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Gender bias in secondary education

An explorative study on the availability of role models for physics and computer science students in Dutch high schools

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Abstract

While the overall gender-gap in the Netherlands has been decreasing in the last couple of decades, females have not yet reached an equal footing in the different fields of STEM. One of the reasons may be the fact that there are not enough female role models being created and presented to female students. Role models are found to have a lasting impact on the feeling of belonging and sense of possibilities for a career in a certain industry or field. They give students the idea that a career path is something that they could pursue and achieve too. Without proper role models in STEM, female students tend to feel that they do not belong and that they would not be good at it.

The focus of this study lies on Dutch secondary education, as at this stage of education the gender-gap in STEM starts to be apparent. In this study we explored the presence of gender-bias in role model availability in Dutch secondary education, and the influences it has on the found gender-gap in STEM. We have analysed physics and computer sciences textbooks for the 4th, 5th, and 6th year of Dutch havo/vwo, and handed out questionnaires to female students in the 3rd year of havo/vwo.

Compared to females, the books include up to 4 times as many males in general, and up to 50 times as many male scientists in relevant fields to physics and computer sciences. This gender-bias in role model availability seems to be picked up by students too, who indicate that they feel that their textbooks give them the feeling that STEM is meant for males and who can hardly name any female scientists by name in contrast to a large number of male scientists.

The results of our study indicate that there is a large gender-bias in role model availability, and that this gender-bias likely deters females from starting a career in STEM. Thus, to decrease the found gender gap in the professional fields of STEM, a good first step would be to decrease the gender-bias in role model availability in secondary education.

Layman's Summary

Alhoewel gender-ongelijkheid in Nederland in de afgelopen tientallen jaren sterk is afgenomen, is dit nog niet het geval voor technische beroepen en sectoren. Nog steeds werken er ongeveer 6 keer zoveel mannen als vrouwen in de sectoren van de ICT en natuurkunde, en zijn er ongeveer 4 keer zoveel mannen als vrouwen die een opleiding beginnen bij een hogeschool of universiteit in de richting van deze beroepen.

Eén van de oorzaken van dit grote verschil tussen mannen en vrouwen in deze beroepen, komt mogelijk door een gebrek aan vrouwelijke rolmodellen: individuen waar leerlingen of studenten tegenop kunnen kijken. Met te weinig vrouwen aanwezig in deze sectoren, zijn er mogelijk ook te weinig vrouwen om tegenop te kijken en aan vrouwelijke leerlingen en studentes te laten zien dat ICT en natuurkunde logische keuzes voor ze kunnen zijn.

In deze studie kijken we of er inderdaad een ongelijkheid is tussen de aanwezigheid van mannelijke en vrouwelijke rolmodellen voor de sectoren in het voortgezet onderwijs, en of er aanwijzingen zijn dat een mogelijke ongelijkheid of gebrek vrouwelijke rolmodellen bijdraagt aan de gender-ongelijkheid binnen deze beroepen.

De resultaten van ons onderzoek laten zien dat er inderdaad een grote ongelijkheid is in de presentatie van rolmodellen in het voorgezet onderwijs en dat dit vrouwelijke leerlingen het idee geeft dat de ICT en natuurkunde sectoren meer iets voor mannen zijn. De tekstboeken voor de schoolvakken van natuurkunde en informatica, voor 4, 5 en 6 havo en vwo, presenteren 3 á 4 keer zoveel mannen als vrouwen in totaal. Bovendien is minder dan 10% van alle personen in de boeken met een beroep in deze sectoren vrouw. Daarnaast geven vrouwelijke leerlingen uit 3 havo/vwo aan dat ze vaak niet gestimuleerd worden om voor een opleiding te kiezen in de richting van deze beroepen, en dat ze het idee hebben dat anderen vinden dat deze beroepen meer iets voor mannen zijn.

De resultaten van ons onderzoek geven weer dat er inderdaad een gender-ongelijkheid is in de aanwezigheid van rolmodellen in het voortgezet onderwijs, dat deze ongelijkheid de leerlingen beïnvloedt. Het lijkt erop dat dit bijdraagt aan de genderongelijkheid in de sectoren van ICT en natuurkunde, maar verder onderzoek zal moeten uitwijzen in welke mate dit inderdaad het geval is.

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Introduction

Over the last half century, inequality, or the gap, between males and females in educational attainment has decreased immensely. With the help of global and local policies (European Union, 2019) encouraging women to pursue higher education, in 2012, 93% of the gap between males and females had been closed globally. In the Netherlands, the gap in educational attainment had even been completely closed, with women attaining by average the same level of education as men. In contrast to the educational attainment however, the gap in economical participation between men and women rested at 75% in 2012 (Schwab et al., 2012), and even decreased to 65% by 2016 (Schwab et al., 2016). Thus, while the gender gap in educational attainment has been closed, the gap in economical participation remains persistent.

One of the reasons that the inequality in economical participation is more persistent than that of educational attainment, is the choices of females when it comes to higher education (Bradley, 2000). High payment – high responsibility occupations are often part of fields that still remain male-dominated (Fernandez-Mateo & Fernandez, 2016; Sassler et al., 2016). This means men, and not women, attaining lucrative jobs – leading to inequality in economical participation.

One of the fields that remains male dominated in the Netherlands, and thus contributes to this inequality, is that of Science, Technology, Engineering and Mathematics (STEM). Although women comprise almost 60% of bachelor graduates from all fields combined, less than 45% of all sciences and less than 30% of all engineering graduates are female (OECD, 2016), with the largest gap between male and female graduates being present in physics, computer sciences and engineering (Card & Payne, 2021; OECD, 2016). This gender-gap in graduation is estimated to be responsible for up to 20% of the existent inequality in economical participation between males and females (Altonji, Arcidiacono, & Maurel, 2015; Card & Payne, 2021).

Thus, what is keeping females from graduating in these fields, and pursuing a career as physicist, engineer, or IT specialist? Females tend to have the idea that a career in the fields of physics, computer science and engineering "just isn't for them" (Kalender et al., 2019). They believe that others think these fields are meant for men, and that they themselves would not be good at it (Sax et al., 2015). For example, female first-year students with grade A for the subject of physics, have the same self-efficacy as males with grade C (Marshman et al., 2018). Not feeling like they belong or would be successful, essentially keeps women from participating in higher education in the fields of physics (Stout et al., 2013), engineering, and computer sciences (Cheryan, Master, & Meltzoff, 2015).

The reason that females tend to have the idea that they do not belong, likely originates in the lack of proper role models (Beede et al., 2011); females that already have a job as physicist, engineer, or IT specialist, and therefor indicate that these fields are for females too and that pursuing such a career is a realistic goal (Gibson & Cordova, 1999; Sealy & Singh, 2009). Thus, it is likely that the gender gap in the professional fields of physics, engineering and computer sciences is, at least partially, the result of a lack of and/or wrong presentation of role models in earlier education (Bakken, 2005). In extent, the lack of role models may thus contribute to the existent gender-gap in economical participation.

For physics, computer science and engineering in the Netherlands, the gap between males and females within the work fields is already present at the start of higher education. For example, far less females than males choose to pursue higher education in these fields, with females comprising less than 20% off all enlistees for studies related to physics, engineering, and computer sciences (VHTO, 2019b, 2019a). While already present, this gap between males and females is smaller when students choose their study program for higher secondary education (Techniekpact, 2020). Thus, a part of the problem seems to arise in higher secondary education when students are choosing their future (higher-) education.

With this in mind, the aim of this study is to gain insight into the gender-bias in role model availability during higher secondary education, and what role this may play in female students' choices to pursue a career in physics, engineering, or computer sciences. To this purpose, the focus lies on the school subjects of physics and computer science, as these lay at the basis of higher education in physics, computer sciences, and engineering (TU Delft, 2021). During our study, we aim to find out *to what extent gender-bias in in role model availability is present in the Dutch secondary education subjects of physics and computer sciences, and whether it plays a role in the gender-gap within these fields.*

Firstly, as textbooks are one of the main sources of role models for students at this stage of education (Bettinger & Long, 2005; Gibson, 2004), the textbooks of physics and computer sciences will be the first object of this study. During the textbook analysis, *we aim to gain insight into the presence of a gender bias in role model availability in physics and computer science textbooks used in higher secondary education*.

Secondly, we will hand out questionnaires to female secondary education students, who are busy deciding what study program to enrol in for higher secondary education (age 13-15). The aim of the questionnaires is to explore *to what extent these students have role models for STEM, and in what way this influences them into choosing for these subjects*.

Theoretical background

Gender gap

The gender gap is already present when students choose their study program for higher secondary education, and remains visible during the rest of the different career paths (Wang & Degol, 2017). In this study, the gender-gap is defined by two of the gender-gap aspects of the *global gender gap report,* namely 'educational attainment' and 'economical participation'. 'Educational attainment' indicates the differences in the level of education at which men and women graduate, and the 'economical participation' focusses on the contribution of females on the economy, compared to the contribution of males (Schwab et al., 2012).

In the Netherlands, there has not been a gender gap in overall educational attainment for the last couple of years (Schwab et al., 2012). In contrast to educational attainment, there has been - and still is a clear gender-gap when it comes to economical participation. In 2016, females only contributed to the economy for 65% compared to males. This percentage is the result of females having lower wages for the same jobs (Janietz & Bol, 2020), difference in level of occupations with females more often having part-time jobs (Matteazzi, Pailhé, & Solaz, 2018), and male dominance in high-reward fields and industries (Cheryan et al., 2015; Cheryan & Plaut, 2010).

Among these high-reward, male dominated fields, the STEM sector is most notable. In contrast to other fields, a mere 13% of all professionals in the Dutch STEM sector is female (van den Berg et al., 2019; van Veelen et al., 2019). This large gender-gap in the Dutch STEM sector is already present, while smaller, at the start of higher education, when approximately 24% of all enlistees for STEM bachelors are women: for each woman that enlists for a bachelor degree in a STEM subject, three men enlist for the same degree (van der Molen, 2020; van Veelen et al., 2019). Furthermore, the gap is present, albeit smaller, in secondary education too, when 33% of all students choosing for a '*Natuur&Techniek'* curriculum are (Techniekpact, 2020).

Role Models

The gender-gap that arises in Dutch physics and computer science education, may origin in the absence of and/or bias in the presentation of role models, and the effects it has on young female students (van der Molen, 2020). A role model, defined as "*a person who someone admires and whose behaviour they try to copy"* (Cambridge, 2013), helps others see that a certain occupation, study or hobby is normal and possible for them to pursue as well (van der Molen, 2020).

From a young age, their upbringing and direct environment offers girls the idea that physics and computer science are not for them, but instead meant for boys (Dowey, 2013). They simply have the idea that others do not see them as physicists or computer scientists (Kalender et al., 2019). This idea causes girls to think that they shouldn't pursue a career in these fields, and that if they do, they would not be good at it (Sax et al., 2015). This leads to a lower self-efficacy, which in turn decreases the student's motivation (Marshman et al., 2018), use of proper learning strategies (Pintrich, 2003; Zimmerman, 2000), perseverance (Bandura, 1991) and finally grades and degrees in education. The influence of role models on self-efficacy shows that not having a proper role model from the start of their upbringing all the way to the end of higher education, decreases female student's motivation and chances of having a successful career in physics or computer science (Opare, 2012).

Role models come in different forms, for example someone in a person's direct environment (Wiese & Freund, 2011), someone famous, teachers (Master, Cheryan, & Meltzoff, 2014), or people they can read about in newspapers, magazines and textbooks (Good, Woodzicka, & Wingfield, 2010; Harrison, 2001; Hutchinson & Torres, 1994). For secondary education, our field of study, role models can be individuals in a student's direct and indirect environment, or fictional and non-fictional individuals found in their textbooks. Not every individual present will be a role model: different aspects such as relevance to the subject (i.e., having a job within the subject's industry), framing (i.e. whether portrayed to be capable or not), amount of mentions and the context (i.e. compared to other individuals in the same sentence or paragraph) may lead to an individual to become a role model (Bakken, 2005). Creating a female role model in a student's direct or indirect environment is not always easy and may be paradoxical: it requires enough females in the STEM sector to begin with. However, secondary-education textbooks are very flexible in this regard, as individuals in these books may be fictional. The text can be readily altered to add new fictional female individuals or change the gender of existing fictional male individuals.

Gender-bias in role model availability.

Two different ways in which gender-bias may be present in the presentation of individuals, and thus availability of role models, are that of (qualitative) stereotypical framing and that of (quantitative) numerical differences (Lockwood, 2006).

In the Netherlands, the problem of stereotypical framing has been studied before. The Netherlands scores highest on gender-stereotypical images of science and engineering when compared to other countries (van der Molen, 2020), indicating a large gender-bias. Stereotypical framing of genders includes the usage of different characteristics to describe different genders. For example, males are often expected and portrayed to have 'agency' characteristics such as being achievement oriented, inclined to take charge, be autonomous and be rational (Heilman, 2012). Contrarily, females are often expected and portrayed to have 'communality' characteristics such as concern for others, being affiliative, emotional sensitive and subservient. Apart from being expected and often portrayed to have the characteristics of their gender, males and females are expected to lack the characteristics of the opposite gender: males are not expected to be affiliative, and females are not expected to be achievement oriented. (Heilman, 2012)

The havo 4 physics book of *Nova natuurkunde,* which is part of our study, illustrates the gender-stereotypical framing very well within some of its assignments, for example: (freely translated from Dutch) *"Michelle is driving with a speed of 15 m s–1 to her work. She realizes that she has forgotten her driver's license and so she brakes"* (Cremers, Lenders, & Molin, 2018, p. 49). Forgetting something is the opposite of being rational, a stereotypical 'agency' characteristic of males. Moreover: (freely translated from Dutch) *"Jos is someone who likes do drive fast. A SPECS average speed measuring starts at t = 0 s. Jos overtakes another driver while going 140 km/h. The overtaking manoeuvre takes a total of 15 s. The SPECS average speed measuring is 1,5 km long. With which constant speed may Jos drive for the rest of the 1,5 km without his average speed going over the limit of 120 km/h?"* (Cremers et al., 2018, p. 33). Driving too fast falls within the 'agency' characteristic of 'taking charge' and is the opposite of the female-stereotype 'communality' characteristic of being 'subservient'.

While the presence of gender-bias in framing and stereotypical presentation of role models is evidently present, not much is known in the Dutch fields of physics, engineering, and computer sciences about the presence of gender-bias in quantitative (numerical) usage of role models. Such quantitative gender-bias has however been studied in textbooks from other countries or subjects. For example, in science textbooks from Brunei, far more men are mentioned – and woman are almost never presented with relevant occupations (Elgar, 2004a). Furthermore, in EFL textbooks from Belgium and the UK, more males are mentioned and males are more likely to be non-fictional (Craeynest, 2015). Similarly, in 12 different introductory textbooks on American government and politics, women are highly underrepresented with only 28% of all texts, sidebars, citations, figures and tables including (any) women (Olivo, 2012). Similar biases have been found in German mathematics textbooks (Ott, 2014) and language textbooks from Australia and Hong Kong (Lee & Collins, 2010).

Method

This study explores the presence of a gender bias in role model presentation in Dutch secondary education, specifically on the subjects of physics and computer sciences. The study focusses on Dutch students of two age groups, namely on students after- and students just before choosing a study program for higher secondary education. These students are respectively (by average) at the age of 15 to 18, and 13 to 15. With respect to the first group, we aim to gain insight into the presence of a quantitative gender bias in role model availability within Dutch (STEM) education textbooks. Among the second group we aim to explore why these girls are interested in physics and computer sciences, and to see in what way this is influenced by the presence of role models. For these two purposes, this study's methodology consists out of two parts:

(1) A quantitative analysis of secondary education textbooks for the years after choosing a study program, specifically havo 4, havo 5, vwo 4, vwo 5 and vwo 6: *Is there a gender bias in role model availability in physics and computer science textbooks used in higher secondary education*?

(2) A mixed-method analysis of questionnaires handed out to girls of the age 13-15 whom have indicated that they are interested in the subjects of physics and computer sciences. These girls are at the level of 3 havo or 3 vwo and are busy deciding what study program to enlist in for higher secondary education: *To what extent do these students have role models for STEM, and in what way this influences them into choosing for these subjects*?

Secondary education textbooks

The textbook analysis was performed on the physics books of *Nova natuurkunde* and the computer science books of *Fundament informatica*. We have chosen for these books specifically as these are the ones that are used most commonly for both subjects in the Netherlands. The publishers of both *Nova natuurkunde* and *Fundament informatica* have been notified, and they have submitted their books voluntarily. *Nova natuurkunde* has separate books for each level, while *Fundament informatica* uses a different combination from a set list of books (called domains by the publisher, see table 1) for the different levels of education (Instruct, 2019). For a list with the specific books that have been analysed for this study, see table 1 below. The analysis itself has been done solely by Koos Bax in the period of August – October 2020.

Table 1: List of books and domains that are part of this study. We have selected all the *Nova natuurkunde* books for the years havo 4 through vwo 6. As *Fundament informatica* does not work with books but domains, we have analysed all models that are used for the same years; havo 4 through vwo 6. All books and domains are of editions that are used in secondary education at the time of this study.

Physics	Edition
Nova natuurkunde havo 4	2018
Nova natuurkunde havo 5	2019
Nova natuurkunde vwo 4	2018-2019
Nova natuurkunde vwo 5	2019
Nova natuurkunde vwo 6	2020

Computer sciences	Edition
Fundament informatica domain A	2018
Fundament informatica domain B	2018
Fundament informatica domain C	2018
Fundament informatica domain D	2018
Fundament informatica domain E	2018
Fundament informatica domain F	2018

Textbook analysis tool

To reach our goal for the textbook analysis; *to gain insight into the presence of a gender bias in role model availability*, we have analysed all books and domains using a tool in the form of a Microsoft Excel table. This tool is specifically created for this study, based on previous textbook analyses and studies on role models (table 2). As stereotypical framing and context has been studied before, these are not part of the analysis tool used in this study (van der Molen, 2020).

Table 2: Analysis tool used in the textbook analysis.

Individual	Gender	Firstness	Occupation	Educ. Level	Relevance	Existence	Time
Unique for each individual	*Male/ Female/ Unknown*	*1st in sentence / 2nd in sentence / 1st in paragraph / 2nd in paragraph*	*Any mentioned occupation/ Unknown occupation*	*MBO/ HBO/ WO*	*Relevant/ Irrelevant*	*Fictional / non-fictional*	*Historical / Contemporary*

Individuals

To study the gender-bias in role model use, we noted each individual who we encountered in the books with a unique code (see table 2). The unique code is used to differentiate between individuals with the same name, and to be able to see how many times the same individual is mentioned. Counting the different individuals this way is a method derived from a psychology textbook analysis by Hogben and Waterman, with the alteration that we focussed on theory text and assignment text in addition to only the images used in their study (Hogben & Waterman, 1997). We opted to include text as, in contrast to the books used in the study by Hogben and Waterman, the physics and computer sciences textbooks that are part of this study have a limited number of images (Bemmel & Koopman, 2019, 2018, 2020; Cremers et al., 2018; Cremers, Lenders, & Molin, 2019) and it is not only images that influence the readers (Peeters et al., 2010).

Furthermore, we have differentiated between different unique individuals, meaning that an individual that is mentioned or portrayed 2 or more times, is collected as such by noting down the same unique individual code 2 or more times (see table 3 for an example). However, for fictional individuals, who are mentioned without a full name, we have differentiated only within the same chapter. For example, someone who is simply called ‘John’ will be given a unique code, and any other John in the same chapter will be given the same code. If there is however a ‘John’ in the next chapter as well, this second ‘John’ will receive a new unique code. In contrast, individuals who are non-fictional will receive a code that is unique across all books and chapters. For example, Albert Einstein in *Nova natuurkunde havo 4* chapter 1 receives the same unique code as Albert Einstein in *Nova natuurkunde vwo 5* chapter 9 (see table 3 for an example). We have differentiated this way between fictional and non-fictional individuals because we expect the readers to see Einstein as the same person across books (and thus the same role model) but to see each new ‘John’ as a separate person.

Table 3: Example of the analysis tool in use. An example of the data, as acquired during the analysis of the *Nova natuurkunde* havo 4 and vwo 5 books. It illustrates how an individual who is mentioned or portrayed twice keeps the same unique code, and that non-fictional individuals keep this code across all books.

Individual	Gender	Firstness	Occupation	Educ. Level	Relevance	Existence	Time of Fame	Additional Remarks
62	*Male*	/	*Physicist*	*WO*	*Relevant*	*Non-fictional*	*Historical*	/
62	*Male*	/	*Physicist*	*WO*	*Relevant*	*Non-fictional*	*Historical*	/
63	*Male*	/	*Unknown*	/	/	/	/	/
64	*Male*	/	*Unknown*	/	/	/	/	/
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
641	*Female*	/	*Unknown*	/	/	/	/	/
62	*Male*	/	*Physicist*	*WO*	*Relevant*	*Non-fictional*	*Historical*	/

Empirical basis of the textbook analysis tool

The first aspect which the tool analyses is the quantity in presence of female individuals within the books compared to male individuals. These individuals may then form role models for the readers. The options here are (1) female and (2) male. With the gender of each individual and a unique code per individual we can compare both the number of gendered individuals, as well as how often each of these individuals are mentioned. This combination of absolute numbers and how often individuals are mentioned is derived from an American History textbook analysis (Chick, 2006). Moreover, the number of times each individual is being mentioned indicates whether this person is important, and thus whether he or she is good at what he or she does (Bakken, 2005).

The second aspect which we analysed is 'firstness'; the sequence in which male and female individuals are mentioned in the books. The options here are (1) first in the sentence, (2) second (or more) in the sentence, (3) first in the paragraph and lastly (4) second (or more) in the paragraph. This method of analysing the hierarchy between the different genders has been adapted from Kultur et al. (2009). If either gender is (by average) mentioned later than the other, this indicates a gender-bias in hierarchy, and thus a negative status for the gender mentioned last.

The third aspect which we analysed is the occupation of the individuals. For each individual mentioned in the books, we noted down their occupation if any was given. The individuals without a known occupation received the code 'unknown'. The occupations are then used for the fourth and fifth aspects: education level and relevance.

For education level we have collected the required level of education for an individual's occupation, differentiating between the Dutch higher education levels of MBO (senior secondary vocational education), HBO (university of applied sciences) and WO (university). These three different levels of education are included in the tool in table 2. To differentiate between these 3 levels, we have made use of the Dutch database of occupations, the *nationale beroepen gids* (NBG, 2020).

For relevance we have noted down whether the occupation is by educational means relevant to the subject of the book at hand; physics for any individuals in the *Nova natuurkunde* books and computer sciences for any individuals in the *Fundament informatica* domains. Options here are (1) relevant and (2) irrelevant. Occupations that require higher education in those fields are noted down as 'relevant', while those who do not are noted down as 'irrelevant' (table 2). Which education is needed for which occupation, is also derived from the Dutch website 'nationale beroepen gids' (NBG, 2020). Both the needed level of education and the relevance to the field of study helps us determine if an individual may form a role model specifically for the fields of physics, engineering, or computer sciences; a female who has a higher education and occupation that is relevant to either of those fields (such as the astronaut Jessica Meir) forms a better role model for a career in physics, engineering, or computer sciences. than a female who is portrayed as a stay-at-home mom (such as a generic 'Anne') (Fahlgren & Sawyer, 2011).

The sixth and seventh aspects which we analysed are whether an individual actually exists or not, and when the individual exist(ed); whether the individuals are fictional or not, and for those who are non-fictional whether they were active in their field during or before the life of our readers. For being fictional or not, the options in the tool are (1) fictional and (2) non-fictional (table 2). For time of existence the options are (1) contemporary and (2) historical, with the former given to those who still are or have been active in the fields of physics, engineering, or computer sciences during the life of the readers. Thus, for the havo 4 and vwo 4 books, anyone still active after 2006 is considered contemporary, with the student's age of 15 in mind. For the havo 5 and vwo 5 books anyone post 2005 is considered contemporary and for vwo 6 anyone post 2004. The differentiation between contemporary and historical individuals is based on the fact that individuals who have been active in the fields of physics, engineering or computer science may form a direct role model to the students who could be part of the same field in a couple of years. This stands in contrast to those who are not active anymore, and thus do not represent the fields of physics, engineering, or computer sciences as they are today. Moreover, we aim to explore whether the any found gender-bias in role model availability is related to the historical gender-gap in STEM: are there less females in the books because of the historical gender-gap or not.

Procedure of result analysis

For the statistical analysis of the results, we have used the program R studio, R version 4.0.2. The same program is used for both the *Nova natuurkunde* and *Fundament informatica* books separately. Any found differences between genders are determined as significant when the relevant tests turn out a p-value of <0.05. Any p value smaller than 0.001 is not written down in detail but instead indicated as <0.001. Before running each statistical test, we checked for normal distribution and any other assumptions for the test at hand. When these assumptions were not met, alternative tests have been used (see below). For importing the data into R, creating figures, and using statistical tests, we have used the R packages "ggplot2", "plyr", "readxl", "FSA" and "extrafont".

Statistical tests

To test the number of unique male and female individuals, we have used the Exact Binomial Test as the data is not normally distributed. The same test has been used to see whether there are more male or female non-fictional individuals. Moreover, to test the number of mentions of each individual, and how this correlates with gender, we have used the Wilcoxon Signed Rank Tests, as the data is not normally distributed. This test is also used to see whether non-fictional males or females are mentioned more frequently. To see whether males or females are more likely to have an occupation that requires a certain level of education (MBO, HBO or WO), we have used the Pearson's Chi-squared Test for Count Data. This same test has also been used to see whether males or females are more likely to have an occupation that is relevant or irrelevant to the field of the textbook at hand. Similarly, to see whether there are more non-fictional contemporary or historical males than females, we have used the Pearson's Chi-squared Test for Count Data. This same test has been used when incorporating relevance; to see if non-fictional males or non-fictional females are more likely to be both relevant and historical or contemporary.

Girls Club IN Questionnaires

We handed out questionnaires to girls at the age of 13-15, who are busy deciding what study program to follow during their higher secondary education. This age group has been selected as there is a smaller gender gap within the different STEM subjects at this stage, in contrast to several years later (Techniekpact, 2020). Moreover, at this exact stage in secondary education, the students are busy deciding what direction they want to go in for the rest of their education: it is therefore a critical point for the emergence of the gender-gap in STEM.

The participants of this study are 24 girls that are part of a U-talent project called *Girls Club IN* (n=24). We have chosen for this group in particular as the project at hand, *Girls Club IN,* is focussed on the two subjects of our study: physics and computer sciences. U-talent is an initiative by Utrecht University to increase the quality of secondary education and help in the transition from secondary to higher/tertiary education ("U-Talent | Over U-Talent," n.d.). The *Girls Club IN* project itself is developed to bring female student together who are interested in the fields of physics and computer sciences ("U-Talent | Girls Club IN: informatica en natuurkunde voor meiden," n.d.). The participants of the project come from 12 different schools in the vicinity of Utrecht only. The 24 girls who are part of this project are thus representative to female students of the age 13-15 who are interested in the subjects of physics, engineering, or computer sciences.

The questionnaire

The questionnaire itself is in Dutch and includes 22 questions. 10 of these are relevant to this study, with the other 12 being focussed on evaluating the project itself. The full questionnaire (in Dutch) can be found in the appendix. We have not included more questions as a questionnaire that is too long tends to get biased results, with participants not answering questions truthfully due to lack of interest or concentration (Galesic & Bosnjak, 2009; Lund & Gram, 1998; Rolstad, Adler, & Rydén, 2011). The list of questions that are used for this study is presented below (table 4). Among the 10 relevant questions, seven use a 5-scale Likert-scale and three are open-ended. The questionnaire was handed out at the end of the last physical meeting of the *Girls Club IN* project of 2020, on October the 27th. The questionnaires were printed on paper, and each student was given some time to answer the questions at the end of the *Girls Club IN* meeting.

Table 4: list of questions that are part of this study. all questions below have been translated from Dutch. Questions in light blue were already part of the original (evaluative) questionnaire, while questions in light green have been added specifically for this study.

1	*I have friends who are interested in the subjects of physics and/or computer sciences*	Likert
2	*My parent's job has something to do with physics and/or computer sciences*	Likert
3	*Which female or male scientists do you know of, in the fields of physics and computer sciences? They may be both alive and dead*	Open
4	*Other people think that STEM-subjects are not really meant for girls*	Likert
5	*I think STEM-subjects are not really meant for girls*	Likert
6	*My textbooks give me the idea that physics/computer sciences are meant for boys*	Likert
7	*Others stimulate me to do something STEM-related when I choose my future education*	Likert
8	*I only want to study something if others feel that it fits me well*	Likert
9	*Who are important for you when you decide what courses to take or what study program you are going to take?*	Open
10	*Will you go study something related to physics or computer sciences, Why or why not?*	Open

Empirical basis of the questionnaire

The 10 questions that are part of this study are based on role model theory and the different known influences on the existent gender-gap in the fields of physics, engineering, and computer sciences. Firstly, questions 1, 2 and 3 (table 4) are focused on the different forms in which role models can exist. These questions are aimed at finding out whether our participants have role models, and if they do, in which form (Beede et al., 2011; Sealy & Singh, 2009). Secondly, questions 4, 5 and 6 are focussed on the possible result of the previous 3 questions; the view that our participants have of the fields of physics, engineering, and computer sciences: do they believe that these subjects are for girls too and that it is normal for a female to work in these fields (Cheryan et al., 2015; Cheryan & Plaut, 2010). Thirdly, the questions 7, 8 and 9 are focussed on the influences of our participant's direct environment when it comes to choosing an education or career path; who is important and in what way? Lastly, question 10 is aimed at finding out why and if our participants are planning on pursuing future education in the fields of physics, engineering, or computer sciences.

Procedure of result analysis

All the answers to the questions have been anonymized by the head of the *Girls Club IN* project, before they were handed over to this study and imported in Microsoft Excel. All questions that include a Likert-scale have been manually recoded to numerical levels, with the most negative "*Fully disagree"* being changed to 1, all the way to the most positive "*Fully agree"* being changed to 5. Similarly, we have recoded the number of famous individuals that are mentioned by the participants into absolute numbers and divided these between females and males. For example, a participant mentioning Marie Curie, Albert Einstein, Isaac Newton and Archimedes, results in 1 female and 3 males.

The data was then imported into R studio, R version 4.0.2. The R package 'ggplot2' is used to create figures (figure 5; table 11). Furthermore, the analysis of question 9 is done with deductive coding, with the pre-set coded including "me", "friends", "parents", "mentor", "teachers", "other family members", "other people I know" and finally "famous person" (table 10). These codes have been set up, keeping the different role models in mind that girls of this age may have (van der Molen, 2020). Furthermore, because of the explorative nature of the last question, question 10 is inductively coded. The codes that have been inductively set up for this question include "*yes and knowing what exactly*", "*yes and knowing a lot of options*", "*yes because interesting/fun*", "*yes but not knowing a lot of options*", "*yes but not knowing what*", "*no because knowing what*" and finally "*no, not knowing what it is*" (table 9).

Results

Textbook analysis

Below, we have set out the results of the quantitative textbook analysis on the physics and computer sciences books for the last 3 years of secondary education. The results include the 5 *Nova natuurkunde* books (4 havo, 5 havo, 4 vwo, 5 vwo and 6 vwo) and 6 *Fundament informatica* domains (A, B, C, D, E and F). In all *Nova natuurkunde* books combined, there are a total of 387 individuals of whom 27.1% are female and 72.9% are male. In all the *Fundament informatica* domains combined, there are a total of 192 individuals, of whom 35.9% are female and 64.1% are male. (table 5)

Table 5: Proportions of individuals in all the *Nova natuurkunde* books and *Fundament informatica* domains combined. The percentages of females and males are relative to the total number in the same row, 8 out of 119 non-fictional females is the same as 6,7%.

		Total	Female		Male	
Nova	Total	387	105	27.1%	282	72.9%
	Non-fictional	119	8	6.7%	111	93.3%
	Have an occupation	185	24	13.0%	161	87.0%
Fundament	Total	192	69	35.9%	123	64.1%
	Non-fictional	22	0	0.0%	22	100.0%
	Have an occupation	39	3	7.7%	36	92.3%

Firstly, it is important to note that for both the *Nova natuurkunde* books as well as the *Fundament informatica* domains, most of the individuals that are mentioned are 'just names'; fictional characters created by the authors of the books/domains to illustrate assignments or explain theory.

For all the *Nova natuurkunde* books combined, only 119 of the 387 individuals are non-fiction; existing people that lay at the basis of discoveries in the fields of physics and computer sciences (such as Albert Einstein, Galileo Galilei, Marie Curie etc.), or people that are used as object in one of the many assignments in the books' and domains' chapters (such as Daphne Schippers or Felix Baumgartner for assignments about speed calculations and gravitational acceleration respectively). For *Fundament*, even a smaller portion of all individuals is non-fictional and actually exist; only 22 of the 192 individuals (table 5).

Furthermore, only 185 of all 387 individuals in the *Nova natuurkunde* books combined, and 39 of all 192 individuals from the *Fundament informatica* domains combined, are presented with an occupation. This includes individuals who are mentioned by name and their occupation, and individuals who are only mentioned by their occupation. An example for the former is (freely translated from Dutch): *"….Is named after the English physicist James Prescott Joule..."* (Cremers, Lenders, & Molin, 2018, p. 208). An example for the latter is (freely translated from Dutch): *"…the police agent gives the position of the Audi the name 'xA'. This is the distance between him and the car…"* (Bemmel & Koopman, 2020, p. 167).

Individuals and number of mentions

As becomes clear from table 5, there are more male than female individuals in both the *Nova natuurkunde* books and the *Fundament informatica* domains. This difference in number of individuals is significant, with 2.69 male individuals for every female in the *Nova natuurkunde* books (Binominal test, $p < 0.001$), and 1.78 male individuals for each female in the *Fundament informatica* domains

(Binominal test, $p < 0.001$). Thus, for both physics and computer sciences, there are more male individuals than there are females.

However, the total number of unique individuals does not say everything about these individuals being role models: the number of times each individual is being mentioned indicates whether this person is important, and whether he or she is good at what he or she does (Bakken, 2005). For example, the male physicist Galileo Galilei is mentioned 11 times in total in all the *Nova* books combined, compared to Marie Curie being mentioned 4 times in the same books. Looking at the amount of mentions off all individuals, we see that in all the *Nova natuurkunde* books combined, males are mentioned by average 2.19 times and females 2.09 times (Wilcoxon rank sum test, $p = 0.78$). Similarly, of all individuals in the *Fundament informatica* domains combined, male individuals are mentioned by average 2.45 times and females 2.25 times (Wilcoxon rank sum test, $p = 0.41$).

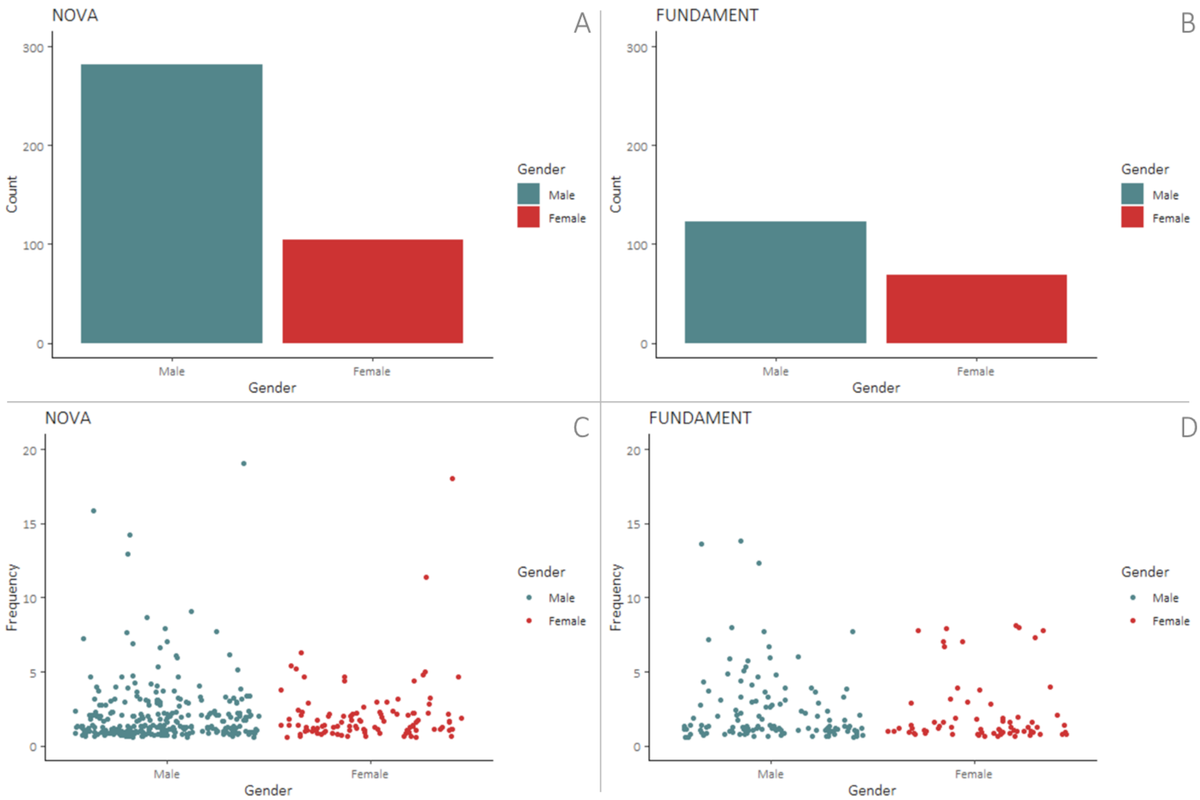


Figure 1: number and frequency of unique individuals. A) the total number of male and female unique individuals in *Nova natuurkunde* on the y-axis. B) the total number of male and female unique individuals in *Fundament informatica* on the y-axis. C) the frequency by which male and female unique individuals are mentioned in *Nova natuurkunde* on the y-axis. D) the frequency by which male and female unique individuals are mentioned in *Fundament informatica* on the y-axis. For both C and D, each dot represents a unique individual. Deviation on the x-axis between dots is for image-readability only; it is there to keep the dots from overlapping.

Occupations

Apart from concrete numbers of male and female individuals, and the number of times by which they are mentioned, much can be said about how these individuals may form role models for the readers by the way in which they are presented; what do they do? When it comes to forming a role model for the subject of physics, there is a sharp contrast between individuals who spend their day working as a physicist or as a house mom (Master et al., 2014; Wiese & Freund, 2011).

Thus, we analysed whether individuals are portrayed with having an occupation, and then what kind of occupation they are portrayed with. As can be seen in table 6, female individuals are less likely to be presented with any occupation in both the *Nova natuurkunde* books, as well as the *Fundament informatica* domains. While in the *Nova* books 27.1% of all individuals are female, an even smaller proportion of 12.5% of all individuals with an occupation is female (decrease of 14.6%). Similarly, in the *Fundament* domains, 35.9% of all individuals is female, and only 7.7% of all individuals with an occupation is female (decrease of 28.2%). (table 6)

Table 6: Individuals with occupations in *Nova natuurkunde* and *Fundament informatica*. The different occupations are further divided in relevance to STEM and required level of education.

		Total	Female		Male	
Nova	Total individuals…	387	105	27.1%	282	72.9%
	…that have an occupation	184	23	12.5%	161	87.5%
	…which requires WO level	113	9	8.0%	104	92.0%
	…which requires HBO level	15	2	13.3%	13	86.7%
	…which requires MBO level	56	12	21.4%	44	78.6%
	…which is relevant to STEM	108	7	6.5%	101	93.5%
	…which is irrelevant to STEM	77	17	22.1%	60	77.9%
Fundament	Total individuals…	192	69	35.9%	123	64.1%
	...that have an occupation	39	3	7.7%	36	92.3%
	…which requires WO level	28	2	7.1%	26	92.9%
	…which requires HBO level	7	0	0.0%	7	100.0%
	…which requires MBO level	4	1	25.0%	3	75.0%
	…which is relevant to STEM	23	1	4.4%	22	95.7%
	…which is irrelevant to STEM	16	2	12.5%	14	87.5%

Education Requirements

Apart from having or not having an occupation, the kind of occupation says a lot about how the individuals that are mentioned in the books and domains influence the readers, or what kind of role model they may form for them (Lockwood, 2006). For example, one of the female individuals in the *Nova natuurkunde* books who is mentioned most frequently, is the Dutch athlete Daphne Schippers. As being a professional athlete does not really require any higher education, Daphne Schippers will probably not form a role model when it comes to pursuing higher education either.

For the *Nova natuurkunde* books, we can see that females are more likely to have an occupation that requires either MBO or HBO level than having an occupation that requires WO level (table 6). For example, out of the 27.1% of all individuals being female, only 12.5% off all individuals that have any occupation is female, and an even smaller proportion 8.0% off all individuals that specifically have an WO-level occupation is female. Contrarily, males are most likely to have an occupation with WO level of education: while 72.9% of all individuals is male, 87.5% of all individuals with an occupation being male, and an even larger proportion of 92.0% of all individuals with a WO level occupation is male (table 6, figure 2).

The *Fundament informatica* domains show similar results, with the difference between males and females being the smallest for the occupations that require MBO-level (75.0% male, 25.0% female), and largest for the occupations that require WO-level (92.3% male, 7.7% female). However, the *Fundament* domains also have no female individuals with an occupation that requires HBO level of education at all (table 6, figure 2).

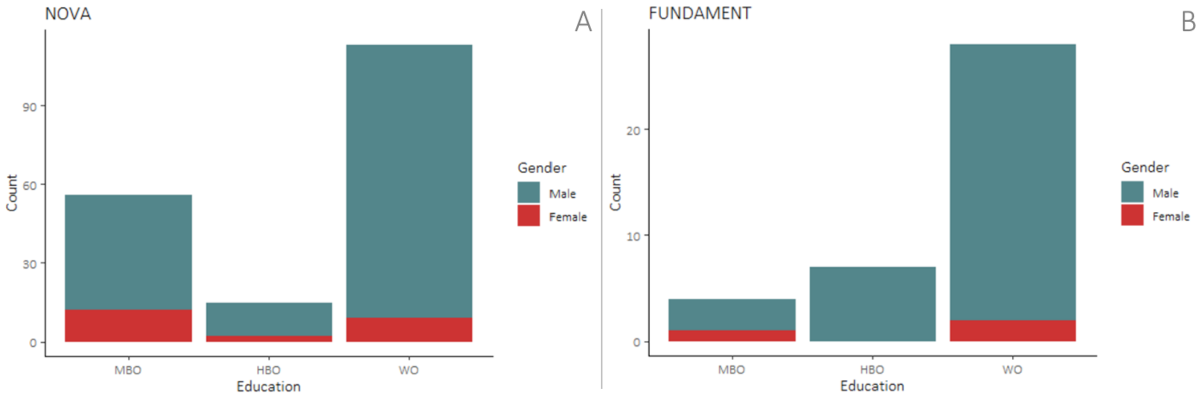


Figure 2: the needed level of education for the occupations that male and female individuals are portrayed with. The numbers are presented for A) *Nova natuurkunde* and B) *Fundament informatica.* Note: the y-axis is not the same for both subjects, with *Fundament informatica* having a much smaller number of total individuals.

Relevance

Apart from having an occupation that requires a certain level of education, the relevance of the occupation to the fields of physics, engineering, or computer sciences is also important when it comes to these individuals forming role models for these fields. For example, when we take another look at the most-mentioned female individual, Daphne Schippers, the occupation of 'professional athlete' is not really relevant to the field of physics. Therefore, Daphne Schippers will probably not (positively) contribute to the choice of female students to pursue anything academical or professional related to physics either. Contrarily, one of the most-mentioned male individuals, Albert Einstein, had an occupation that is very relevant to the field of physics, making Einstein far more likely to be a role model for this field specifically (van der Molen, 2020). Thus, we analysed whether the female and male individuals who are presented in both *Nova natuurkunde* and *Fundament informatica* have an occupation that is relevant to either field (table 6).

In the *Nova natuurkunde* books, from the 108 individuals who have an occupation that is relevant to physics, only 7 are female and 101 are male. That is respectively 6.5% and 93.5%. However, as indicated earlier, there are more males with an occupation to begin with – making it more likely that they have an occupation that is relevant too. However, if we only look at the likeliness to have a relevant occupation compared to having an irrelevant occupation, the bias between males and females is still present: out of the 161 males who have any occupation, 101 have an occupation that is relevant to the field of physics (62.7%). For females, from the 24 individuals that have any occupation, 7 have an occupation that is relevant to physics (30.4%). That is less than half of the percentage of males, indicating that males are more likely to have a relevant occupation (Chi-squared test, p = 0.004).

In the *Fundament informatica* domains, from the 23 individuals who have a job that is relevant to computer sciences, 22 is male and only 1 is female (95.7% vs. 4.3%). However, here too males have more occupations in general. Looking at the likeliness to have an irrelevant or a relevant occupation however, we see that here too males are more likely to have a relevant job: out of the 36 male individuals with any occupation, 22 have one that is relevant to computer sciences (61.1%). For females, out of the 3 females with any occupation, only 1 has one that is relevant to computer sciences (33.3%). So, here too, the percentage of males having a relevant occupation is almost double that of females. However, the total number of females present in the *Fundament informatica* domains is too small to turn out any significant data (Chi-squared test, p = 0.74).

Fictional and Non-fictional individuals

Apart from an individual's occupation or the number by which they are mentioned, another aspect that influences whether he or she forms a role model for the readers is whether they are fictional or non-fictional: whether they exist in the student's world or are completely imaginary (Drury, Siy, & Cheryan, 2011). For example, a successful computer-software developer such as Steve Jobs or Bill gates give a more representative image (and thus role model) for the field of computer sciences, and thus forms a better role model than a fictional 'John' who allegedly started his own IT company but who in reality does not really exist. Thus, we took the total number of individuals that are mentioned in the *Nova natuurkunde* books combined and the *Fundament informatica* domains combined and differentiated between fictional and non-fictional individuals (table 7).

Table 7: Proportion of fictional and non-fictional individuals. Non-fictional individuals are further divided into contemporary and historical figures.

		Total	Male		Female	
Nova	Total individuals…	387	282	72.9%	105	27.1%
	…that are non-fictional	119	111	93.3%	8	6.7%
	…and historical	67	66	98.5%	1	1.5%
	…and contemporary	52	45	86.5%	7	13.5%
	…that are fictional	268	171	63.8%	97	36.2%
Fundament	Total individuals…	192	123	64.1%	69	35.9%
	…that are non-fictional	18	18	100.0%	0	0.0%
	…and historical	2	2	100.0%	0	0.0%
	…and contemporary	16	16	100.0%	0	0.0%
	…that are fictional	156	87	55.8%	69	44.2%

When we compare the ratio of males to females of all individuals within the *Nova natuurkunde* books and compare this with the ratio of males to females of individuals who are non-fictional in the *Nova natuurkunde* books, we can see that there are significantly less female non-fictional individuals: 23.1% of all individuals is female, only 6.7% of non-fictional individuals (Chi-squared test, $p < 0.001$). For *Fundament informatica,* the difference between male and female non-fictional individuals is even greater: there are no non-fictional female in any of the domains, compared to 18 non-fictional males.

Apart from absolute numbers, we have also analysed how often these non-fictional individuals are mentioned - and whether this is different for females and males (figure 3). While there is indeed a difference here (male non-fictional individuals are mentioned by average 2.57 times, females 3.5

times), it is not significant due to the small sample size of female non-fictional individuals (Wilcoxon SR test, p = 0.4915).

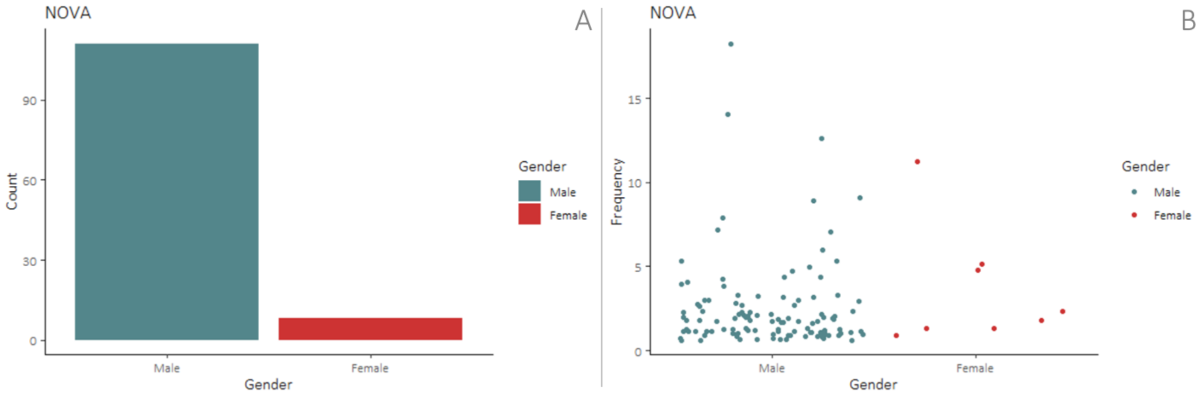


Figure 3: Number and frequency of non-fictional individuals in *Nova natuurkunde*. A) the total number of male and female non-fictional individuals. B) the frequency by which the non-fictional individuals are mentioned within the books.

Historical or Contemporary

Apart from being non-fictional or fictional, it is also important whether the individuals are part of the existing world of the readers, in order for them to be seen as role models (González-Pérez, Mateos de Cabo, & Sáinz, 2020; Lockwood, 2006). For example, Galilei Galileo would be less likely to become a role model since he lived in the 17th century, than Steve Jobs or Bill Gates would. In our analysis we have therefor differentiated between these two kinds of non-fictional individuals by classifying them as either 'historical' or 'contemporary' (table 7).

For *Nova natuurkunde*, there are more historical non-fictional individuals in total (67 historical compared to 52 contemporary), of whom 66 are male (98.5%). Among the contemporary non-fictional individuals, the difference is smaller: 13.5% is female, or 7 out of 52 individuals (Chi-squared test, p = 0.0266). Contrarily, in all *Fundament informatica* domains combined, the most non-fictional individuals are contemporary (16 out of 18). However, there are no non-fictional females among them, thus making a comparison between males and females redundant (table 7).

Relevance of non-fictional individuals.

The tests on the differences between males and females when it comes to required level of education, relevance of occupation and being fictional or non-fictional all indicate a clear gender bias: males are portrayed with occupations that (by average) require a higher level of education, that are more often relevant to the subjects of physics, engineering, and computer sciences, and in both the books and domains males are less likely to be fictional, to be made up. However, the differentiation between being a contemporary or historical figure indicates that the gender-gap is most prominently present among historical individuals (1 female) and less among contemporary individuals (7 females). This indicates that the present gender-gap might decreasing.

Nevertheless, there is still the case of Daphne Schippers, the well-known Dutch athlete. She is also part of the 7 females who are non-fictional and contemporary. However, as stated before; with her profession she is not really relevant when it comes to creating female role models for the fields of physics, engineering, or computer sciences. Thus, we have combined the study of relevance of occupation with that of being either historical or contemporary: we have looked at all non-fictional individuals in the *Nova natuurkunde* books combined (Again, due to absence of non-fictional females this cannot be done with *Fundament informatica*, see table 7), checked whether they are historical or contemporary and differentiated between their occupation being relevant or irrelevant to the field of physics (figure 4).

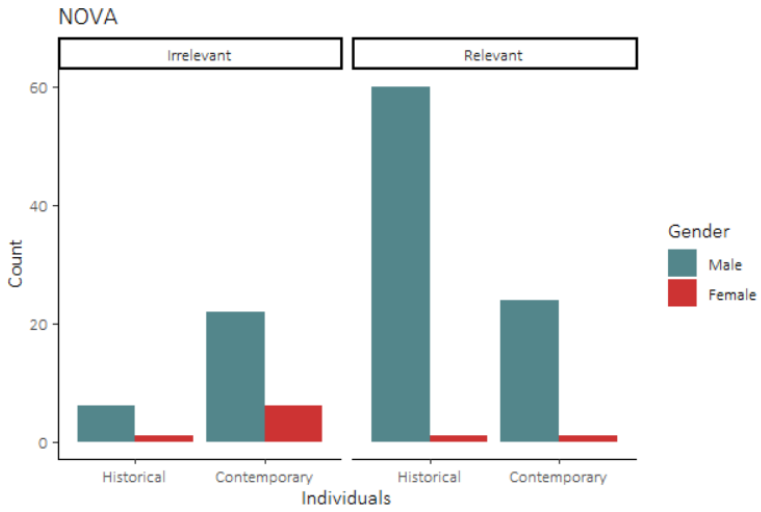


Figure 4: the non-fictional males and females divided into relevance and being either historical or contemporary. The figure shows the proportion of female and male non-fictional individuals having either an irrelevant (left half) or relevant (right half) occupation. On the x-as, the figure differentiates between historical and contemporary individuals and males (blue) and females (red). The figure shows that the increase of female non-fictional individuals is only visibly in irrelevant occupations.

As can be seen in figure 4, the increase of female non-fictional individuals over time (indicated by being historical or contemporary) is completely due to the irrelevant occupations present in the books. If we only look at the relevant non-fictional individuals, there is no increase at all; there is only 1 historical and only 1 contemporary female, respectively the physicist/chemist Marie Curie and the astronaut Jessica Meir. This indicates that while the presence of females in the fields of physics, engineering, and computer science has increased (albeit in a small number), this increase cannot be seen in the presence of female non-fictional individuals in the *Nova natuurkunde* books.

Firstness

The last part of our textbook analysis focussed on 'firstness': the presence of any in-text hierarchy between males and females in the books. We tested for this by noting down any occurrences of firstness in the books and differentiating between firstness in paragraphs and firstness in sentences (table 8).

In all the *Nova natuurkunde* books combined, firstness occurred 17 times (including sentence and paragraph firstness). These 17 cases show a trend in which males are mentioned first, in either sentences or paragraphs; indicating a hierarchy in which males are dominant. However, with only 17 cases and some combinations not happening even once (i.e., males 2nd in paragraph, see table 8), we cannot statistically test any correlation between firstness and gender.

In all the *Fundament informatica* domains combined, firstness occurred only 2 times; once with a female being mentioned first in a paragraph and once with a male being mentioned first in a paragraph. These results do not show any trend or correlation.

Table 8: firstness of individuals within the *Nova natuurkunde* books. The numbers indicate how many times firstness occurred. For each time firstness occurs, it is written down twice; once for the female and once for the male side, leading to the same but opposite numbers for males and females.

	1st in paragraph	1st in sentence	2nd in paragraph	2nd in sentence	
Male	3	9	0	5	
Female	0	5	3	9	

Questionnaires

Below, we have set out the results of the questionnaire analysis, handed out to 24 participants of the U-talent project called *Girls Club IN.* The project itself is directed at girls of the age 14-15 who have an interest in the subjects of physics and/or computer sciences. Being at this age, these girls are about to choose a study program for higher secondary education. At this stage of secondary education, the gender-gap in the fields of physics and computer sciences is almost absent (Techniekpact, 2020). The questionnaires are focussed on gaining insight into why these girls are interested in physics and computer sciences, and to see in what way this is influenced by role models. We will first have a look at our participant's choice and motivation for pursuing higher education and/or a career in physics, engineering, or computer sciences. Then, we will have a look at the presence of role models in our participant's direct and indirect environment. Finally, we will see how our participants feel these role models influence them in their choices.

Interest in physics and computer sciences

Most of the participants of our questionnaire indicate that they are interested in following higher education in the fields of physics or computer science. 21 out of 24 answer the question "*Will you go study something related to physics or computer sciences, why or why not?*") with 'yes'. The coding of the answers indicates that the most mentioned reason for being open to following higher education in these fields is finding it interesting (10 out of 21). Furthermore, 3 participants indicate that they already have a specific career in mind, and 6 that their choice for STEM is based on knowing that there are a lot of career options in STEM. The last 6 that are open to education in these fields are still doubting about their choice, 3 because they do not really know what either field entails, and 3 because they do not know whether they would have enough career choices. (table 9)

Table 9: Question coding. The table shows the coding occurrences among the answers on the question "*Will you go study something related to physics or computer sciences, Why or why not?*". The codes have been set up inductively, based on the received answers. Positive answers are marked in green, negative in red.

Code – reason for choice	Number of participants
Yes, and I know what I want exactly	2
Yes, and I know there are a lot of options	3
Yes, because I like it / I find it interesting	10
Yes, but I am not sure if there are enough options	3
Yes, but I am not sure because I do not know what it is	3
No, because I know what I want exactly	2
No, because I do not like it / I do not find it interesting	1

Role models for physics and computer sciences

Apart from our participants' choices for future education, we have analysed the presence of role models in their direct and indirect environment. 16 out of 24 students score the statement "*I have friends who are interested in the subjects of physics and/or computer sciences*" with 4 or 5 (respectively 'agree' and 'strongly agree'), and only 2 score the statement with 2 or 1 (respectively 'disagree' and 'strongly disagree'). However, only 8 out of 24 participants score the statement "*My parent's job has something to do with physics and/or computer sciences"* with a 4 or higher, compared to 13 out of 24 scoring it with a 2 or lower. (table 11) There is one participant who scores both statements with a 2 or lower. The scoring of these two statements indicates that most of our participants (23/24) have at least either a parent or a friend that is interested in either of these two fields, meaning that they have potential role models in their direct environment (Wiese & Freund, 2011).

In another question, we asked the participants to name any famous scientists in either field that they know of. Such scientists could form relevant role models, as they are known, part of the participant's living world and have an occupation that is relevant to either field (González-Pérez et al., 2020). However, the results show only 5 out of the total of 24 participants mention at least one female, compared to 20 out of 24 participants mentioning at least one male. Furthermore, many participants know multiple males, with only one participant knowing multiple females (figure 5).

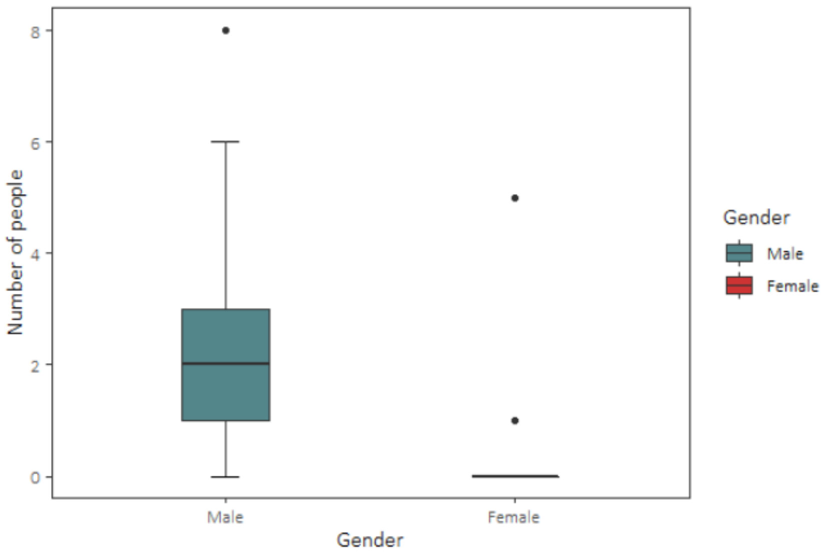


Figure 5: number of well-known scientists in the fields of physics and/or computer sciences. The boxplot shows the number of female and male well-known scientists that the participants could come up with answering the question "*Which female or male scientists do you know of, in the fields of physics and computer sciences? They may be both alive and dead"*. The y-axis shows the number of male / female scientists that the participants could come up with per participant, with the highest being 8 different male scientists mentioned by 1 participant. The dots indicate outliers.

Influence of role models

While the participants indicate that most of them have either friends or parents with an interest in physics or computer science, figure 5 indicates that most of our participants do not have any famous female role models: most of them simply do not know any female famous scientists. Does this lack of relevant role models influence our participants in their view on the fields of physics, engineering, and computer sciences?

As can be seen in table 11, our participants indicate that they do not feel like the fields of physics and/or computer sciences are not really meant for girls. Only 1 out of our 24 participants answer the statement "*I think STEM-subjects are not really meant for girls"* with 'agree', and none answer it with 'strongly agree'. However, 7 out of 24 participants answer the statement "*Other people think that STEM-subjects are not really meant for girls"* with 'agree', indicating that at nearly a third of all participants feel that other people think that females do not really belong in the fields of physics and computer sciences. What exactly has led to this idea is not clear however, as there is no correlation with the presence or absence of parents or friends with an interest in physics or computer sciences – nor is there a correlation with the number of famous female scientists they know of. Furthermore, 8 out of the 24 participants either disagree or strongly disagree with the statement "*My textbooks give* *me the idea that physics/computer sciences are meant for girls"*, indicating that a third of our participants feel that the book negatively influences them into thinking that these fields are meant for boys.

Apart from indirectly influencing our participants for choosing for STEM by letting them think that they do or do not belong – or letting them think that others believe that they do or do not belong, their environment may influence our participants directly as well. When asked who plays a role in their choices, 7 participants indicate that no-one plays a role except for they themselves, 10 participants indicate a combination of themselves and others, and 7 participants indicate that only others play a role, without mentioning themselves. Other people that play a role here are the participants' parents (12), teachers in general (6), mentors (2), other family members than the participant's parents (6) and 1 unspecified individual. (table 10)

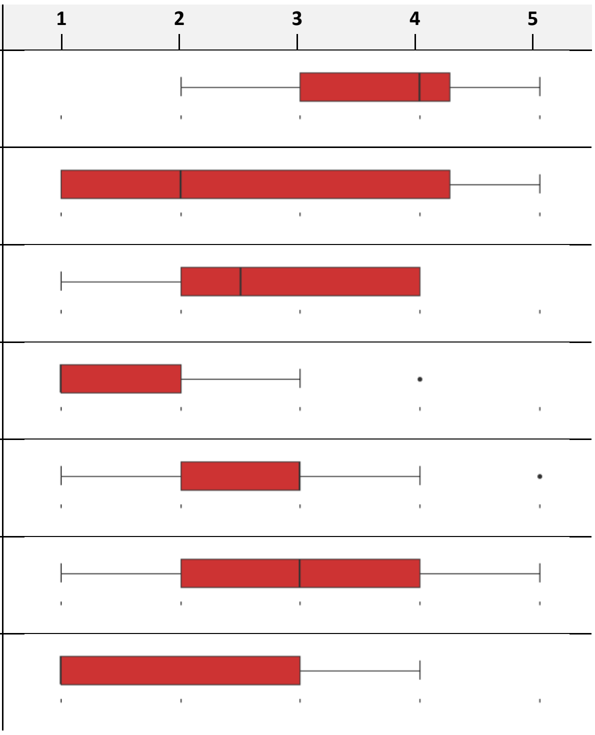
Table 10: Question coding. The table shows the coding occurrences among the answers on the question "*Who are important for you when you decide what courses to take or what study program you are going to take?".* The 24 horizontal columns each represent one of the respondents (numbered 1 to 24). The different codes, representing individuals of importance for making choices, are indicated vertically on the left side of the table. Each green block indicates that the participant's answer included the specific coding. The total by which each code (and thus individual) is mentioned among all participants is indicated on the right side of the table.

Participants →	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
Who is ↓ important																									Tot ↓
Myself		■				■	■	■		■	■		■	■	■	■	■	■	■	■	■		■	■	17
My parents	■		■	■	■				■	■		■		■		■			■		■	■			12
My teachers	■		■		■				■	■											■				6
My mentor										■											■				2
Other family		■		■								■		■					■			■			6
Famous people																									0
non-specified																		■							1

Thus, as can be seen in table 8 others do often influence our participants in their choice for future education (17/24). But how do they influence them? 8 out of the 24 participants either disagree or strongly disagree with the statement "*Others stimulate me to do something STEM-related when I choose my future education"* (table 11), but the same number of participants answer this question with 'agree' and 'strongly agree'. Furthermore, although 14 out of the 24 participants indicate that at least someone else is important when it comes to choosing their future education (table 10), not even 1 student agrees or strongly agrees with the statement "*I only want to study something if others feel that it fits me well"* (table 11). This indicates that while others may me important for them, they all believe that they themselves eventually decide what they want to do.

Table 11: Likert-scale questions. The answers are scaled from 1 to 5; “strongly disagree”, “disagree”, “neutral”, “agree” and finally “strongly agree”. The red boxes represent the interquartile range (IQR). The vertical stripe in the middle of each boxplot indicates the median of the data, the dots indicate outliers.

Question
I have friends who are interested in the subjects of physics and/or computer sciences
My parent’s job has something to do with physics and/or computer sciences
Other people think that STEM-subjects are not really meant for girls
I think STEM-subjects are not really meant for girls
My textbooks give me the idea that physics/computer sciences are meant for girls
Others stimulate me to do something STEM-related when I choose my future education
I only want to study something if others feel that it fits me well



Discussion

The aim of this explorative study was to answer the following research question: *to what extent is gender-bias present in role model availability in Dutch STEM secondary education, and whether it plays a role in the gender-gap within these fields?* We set out to answer this by analysing Dutch physics and computer sciences textbooks for the last three years of secondary education, and by handing out questionnaires to female students of the age 13-15 with an interest in these subjects. During the textbook analysis, we gained insight into the presence of a gender bias in role model availability in these textbooks. With the questionnaires, we explored the presence of role models for female students of the age 13-15, and how this influences them into choosing for physics and computer sciences.

Textbook analysis

Firstly, the results of the textbook analysis indicate that there are far fewer female individuals in both the physics and computer sciences books combined. This is in line with previous studies, for example the textbook analyses of English textbooks of the UK and Belgium in which more males are mentioned as well (Craeynest, 2015), and the 12 American politics textbooks in which females are only represented in 28% of all texts and images (Olivo, 2012).

Furthermore, the textbook analysis results indicate that male individuals are more likely to be presented with an occupation that is relevant to the field of physics or computer sciences, and an occupation that requires a higher level of education in these fields. Similar results have been found in science textbooks from Brunei, in which females are never mentioned with an occupation relevant to STEM (Elgar, 2004b). In fact, the results of our textbook analysis show that females with an occupation and education that is relevant to STEM are not only presented in far fewer numbers relatively to males, but they are present in an absolute small number as well: only 2 females with a relevant, high-level occupation are presented in all the *Nova natuurkunde* books, and none in all the *Fundament informatica* books. This illustrates STEM as a field or industry in which it is very rare for females exist and thrive, and will contribute to the persisting belief of females that they do not belong (Beede et al., 2013; Kalender et al., 2019).

Moreover, male individuals in the books are more often non-fictional than females. This too is in line with the EFL textbook analysis done by Craeynest (2015). However, this is not necessarily negative: in the introduction, we illustrated how textbooks offer the perfect opportunity to decrease the gender-bias in the image of the field, by including fictional females in STEM. After all, fictional females require no existing females in STEM to be created, effectively bypassing the existent gender-gap in the field. Although both books have apparently added quite a few fictional females, males are present in larger number here too. Thus, instead of using the flexibility of fictional individuals in textbooks to decrease the present gender-bias in the books, both publishers have not made use of this opportunity and included more males here too.

Lastly, any reader of the *Nova natuurkunde* books may be inclined to expect more historical males compared to historical females, as the gender-gap in the fields of physics and engineering has been present for a long time. However, the results indicate that there is no difference between contemporary and historical individuals who are relevant to either field. In the physics books, there is only 1 contemporary female scientist and only 1 historical female scientist - as opposed to 24 contemporary male scientists and 60 historical male scientists. Contrarily to physics, a large difference between male and female non-fictional individuals is not to be expected for the *Fundament informatica* books, as this field has not always been male dominated (Fink, 2011). Interestingly, in the newest field, the differences between males and females are the largest: there is not even one female with a relevant occupation in any of the *Fundament informatica* books. This shows us that while the still existent gender gap in these fields is and has been decreasing in educational attainment and economical participation (Schwab et al., 2012), this decrease is not represented in the books by any means.

To summarize, females are both present in smaller numbers and less often presented with a high-level education and an occupation that is relevant for pursuing a career in physics, engineering, or computer sciences. As such, both the physics and the computer sciences books show a very clear gender-bias. Both books portray a field of science in which males are the rule, and females the exception. This confirms that the secondary education physics and computer sciences books contribute to the problem; the presentation of the field as being male dominated and meant for males, which in extension leads to females believing that they do not belong (Cheryan et al., 2015).

Questionnaires

The questionnaires were handed out to 24 female students from the third year of secondary education. The participants are part of a project that is specifically focussed on girls that have an interest in the subjects of physics and computer sciences, thus our participants already have an interest in these fields. In fact, 21 out of 24 participants specifically indicate that they aim to pursue a career in STEM.

The results of the questionnaires show that most participants (23/24) have at least one parent or friend with an interest in either field. While these individuals in our participants' direct environment may form role models for STEM (Wiese & Freund, 2011), only one third of all participants indicate that they feel stimulated by the individuals in their direct environment to pursue a career in these fields. Similarly, almost none of the students (2/24) can name any female scientist, in contrast to being able to name multiple male scientists. This indicates that the students do not have female scientists to look up to either and that these female students have a lack of female role models for STEM. The fact that our participants lack female role models and do not feel stimulated to pursue a career in STEM, in line with previous research on the importance of role models and their influences on stimulating students (Beede et al., 2011; González-Pérez et al., 2020; van der Molen, 2020).

Furthermore, a third of our participants indicate that their books make them feel that they do not belong in the fields of STEM, which indicates that the found gender-bias in our textbook analysis may very well be present in the books of for these earlier years of secondary education as well. Moreover, nearly a third of the participants indicate that they think that others believe STEM to be a field for men. This idea may originate in the lack of role models showing that it is normal for females to pursue a career in STEM too (Beede et al., 2011), which may lead students to believe that they do not belong (Cheryan et al., 2015).

To summarize, our participants are part of a group of female students that already have an interest in STEM. Thus, we did expect that this group in particular would have role models to look up to, or where perhaps being stimulated more than average by their direct or in-direct environment. However, the results indicate that this is not the case: the participants do not feel stimulated by their direct environment, they do not have female scientists to look up to, and they indicate that their textbooks portray STEM as a field for men. The results of the questionnaire thus show us that the gender-bias in role model availability is not only present in the later years of secondary education as indicated by our textbook analysis, but that it is also present at the stage at which students choose their study curricula for higher secondary education.

While results illustrate that there are hardly any role models available to influence female students into choosing for STEM, this has evidently not kept our participants from still choosing for these fields. Thus, to increase the participation of females in STEM, further research is needed to understand what other aspects influence female students into choosing for these subjects, and how these can be used to the benefit of other students.

Conclusion

In this study, we aimed to explore the presence of a gender bias in role model availability in secondary education for STEM. To this purpose, we measured the presence of a gender bias in role model availability in textbooks for physics and computer sciences for the fourth, fifth, and sixth year of secondary education. Furthermore, we explored the gender-bias in role model availability for female students in the third year of secondary education via questionnaires. Results of our textbook analysis and questionnaires indicate that there is indeed a gender-bias in role model availability in Dutch secondary education on the subjects of physics and computer sciences. Female individuals in the books are present in far smaller numbers than males and are less often than males portrayed with a relevant occupation and high-level education. Moreover, there are hardly any actually existing, non-fictional female scientists in the books, compared to a large number of non-fictional male scientists.

This lack of female scientists is also found among the results of the questionnaire handed out to female students in the third year of secondary education, with our participants being largely unable to name any female scientists compared to a large number of male scientists. Moreover, this lack of available female role models may give these female students the feeling that they do not belong in STEM, as they indicate that they do not feel stimulated to pursue a career in these fields, that they think that their environment sees STEM as a field meant for males, and that this idea is also portrayed in their textbooks for both physics and computer sciences.

To conclude, the results of this study show that there is indeed a clear and large gender bias in role model availability for students in STEM, both in the third and in the fourth, fifth and sixth year of secondary education. This bias does sketch an image for students of a field in which females do not belong. Although the participants of this study indicate that they are still interested in pursuing a career in STEM, this lack of role models is likely to cause other students from entering the fields of STEM after they graduate from secondary education.

To decrease the present gender gap in the professional fields of STEM, decreasing the gender-bias in role model availability in secondary education can thus be a first step. Teachers and publishers of the books could focus on adding more female individuals with occupations that are relevant to- and require education in the subjects of physics and computer sciences. This can be done by including a lot more fictional individuals, as these require no actual females in STEM. However, there are a lot of non-fictional individuals that can be included as well. In fact, the old argument 'there are simply more men in STEM, thus there are more men in the books' is indicated to be invalid by this study: there are many important females for physics, engineering, and computer sciences who are not mentioned at all, or to a very limited extent. Shedding more light on the important role of females in STEM will help female students see that choosing for STEM *is* something for them and that they do belong there too.

While decreasing the gender-bias in role model availability in the books is something that can be easily done and will help sketch an image of a field in which females do belong as well, more research is needed to see to what extent the gender-bias in role model availability exactly contributes to the gender-gap found in the professional field of STEM.

References

Altonji, J., Arcidiacono, P., & Maurel, A. (2015). *The Analysis of Field Choice in College and Graduate School: Determinants and Wage Effects*. Cambridge, MA. https://doi.org/10.3386/w21655

Bakken, L. L. (2005). Who Are Physician–Scientists' Role Models? Gender Makes a Difference. Retrieved March 11, 2020, from https://journals-lww-com.proxy.library.uu.nl/academicmedicine/Fulltext/2005/05000/Who_Are_Physician_Scientists__Role_Models__Gender.20.aspx

Bandura, A. (1991). Social cognitive theory of self-regulation. *Organizational Behavior and Human Decision Processes*, *50*(2), 248–287. https://doi.org/10.1016/0749-5978(91)90022-L

Beede, D. N., Julian, T. A., Langdon, D., McKittrick, G., Khan, B., & Doms, M. E. (2011). Women in STEM: A Gender Gap to Innovation. *SSRN Electronic Journal*, 51–61. https://doi.org/10.2139/ssrn.1964782

Bemmel, H. van, & Koopman, L. (2019). *Nova Natuurkunde 5 vwo*. (C. Biemans, Ed.) (2019th ed.). Malmberg.

Bemmel, H. Van, & Koopman, L. (2018). *Nova Natuurkunde 4 vwo*. (C. Biemans, Ed.) (2018th–2019th ed.). Malmberg.

Bemmel, H. Van, & Koopman, L. (2020). *Nova Natuurkunde 6 vwo*. (C. Biemans, Ed.) (2020th ed.). Malmberg.

Bettinger, E. P., & Long, B. T. (2005). Do Faculty Serve as Role Models? The Impact of Instructor Gender on Female Students. *American Economic Association*.

Bradley, K. (2000). The Incorporation of Women into Higher Education: Paradoxal Outcomes? *Sociology of Education*, *73*(1), 1–18. Retrieved from https://www.jstor.org/stable/pdf/2673196.pdf?casa_token=WByrGE16708AAAAA:XWvyHHImb9sm_J1oSW4-QxUaOarWz1KnnYO472D72BGyKb0XQxF3dniYl1e6zOClbGps_CVxxzqm62nif13XBty3QyIIJtOXMAJCd6iWGYIn7-aXEkyI

Cambridge. (2013). *Cambridge Advanced Dictionary* (Vol. 58). Cambridge University Press. Retrieved from https://dictionary.cambridge.org/dictionary/english/role-model

Card, D., & Payne, A. A. (2021). HIGH SCHOOL CHOICES AND THE GENDER GAP IN <scp>STEM</scp>. *Economic Inquiry*, *59*(1), 9–28. https://doi.org/10.1111/ecin.12934

Cheryan, S., Master, A., & Meltzoff, A. N. (2015). Cultural stereotypes as gatekeepers: increasing girlsâ€™ interest in computer science and engineering by diversifying stereotypes. *Frontiers in Psychology*, *6*(FEB), 49. https://doi.org/10.3389/fpsyg.2015.00049

Cheryan, S., & Plaut, V. C. (2010). Explaining Underrepresentation: A Theory of Precluded Interest. *Sex Roles*, *63*(7–8), 475–488. https://doi.org/10.1007/s11199-010-9835-x

Chick, K. A. (2006). Gender Balance in K-12 American History Textbooks. *Social Studies Research and Practice Www.Socstrp.Org*, *1*(3). Retrieved from www.socstrp.org

Craeynest, F. Van. (2015). Gender representations in EFL textbooks : a quantitative and qualitative content analysis.

Cremers, R., Lenders, L., & Molin, F. (2018). *Nova Natuurkunde 4 havo*. (E. Verstraelen, Ed.) (2018th ed.). Malmberg.

Cremers, R., Lenders, L., & Molin, F. (2019). *Nova Natuurkunde 5 havo*. (E. Verstraelen, Ed.) (2019th ed.). Malmberg.

Dowey, A. L. (2013). Attitudes, Interests, and Perceived Self-efficacy toward Science of Middle School Minority Female Students : Considerations for their Low Achievement and Participation in STEM Disciplines. Retrieved from https://escholarship.org/uc/item/6n51c5bw

Drury, B. J., Siy, J. O., & Cheryan, S. (2011). When Do Female Role Models Benefit Women? The Importance of Differentiating Recruitment From Retention in STEM. *Psychological Inquiry*, *22*(4), 265–269. https://doi.org/10.1080/1047840X.2011.620935

Elgar, A. G. (2004a). Science textbooks for lower secondary schools in Brunei: issues of gender equity. *International Journal of Science Education*, *26*(7), 875–894. https://doi.org/10.1080/0950069032000138888

Elgar, A. G. (2004b). Science textbooks for lower secondary schools in Brunei: issues of gender equity. *International Journal of Science Education*, *26*(7), 875–894. https://doi.org/10.1080/0950069032000138888

European Union. (2019). About school policy | Education and Training. Retrieved November 25, 2020, from https://ec.europa.eu/education/policies/school/about-school-policy_en

Fahlgren, S., & Sawyer, L. (2011). The power of positioning: on the normalisation of gender, race/ethnicity, nation and class positions in a Swedish social work textbook. *Gender and Education*, *23*(5), 535–548. https://doi.org/10.1080/09540253.2010.511605

Fernandez-Mateo, I., & Fernandez, R. M. (2016). Bending the Pipeline? Executive Search and Gender Inequality in Hiring for Top Management Jobs. *Management Science*, *62*(12), 3636–3655. https://doi.org/10.1287/mnsc.2015.2315

Fink, B. D. (2011). Researcher reveals how "Computer Geeks" replaced "Computer Girls." *Gender News*.

Galesic, M., & Bosnjak, M. (2009). Effects of Questionnaire Length on Participation and Indicators of Response Quality in a Web Survey. *Public Opinion Quarterly*, *73*(2), 349–360. https://doi.org/10.1093/poq/nfp031

Gibson, D. E. (2004). Role models in career development: New directions for theory and research. *Journal of Vocational Behavior*, *65*(1), 134–156. https://doi.org/10.1016/S0001-8791(03)00051-4

Gibson, D. E., & Cordova, D. I. (1999). Women's and Men's Role Models: The Importance of Exemplars. In *Mentoring Dilemmas* (pp. 135–154). Psychology Press. https://doi.org/10.4324/9781410601612-14

González-Pérez, S., Mateos de Cabo, R., & Sáinz, M. (2020). Girls in STEM: Is It a Female Role-Model Thing? *Frontiers in Psychology*, *11*(September). https://doi.org/10.3389/fpsyg.2020.02204

Good, J. J., Woodzicka, J. A., & Wingfield, L. C. (2010). The Effects of Gender Stereotypic and Counter-Stereotypic Textbook Images on Science Performance. *The Journal of Social Psychology*, *150*(2), 132–147. https://doi.org/10.1080/00224540903366552

Harrison, A. G. (2001). How do teachers and textbook writers model scientific ideas for students? *Research in Science Education*, *31*(3), 401–435. https://doi.org/10.1023/A:1013120312331

Heilman, M. E. (2012). Gender stereotypes and workplace bias. *Research in Organizational Behavior*, *32*, 113–135. https://doi.org/10.1016/j.riob.2012.11.003

Hogben, M., & Waterman, C. K. (1997). Are all of your students represented in their textbooks? A Content Analysis of Coverage of Diversity Issues in Introductory Psychology Textbooks. Retrieved February 12, 2020, from http://web.b.ebscohost.com.proxy.library.uu.nl/ehost/pdfviewer/pdfviewer?vid=1&sid=8fa3a0ef-4a04-4365-83d0-373eac2c56d9%40pdc-v-sessmgr06

Hutchinson, T., & Torres, E. (1994). Textbook as agent of change. Retrieved March 22, 2020, from https://academic-oup-com.proxy.library.uu.nl/eltj/article-abstract/48/4/315/2797673

Instruct. (2019). *Producten en Prijzen Fundament Informatica*.

Janietz, C., & Bol, T. (2020). Occupations, organizations, and the structure of wage inequality in the Netherlands. *Research in Social Stratification and Mobility*, *70*, 100468. https://doi.org/10.1016/j.rssm.2019.100468

Kalender, Z. Y., Marshman, E., Schunn, C. D., Nokes-Malach, T. J., & Singh, C. (2019). Why female science, technology, engineering, and mathematics majors do not identify with physics: They do not think others see them that way. *Physical Review Physics Education Research*, *15*(2), 020148. https://doi.org/10.1103/PhysRevPhysEducRes.15.020148

Kultur, L., Johansson, S., & Malmsjö, K. B. (2009). *Gender Bias in EFL Textbook Dialogues*. Malmö högskola/Lärarutbildningen.

Lee, J. F. K., & Collins, P. (2010). Construction of gender: a comparison of Australian and Hong Kong English language textbooks. *Journal of Gender Studies*, *19*(2), 121–137. https://doi.org/10.1080/09589231003695856

Lockwood, P. (2006). *"Someone like me can be succesful": Do college students need same-gender role models?*

Lund, E., & Gram, I. T. (1998). Response rate according to title and length of questionnaire. *Scandinavian Journal of Social Medicine*, *26*(2), 154–160. https://doi.org/10.1177/14034948980260020401

Marshman, E. M., Kalender, Z. Y., Nokes-Malach, T., Schunn, C., & Singh, C. (2018). Female students with A's have similar physics self-efficacy as male students with C's in introductory courses: A cause for alarm? *Physical Review Physics Education Research*, *14*(2), 020123. https://doi.org/10.1103/PhysRevPhysEducRes.14.020123

Master, A., Cheryan, S., & Meltzoff, A. N. (2014). Reducing adolescent girls' concerns about STEM stereotypes: When do female teachers matter? Retrieved March 22, 2020, from https://www-cairn-info.proxy.library.uu.nl/revue-internationale-de-psychologie-sociale-2014-3-page-79.htm

Matteazzi, E., Pailhé, A., & Solaz, A. (2018). Part-time employment, the gender wage gap and the role of wage-setting institutions: Evidence from 11 European countries. *European Journal of Industrial Relations*, *24*(3), 221–241. https://doi.org/10.1177/0959680117738857

NBG. (2020). Nationale Beroepen Gids. Retrieved February 11, 2021, from https://www.nationaleberoepengids.nl/

OECD. (2016). *Education Database: Graduates by field (Edition 2016)*. Retrieved from https://doi.org/10.1787/e3130ebf-en

Olivo, C. (2012). Bringing Women In: Gender and American Government and Politics Textbooks. *Journal of*

Political Science Education, *8*(2), 131–146. https://doi.org/10.1080/15512169.2012.667676

Opare, P. (2012). Factors That Female Higher Education Faculty in Select Science, Technology, Engineering, and Mathematics (STEM) Fields Perceive as Being Influential to Their Success and Persistence in Their Chosen Professions. *STEMPS Theses & Dissertations*. https://doi.org/10.25777/m44g-4q33

Ott, C. (2014). Geschlechtsidentität (en) im Mathebuch: Was die Sprache in Bildungsmedien über ihre Gesellschaft verrät. *Lernen Und Geschlecht*, 241–254.

Peeters, M. J., Churchwell, M. D., Mauro, L. S., Cappelletty, D. M., & Stone, G. E. (2010). A student-inclusive pharmacotherapeutics textbook selection process. *Currents in Pharmacy Teaching and Learning*, *2*(1), 31–38. https://doi.org/10.1016/j.cptl.2009.12.004

Pintrich, P. R. (2003). A Motivational Science Perspective on the Role of Student Motivation in Learning and Teaching Contexts. *Journal of Educational Psychology*, *95*(4), 667–686. https://doi.org/10.1037/0022-0663.95.4.667

Rolstad, S., Adler, J., & Rydén, A. (2011). Response burden and questionnaire length: is shorter better? A review and meta-analysis. *Value in Health : The Journal of the International Society for Pharmacoeconomics and Outcomes Research*, *14*(8), 1101–1108. https://doi.org/10.1016/j.jval.2011.06.003

Sassler, S., Glass, J., Levitte, Y., & Michelmore, K. M. (2017). The missing women in STEM? Assessing gender differentials in the factors associated with transition to first jobs. *Social Science Research*, *63*, 192–208. https://doi.org/10.1016/j.ssresearch.2016.09.014

Sax, L. J., Kanny, M. A., Riggers-Piehl, T. A., Whang, H., & Paulson, L. N. (2015). “But I’m Not Good at Math”: The Changing Salience of Mathematical Self-Concept in Shaping Women’s and Men’s STEM Aspirations. *Research in Higher Education*, *56*(8), 813–842. https://doi.org/10.1007/s11162-015-9375-x

Schwab, K., Brende, B., Zahidi, S., Magnoni, S., Bekhouche, Y., Guinault, A., … Tyson, L. D. (2012). *The Global Gender Gap Report 2012*. World Economic Forum.

Schwab, K., Samans, R., Zahidi, S., Leopold, T. A., Ratcheva, V., Hausmann, R., & Tyson, L. D. (2016). *The Global Gender Gap Report 2016*. *World Economic Forum*. World Economic Forum.

Sealy, R. H. V., & Singh, V. (2009). The importance of role models and demographic context for senior women’s work identity development. *International Journal of Management Reviews*, *12*(3), 284–300. https://doi.org/10.1111/j.1468-2370.2009.00262.x

Stout, J. G., Ito, T. A., Finkelstein, N. D., & Pollock, S. J. (2013). How a gender gap in belonging contributes to the gender gap in physics participation (pp. 402–405). https://doi.org/10.1063/1.4789737

Techniekpact. (2020). HAVO/VWO - Monitor Techniekpact 2020. Retrieved February 17, 2021, from http://www.techniekpactmonitor.nl/havovwo

TU Delft. (2021). Admission Requirements. Retrieved February 17, 2021, from https://www.tudelft.nl/en/education/programmes/bachelors/ct/bachelor-of-civil-engineering/admission-requirements

U-Talent | Girls Club IN: informatica en natuurkunde voor meiden. (n.d.). Retrieved February 19, 2021, from https://u-talent.nl/nieuws/2019/12/girls-club-in-informatica-en-natuurkunde-voor-meiden/

U-Talent | Over U-Talent. (n.d.). Retrieved February 19, 2021, from https://u-talent.nl/over-u-talent/

van den Berg, H., Fernandez Beiro, L., & Gielen, W. (2019). *De arbeidsmarkt in cijfers 2019*.

van der Molen, J. H. W. (2020). Why Do Dutch Girls Do Not Choose for Science and Engineering?

van Veelen, R., Derks, B., & Endedijk, M. D. (2019). Double trouble: How being outnumbered and negatively stereotyped threatens career outcomes of women in STEM. *Frontiers in Psychology*, *10*(FEB), 1–18. https://doi.org/10.3389/fpsyg.2019.00150

VHTO. (2019a). Cijfers HBO. Retrieved February 23, 2020, from https://www.vhto.nl/cijfers-onderzoek/cijfers/cijfers-hbo/

VHTO. (2019b). Cijfers WO. Retrieved February 23, 2020, from https://www.vhto.nl/cijfers-onderzoek/cijfers/cijfers-wo/

Wang, M.-T., & Degol, J. L. (2017). Gender Gap in Science, Technology, Engineering, and Mathematics (STEM): Current Knowledge, Implications for Practice, Policy, and Future Directions. *Educational Psychology Review*, *29*(1), 119–140. https://doi.org/10.1007/s10648-015-9355-x

Wiese, B. S., & Freund, A. M. (2011). Parents as role models: Parental behavior affects adolescents' plans for work involvement. *International Journal of Behavioral Development*, *35*(3), 218–224. https://doi.org/10.1177/0165025411398182

Zimmerman, B. J. (2000). Self-Efficacy: An Essential Motive to Learn. *Contemporary Educational Psychology*, *25*(1), 82–91. https://doi.org/10.1006/ceps.1999.1016

Appendix

Full Questionnaire

Vragenlijst Girls Club IN

Voor- en achternaam:
School:
Klas:

1. Weet je al welk profiel je gaat kiezen voor de bovenbouw?
   - ☐ Ja, Natuur en Gezondheid
   - ☐ Ja, Natuur en Techniek
   - ☐ Ja, Cultuur en Maatschappij
   - ☐ Ja, Economie en Maatschappij
   - ☐ Nee, ik heb nog geen enkel idee
   - ☐ Ik twijfel nog tussen: …………………………………………………………………

2. Waarom kies je voor dit profiel, of waarom twijfel je nog of weet je het nog niet?

………..

3. Wie zijn voor jou belangrijk bij het maken van keuzes over de vakken die je wilt volgen of het profiel dat je gaat kiezen? (bijvoorbeeld je familie, ouders, docenten)?

……….

4. Ik doe mee omdat…..

Meerdere opties mogelijk
   - ☐ Ik heb me opgegeven, omdat het me leuk lijkt.
   - ☐ Ik doe mee, omdat het van een docent moet.
   - ☐ Ik doe mee, omdat het van mijn ouder(s) moet.
   - ☐ Op basis van mijn (hoge) cijfers
   - ☐ Alle meiden in 2vwo mochten zich opgeven.
   - ☐ Mijn docent heeft me aangemeld.
   - ☐ Anders, namelijk …………………….

Geef aan in hoeverre onderstaande uitspraken voor jou gelden.		Zeer mee oneens	Mee oneens	Niet eens /niet oneens	Mee eens	Zeer mee eens
5.	Ik doe mee om meer meiden te ontmoeten met interesse in Natuurkunde of Informatica.					
6.	Ik heb vrienden/vriendinnen die geïnteresseerd zijn in natuurkunde en/of informatica.					

Geef aan in hoeverre onderstaande uitspraken voor jou gelden.		Zeer mee oneens	Mee oneens	Niet eens /niet oneens	Mee eens	Zeer mee eens
7.	Mijn ouders doen (voor werk) iets met natuurkunde en/of informatica.					

De volgende uitspraken gaan over informatica en natuurkunde. Geef aan in hoeverre de uitspraken voor jou gelden.		Zeer mee oneens	Mee oneens	Niet eens /niet oneens	Mee eens	Zeer mee eens
8.	Ik weet wat het vak informatica inhoudt.					
9.	Ik weet wat het vak natuurkunde inhoudt.					
10.	Ik weet wat voor soort banen je kan hebben als informaticus.					
11.	Ik weet wat voor soort banen je kan hebben als een natuurkundige.					
12.	Ik vind natuurkunde leuk.					
13.	Ik vind informatica leuk.					
14.	Ik ben goed in informatica					
15.	Ik ben goed in natuurkunde					
16.	Ik vind technische vakken meer iets voor jongens dan voor meisjes.					
17.	Anderen vinden dat technische vakken niet echt voor meisjes zijn					
18.	Ik wil alleen iets gaan studeren wat anderen (ook) bij mij vinden passen.					
19.	Anderen stimuleren mij om iets technisch te gaan doen met mijn opleiding					

20.	Mijn schoolboeken geven mij het idee dat technische vakken voor meisjes zijn					

21. Ik zou wel/niet natuurkunde, informatica of iets anders technisch willen studeren omdat

………….

22.	Welke bekende vrouwelijke (informatica en natuurkunde) wetenschappers ken je, al is het alleen maar van naam? Ze mogen dood of nog levend zijn. *Het is niet erg als je er geen een weet!* 1……………………………………………………………………………… 2……………………………………………………………………………… 3……………………………………………………………………………… 4………………………………………………………………………………. 5………………………………………………………………………………. 6……………………………………………………………………………… 7……………………………………………………………………………… 8……………………………………………………………………………… 9………………………………………………………………………………. 10……………………………………………………………………………….