Netherlands. In Figure 1, insufficient early experience is linked to the masculine culture because having girls interact with role models from a young age can counteract the effects of the masculine culture. The lack of early experience is not solely to blame for the lower representation of women but paired with the perceived masculine culture, gender gaps start to occur.

1. Few course offerings.

The few course offerings in the model refers to educational policy mandating some STEM subjects and not offering others as greater access to STEM courses reduces the gender disparity (Cheryan et al., 2017). For instance, in contrast to mathematics, computer science is not a mandatory subject in secondary school in the Netherlands (Rijksoverheid, 2022a). In primary education computer science is also not mandatory but primary school are obliged to offer lessons science and technology (Rijksoverheid, 2022b).

2. Freedom to choose courses.

Even when students get the opportunity to opt for computer science in secondary education they tend not to. The last 10 years the percentage of preuniversity students graduating secondary school with computer science as elective subject has remained around 12% (TechniekPact, 2020). The gender disparity already occurs here with 20% of the male students choosing computer science compared to 5,3% of their female counterparts. Mandating students to opt for a course can help reduce gender disparities (Cheryan et al., 2017).

Gender gaps in self-efficacy

Turning to the last factor, the gender gap in self-efficacy in computer science. As Figure 1 shows, the stereotypes within computer science lowers females' self-efficacy and their sense of belonging in the field (Cheryan et al., 2017). Self-efficacy is defined as the belief, one can master a particular task (Bandura, 1994). Increasing computer experience has proven to increase self-efficacy and lowers computer anxiety in students (Doyle et al., 2005).

Research shows male students tend to perceive higher self-efficacy than females (Miura, 1987) even though female and male students are known to perform equally well in computer science courses (Beyer, 2008). Female students also state lower confidence in computing ability than male students (Beyer et al., 2003). In contrast, another study shows Malaysian students show no gender gap in self-efficacy in computer science (Sam et al., 2005).

The present study measures female and male students' self-efficacy for secondary school computer science by using the MSLQ (RQ1). Subsequently, students are also asked within the focus groups if they think they "have what it takes to study computer science", suggesting their computer science self-efficacy (RQ2).

Method

To answer the research questions a mixed method approach was chosen. For the quantitative part of the research (RQ1) the motivation section of the Motived Strategies for Learning Questionnaire (MSLQ) was used mainly for its self-efficacy scale. The other scales are reported but exceed the scope of this research. In the qualitative part of the research, (RQ2) reasons for pursuing or not pursuing a career in computer science are discussed within focus groups.

Context

The research took place in the center of the Netherlands at a public secondary school which teaches all education levels within their two different nearby locations. One location houses the pre-vocational education students while the other location, where the research was conducted, houses the pre-university students. A final sample of 122 Dutch 11th & 12th grade pre-university (havo[1], vwo[2]) students, aged 16 to 19 (M = 16.69, SD = 0.71), who had chosen computer science as an elective secondary school subject computer science were included in the quantitative part (RQ1) of the research. A subset of 17 students of these students participated in focus groups for the qualitative part (RQ2). To ensure the confidentiality the participants gave their consent for the usage of the interviews for the research and were ensured that statements made in the focus groups could not be individually linked back to them. Furthermore, the students were aware that all the focus group interviews would be transcribed and safely stored.

Table 1 shows the total number of students by their education level and identified gender. This target group was mainly chosen because most of the participants will continue to tertiary education and will have to choose a follow-up study within one year.

At the time of the research there was a total of six 11th & 12th grade computer science classes with one female teacher who started teaching at the school in the previous school year and one male teacher who worked at the school for a longer period and also taught the subject chemistry. In the previous school year there was one other female teacher who started teaching at that year and stopped by the end of the school year. The school year prior to that there was another female teacher who left the school. The researcher also did a computer science teacher internship in the year prior to the research.

Table 1
Gender of participants of questionnaire by education level

		Education level			
		11th grade havo	11th grade vwo	12th grade vwo	Total
Gender	Male	19	35	37	91
	Female	7	11	13	31
Total		26	46	50	122

[1] In the Dutch secondary education system, havo (senior general secondary education) prepares students for the hbo (university of applied sciences). (Nuffic, 2022)
[2] Vwo (university preparatory education) prepares students for the wo (university).

Instruments

Motivated Strategies for Learning Questionnaire

The Motivated Strategies for Learning Questionnaire (MSLQ) is a self-report instrument designed to assess students' motivation orientations and their learning strategies for a course (Pintrich, Smith, García, & McKeachie, 1991).

The questionnaire is based on a 7-point Likert scale in which students state to what extent statements apply to them. The MSLQ comprises two sections: a motivation section and a learning strategy section. The scope of the research limits itself to the motivation section. The motivation section originally contains 31 items, but the questionnaire used in this study contains 33 items. This is because this study applies an adapted and translated Dutch version of the MSLQ by Blom & Severiens (2008) which was already tested for its reliability. In that study the questionnaire was focused on the students' attitude towards the subject's history. The motivation section of the MSLQ comprises six scales: intrinsic & extrinsic goal orientation, test anxiety, task value, control of learning beliefs and self-efficacy.

Final questionnaire

The MSLQ was introduced to the participants by the researcher at the beginning of one of the participants' computer science lessons. At the time one period was 40 minutes. The students completed the questionnaire within approximately 20 minutes. All six 11th & 12th grade computer science classes participated in the study.

In the questionnaire students were firstly asked to fill out general demographic information (e.g.: gender, education level & profile) about themselves (see Appendix A). Table 1 shows an overview of the number of participants by gender and education level. The questionnaire was sent out to all 11th & 12th grade preuniversity students at the school, aged 16 to 19 (M = 16.69, SD = 0.71) who had chosen computer science as an elective secondary school subject (N = *131*). Only the completed questionnaires (N = 122) were included in the research and administered for analysis. Approximately a quarter of the participants identified as female (N = 31), and the remaining participants identified as male (N = 91). One student identified its gender as "other" and was not in included in the results because the research questions are aimed at answering differences between male and female students. The internal consistency for the final questionnaire is reported in Table 2.

Table 2
Internal consistency final MSLQ

Scales	Cronbach's Alpha (α)	N items	Items
Control of own learning	.64	5	4, 10, 18, 24, 33
Extrinsic goal orientation	.70	6	1, 2, 3, 8, 13, 29
Intrinsic goal orientation	.59	4	16, 22, 23, 31
Task Value	.80	5	11, 17, 25, 26, 32
Test Anxiety	.72	5	5, 9, 14, 19, 27
Self-efficacy	.85	8	6, 7, 12, 15, 20, 21, 28, 30

Pilot

In the initial stage of the research a pilot of the full MSLQ with both the motivation and learning strategies section was administered on a 10th grade computer science class. This pilot was done to test the overall consistency of the questionnaire and to decide whether the length was appropriated. The pilot was done in the beginning of the lockdown related to the covid-19 pandemic. The internal consistency of the responses was not satisfactory, related to the fact that the students reported insufficient time to fill out the questionnaire.

Based on the pilot findings, in continuation of the study all the questionnaires were taken in class with the researcher present. Also, the decision to exclude the learning strategies section from the MSLQ was made. To ensure reliability, future researchers should apply the modularity of the MSLQ as allowed by the MSLQ manual (Pintrich, Smith, García, & McKeachie, 1991). The internal consistency for the final questionnaire is reported in Table 3.

Table 3
Internal consistency MSLQ pilot

Scales	Cronbach's Alpha (α)	N items	Items
Control of own learning	.45	5	4, 10, 18, 24, 33
Extrinsic goal orientation	.57	6	1, 2, 3, 8, 13, 29
Intrinsic goal orientation	.84	4	16, 22, 23, 31
Task Value	.84	5	11, 17, 25, 26, 32
Test Anxiety	.69	5	5, 9, 14, 19, 27
Self-efficacy	.84	8	6, 7, 12, 15, 20, 21, 28, 30

Focus groups

After the completion of the anonymous MSLQ, the students were asked to fill out a voluntary non-anonymous questionnaire, if they were interested in a follow-up focus group interview about the subject of gender disparities in computer science education. Focus groups were used as a qualitative data collection method to get an in-depth insight in students' views on the reasons for (not) pursuing computer science through discussion. Focus groups are a great way to involve a high number of participants in the research with a wide range of views and opinions (Denscombe, 2017). The desired size of a focus group was 4 or 5 students. Focus groups were chosen instead of interviews mainly for their time efficiency. Also setting up multiple in-person interviews during the corona regulations would be daunting since there was limited free spaces as classes were divided in groups to limit big groups coming together.

The results of this non-anonymous questionnaire were used to contact and divide the students based on their gender and whether they had seriously considered computer science as follow-up tertiary study. As a result, the four focus groups depicted in Figure 2 were formed:

1. F+, female students who did seriously consider computer science ($n = 7$).
2. F-, female students who did *not* seriously consider computer science ($n = 7$).
3. M+, male students who did seriously consider computer science ($n = 3$).
4. M-, male students who did *not* seriously consider computer science ($n = 4$).

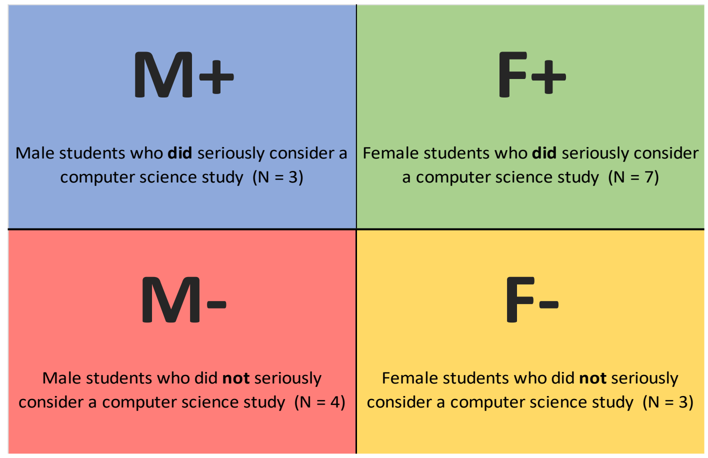

Figure 2 four focus groups dived by gender and serious consideration for a follow-up computer science study in tertiary education

The semi-structured focus group interviews were conducted in the students' lunchbreak. Because of Covid-19 regulations at the time, the time of the lunchbreak was reduced from 30 to 25 minutes.

Based on the six aforementioned factors causing underrepresentation of women in computer science (Figure 1), the focus group questions were formulated (Appendix B) and a codebook was deductively constructed (Table 4). Quotes from the focus group were rated by the researcher and a researcher who is familiar with the topic of underrepresentation of women in STEM education. To determine the level of agreement between the raters an interrater reliability test using the Cohen's Kappa statistic was performed resulting in a near perfect agreement ($\kappa = .829$, $p < .001$).

Data analysis

Analysis MSLQ (RQ1)

The data of the MSLQ was statically analyzed in SPSS. Firstly, the student with gender "other" were omitted. The internal consistency was measured by doing an interrater reliability test. Before calculating the descriptive statistics, the negative variables were recoded into new variables. The descriptive statics were calculated for both female and male students for each motivation strategy subscale in the MSLQ. Lastly, an independent sampled *t*-test was conducted to check for significant difference between male and female students for the six constructs of the motivation section of the MSLQ.

Analysis Focus groups (RQ2)

Based on the six factors leading to underrepresentation as depicted in Figure 1, the code book in Table 4 was deductively coded and questions were formulated (Appendix B) for the semi structured focus groups. The audio of the focus group interviews was recorded and transcribed. Quotes were coded based on the codebook. A random selection of the quotes along with the codebook of all 4 focus groups were sent to be rated by a second rater resulting in a near perfect agreement ($\kappa = .829$, $p < .001$).

Table 4

Codebook with categories and example quotes based on the factors leading to underrepresentation of women in computer science.

Category	Name	Explanation	Example Quote
1: SP	Stereotypes of people in the field of computer science.	The stereotypes of people in the field of computer science are that they are white males, who are socially awkward, and singularly focused on technology.	Computer science students are boys who are nerdy and only focus on technology.
2: NSWA	Negative stereotypes of women's abilities.	Women are negatively stereotyped as having lower abilities in math intensive fields and science than men.	Boys are better than girls in computer science, so they also perform better.
3: LFRM	Lack of female role models.	Because of the lack of female representation in computer science, there are fewer potential female role models in these fields.	I don't know a lot of women in computer science. I do know some men though.
4: FCO	Few course offerings.	In Dutch secondary schools, computer science is a nonmandatory elective which can be chosen by preuniversity students in the 10th grade.	I never followed a computer science course before this one. It was never offered to me.
5: FCC	Freedom to choose courses.	Secondary school students in the Netherlands are more likely to choose another course instead of the computer science elective. Only 12% of all Dutch students choose computer science.	I picked the computer science course because it was an elective in which I don't have to do exams.
6: GGSE	Gender gaps in self-efficacy	Some studies state that women have a lower self-efficacy in computer science courses.	I don't think it has what it takes to study computer science.

Results

RQ1: Results MSLQ

The results of the Motivated Strategies for Learning Questionnaire shows that Dutch female students (*M* = 4.21, *SD* = 1.18) report a significantly higher ($p < .005$) task value than their male counterparts (*M* = 3.63, *SD* = 1.13) for the secondary school subject computer science, $t(120) = -2.43$, $p = .383$. The other measured scales within the motivation section of the MSLQ show no significant difference between male and female students. The descriptive statics of the MSLQ are reported in Table 5.

Table 5

Descriptive statistics of the Motivated Strategies for Learning Questionnaire.

	test_anxiety		Task value		Extrinsic goal orientation		Intrinsic goal orientation		Control of Learning		Self Efficacy	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
M	3.09	3.19	3.63	4.21	4.53	4.64	4.39	4.43	5.08	5.28	5.13	5.25
SD	1.12	1.10	1.13	1.18	0.98	1.04	1.07	1.13	0.96	0.65	0.87	0.91

RQ2: Focus group findings

Figure 3 visualizes the number of quotes per focus group by the categories stated in Table 4. The findings of the focus groups (Figure 3) are now discussed consecutively by category:

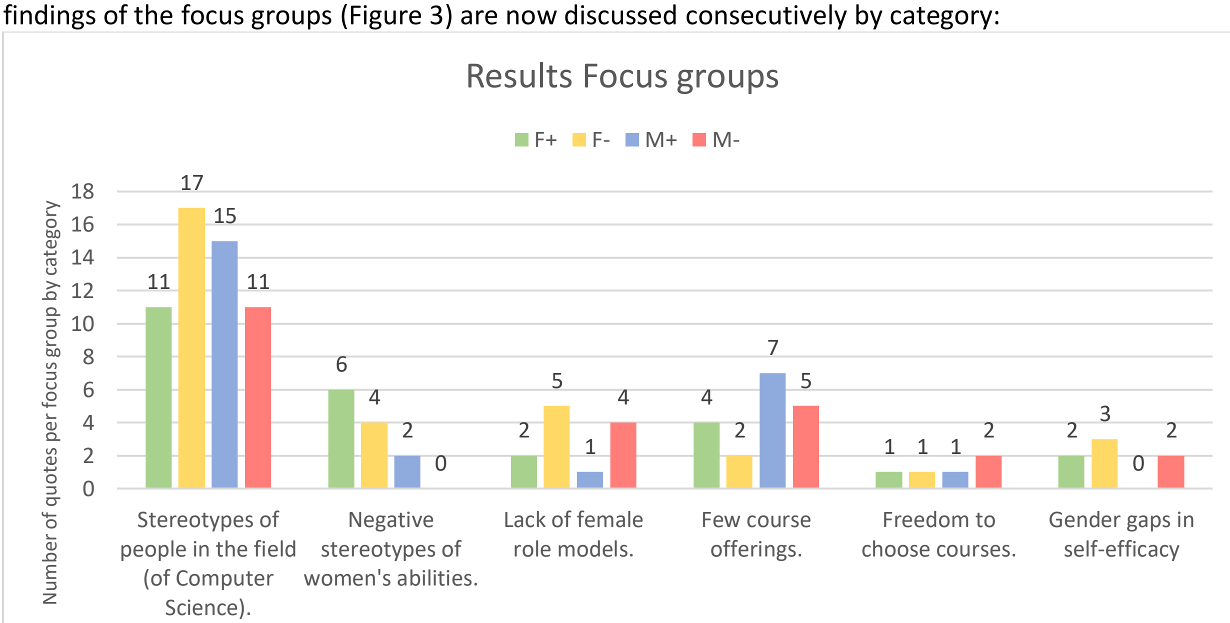

Figure 3 The number of quotes per focus group dived by its category.

1. Stereotypes of people in the field of computer science.

By far the largest category in all focus groups, with half of all quotes (54 out of a total of 108 quotes), relates to stereotypes of people in the field of computer science. When asked to describe a typical computer science student, all groups mention, the in literature described, women deterring stereotypes of people in computer science.

When asked to describe a computer science student a student from the F+ said: “Well often you think about guys or when I say that I want to study computer science or artificial intelligence it's like: Oh really, is that something for you. So, I think it's a […] bit more masculine or something”. Another student in that same group reports: “maybe an ugly handwriting […] from typing a lot or something”. In the F- group a typical computer science student was described as: “A boy with glasses. Often”. A student in the M+ group described a computer science student as: “[…], glasses, a little skinny, very smart. At home a lot behind the computer playing video games.” A M- group student describes computer science students as: “[…] somewhat nerdy men uhm, who are quite busy with computers.”

The overall quotes described people in the computer science as nerdy boys with glasses that are solely focused on technology. It is noteworthy that these stereotypes are prevalent in all four focus groups, albeit mentioned somewhat more often in the F- group.

2. Negative stereotypes of women's abilities.

The F+ group mention the most quotes on the topic of negative stereotypes on women in abilities (6 out of 12 quotes). Importantly however, all these quotes came from one student in the largest focus group (F+, N=7) who argued that boys tend to incorporate logical thinking more than girls and therefore having an advantage when it comes to math intensive fields. This student stated: “I think boys are more inclined to think logically, […] which fits with computer science […] More than girls have that”. She further argues: “[…] also when you look at what kind of jobs women take. Women are more likely to go into jobs with compassion that really engages with people.”

Overall students in all focus groups, the students report that they think females can perform as well as males in computer science.

3. Lack of female role models.

A long silence emerges when the researcher asked in the F+ group if they know any successful women in computer science. After a while one student says: “You have that uh... that one lady”. She continues to describe, Katie Bouman, a female computer scientist who was recently in the news and accomplished taking a picture of a black hole. She recalled this female scientist as being successful in computer science but could not mention her name. The latter was the case in all the groups.

The F- group mention the most quotes on the lack of female role models (5 of the 12 quotes). Only one student of the M+ group was able to call several female computer scientists by name. In all groups students were able to name male role models in computer science (e.g.: Steve Jobs, Bill Gates & Elon Musk).

4. Few course offerings.

None of the participants in the focus groups said to have mandatory computer science courses prior to the elective they chose in 10th grade which is in line with Dutch national policies.

Most participants mention that most of their computer science experience started in the 10th grade when they choose the elective. One student in the F+ group mentions getting the choice in 3rd grade of primary school to take a programming course in which she made a website. Two students (1 in M+ and 1 in M-) tried programming in Python in their free time. One F+ student also has informal experience prior to secondary school and mentions that here father finds programming interesting and had enrolled here in a programming class which was given by a university.

Throughout the focus groups students mention that boys have a head start in computer science because they play videogames and with cars from a young age.

5. Freedom to choose courses.

The students in the focus groups all opted for computer science as an elective. The opinions on why they choose this elective differ. One of the students (F-) says that here mother advised here to pick the elective because “computer science is the future”.

A F+ student mentions that in the beginning she did not have any motivation for the computer science elective and choose the subject because computer science is a subject in which students currently don’t have to make central exams. Along the way this student started liking the subject and opted in for a bachelor study in artificial intelligence.

6. Gender gaps in self-efficacy

When asked if the students thought they could handle a computer science study, a F- student answered: “No, because I think that…. I sometimes notice that there is a certain kind of logic behind it, […] but sometimes I just really don’t understand […]. For example, […] all those number systems and such. […] That must all sort out well in your head […]”.

A F+ student states she is confident she could handle a computer science study but sometimes doubts herself because of the current masculine culture. She states that there are “[…] only men […], I thought maybe women can't handle it or something but now they are coming more and more women, so I think it's possible”.

In the M- group one male student simply says: “I don't think I can handle it (a computer science study), […] I can’t completely go along”. One of his peers agrees with him by stating a known stereotype: “[…] for me it’s kind of the same, I would not uhm, want a fulltime desk job”.

Male students who did seriously consider computer science (M+) shows no lack of self-efficacy in computer science which contrasts with the groups that did not consider computer science (M- & F-). Some students in the F- & M- focus groups state that they don’t think that they have what it takes to pursue a study in computer science.

Overall, the students in the focus groups think they could successfully complete a computer science study, but won't, because they are simply not that interested in computer science.

Conclusion

We now revisit the research questions:

RQ1: To what extent do motivation strategies for computer science in secondary school differ for 11th & 12th grade Dutch preuniversity male and female students?

Dutch 11th & 12th grade preuniversity students don't differ that much when it comes to incorporating motivation strategies for the secondary school subject computer science. The results of the MSLQ indicate that female students show a significantly higher task value for computer science than their male counterparts. No explanation was found for the measured gender difference in task value for computer science. No significant differences were measured for test anxiety, control of learning, self-efficacy, intrinsic & extrinsic goal orientation.

RQ2: What do 11th & 12th grade Dutch preuniversity male and female students report on the reasons for pursuing or not pursuing a computer science study?

From the results of the focus groups, we can conclude that Dutch secondary school students are aware of the stereotypes that deter women from computer science, such as that computer science students are nerdy males that are singularly focused on technology. The students do not so much seem to doubt women's computer science abilities, but the presence of female role models often seem to be lacking for these Dutch students.

The participants had little early obligatory computer science experience prior to the 10th grade. Even in secondary school opting for computer science remains a choice that only 12% of all Dutch students make. Some students in the different focus groups did acquire informal computer science experience in an informal setting by doing online tutorials or making a website. Secondary school male students who seriously considered computer science don't report any lack in self-efficacy compared to their peers in the other groups.

Discussion

Limitations of the study

The data collection of the research was done during the Covid-19 pandemic at the end of 2020. Corona regulations were effective at the school leading to small adaptions to the initial research design. For instance, the scheduled time for the focus groups had to be shortened from 30 to 25 minutes because of students' shorter lunchbreaks at the time. For the same reason, the number of participants for the focus groups was lower than expected. A group size of 4 to 5 was the aim.

The researcher gave lessons to one pre-university (5 vwo) class at the school for one semester, one year prior to the research. These lessons were in the context of a teacher internship. This results in some students already knowing the researcher.

Implications

The model of Cheryan et al. (2017) has shown is applicability in a Dutch educational setting for categorizing the factors for low representation of females in computer science. The model shows to be consistent with the findings in this research as the quotes on masculine stereotypes in computer science were the most prevalent in the focus groups.

This research is an indication that Dutch students rarely know any relatable computer science role models and get little computer science experience prior to secondary school. Primary school teachers can learn from this by incorporating more computer science in their lessons to increase the overall interest in computer science and by making their pupils meet relatable female computer science professionals to counter the stereotypes of people in the field of computer science. Also, Dutch educational policy should be adapted to mandate computer science preferably as early as possible.

The MSLQ did not find any gender differences in self-efficacy for secondary school computer science. However, to increase the validity of this finding, students' computer science self-efficacy should be measured at more schools.

The present study shows that the stereotypes on people in computer science are present in female and male students regardless of whether they have serious intentions for pursuing a study in computer science.

Future research

In terms of future research, it would be useful to extend the current findings by examining all 10^{th} grade students, even those who chose other electives. This should be done at multiple secondary schools. This will show a more credible picture since secondary school computer science is not mandatory to pursue computer science in tertiary education.

This research does not zoom in on task value expectancies for secondary school computer science. No other research which measures the motivation strategies for the subject computer science (as a whole) in secondary school students was found. The research on this subject is quite limited and requires further investigation.

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Appendix A

Motivated Strategies for learning Questionnaire (MSLQ)

Achtergrondinformatie

- Wat welke leerjaar zit jij en op welk niveau?
- Wat is je geslacht?
- Hoe oud ben jij?
- Welk profiel heb jij?
- Heb je wel eens serieus overwogen om iets met informatica te gaan studeren?

Vragen

1. Ik wil in het vak informatica graag beter zijn dan de gemiddelde leerling.
2. Ik vind het wel mooi als toets resultaten voor het vak informatica op het voor iedereen te zien zijn. Dan kan ik zien hoe goed ik scoor.
3. Ik leer altijd voor een goed cijfer, of ik een vak nou leuk vind of niet.
4. Als ik op de goeie manier studeer, krijg ik de stof van het vak informatica wel onder de knie.
5. Wanneer ik een toets maak voor het vak informatica, denk ik altijd dat anderen het wel beter zullen doen.
6. Ik denk dat ik dit jaar goede cijfers ga halen voor het vak informatica.
7. Ik heb wel er vertrouwen in dat ik de teksten die we voor het vak informatica moeten lezen – hoe moeilijk ze ook zijn - kan begrijpen.
8. Op dit moment is het mij heel wat waard om een goed cijfer te halen voor het vak informatica.
9. Wanneer ik met een toets vraag van het vak informatica bezig ben, moet ik er steeds denken dat ik andere vragen misschien niet weet.
10. Als ik het vak informatica niet haal, ligt dat in de eerste plaats aan mezelf.
11. Ik maak alle opdrachten van het vak informatica omdat ik de stof van dit jaar graag goed wil beheersen.
12. De basisbegrippen van het vak informatica krijg ik in elk geval onder de knie.
13. Ik ben er wel op uit een zo hoog mogelijk rapportcijfer te halen voor het vak informatica.
14. Als ik een toets voor het vak informatica maak, denk ik altijd aan wat er gebeurt als ik hem niet haal.
15. Ik vertrouw erop dat ik ook de ingewikkelde onderwerpen van het vak informatica die de docent aan de orde stelt, kan begrijpen.
16. Bij een vak als informatica heb ik het liefst een leerboek dat mij nieuwsgierig maakt, ook al is de stof moeilijk.
17. Ook door de opdrachten en het huiswerk, ben ik heel geïnteresseerd in waar het vak informatica over gaat.
18. Als ik mij inspan, lukt het mij wel de stof van het vak informatica te begrijpen.
19. Tijdens een toets of proefwerk van het vak informatica ben ik altijd opgelaten en onrustig van binnen.
20. Ik ben vol vertrouwen dat ik mijn opdrachten en toetsen van het vak informatica heel goed ga maken.

21. Voor het vak informatica haal ik gemakkelijk een voldoende, verwacht ik.
22. Ik vind het fijn om de stof van het vak informatica helemaal te begrijpen.
23. Als ik bij het vak informatica de kans krijg, kies ik onderwerpen waar ik iets van leer, zelfs als dat betekent dat ik een minder goed cijfer haal.
24. Als ik de stof van het vak informatica niet begrijp komt dat omdat ik te weinig moeite heb gedaan.
25. Ik vind de opdrachten die ik voor het vak informatica moet doen leuk.
26. Ik wil heel graag begrijpen waar het vak informatica allemaal over gaat en de opdrachten helpen me daarbij.
27. Ik heb last van de zenuwen als ik een proefwerk maak voor het vak informatica.
28. Ik weet zeker dat ik de vaardigheden die je bij het vak informatica leert, ga beheersen.
29. Ik wil anderen graag laten zien dat ik in staat ben het vak informatica met succes te volgen.
30. Wanneer ik kijk naar de eisen van het vak informatica, naar de informaticadocent en naar wat ik al kan en weet, dan weet ik zeker dat ik het haal.
31. Bij het vak informatica wil ik graag een uitdagend leerboek zodat ik nieuwe dingen kan leren.
32. Door het maken van het huiswerk en de opdrachten leer ik niets extra's over het vak informatica. (Negatief)
33. Het maakt niet zoveel uit hoe ik leer of hoeveel ik doe voor het vak informatica, ik begrijp de leerstof of ik begrijp het niet. (Negatief)

Appendix B

Questions focus groups

1. Omschrijf eens een typische informatica student?
2. Denken jullie dat iedereen geschikt is geschikt is om informatica te gaan studeren?
3. Denken jullie dat jongens en meisjes evengoed zijn in informatica?
4. Kennen jullie vrouwen die succesvol zijn in de informatica?
5. Hoeveel programmeer ervaring hebben jullie?
6. Hebben jullie op school of vorige scholen al eerder programmeerlessen gevolgd?
    a. Waren deze lessen verplicht?
    b. Wat vond je daarvan?
7. Denk jij dat je een informatica studie aan zou kunnen?
8. Waarom hebben jullie (nooit) serieus overwogen om informatica te studeren? (Extra)