

My Daughter a STEM-career? ‘Rather not’ or ‘No problem’? A case study

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ABSTRACT

If one wants to close the gender gap in STEM, girls need to start STEM courses. The stereotypical socialization does not lead girls in the direction of science and technology. And although the influence of parents does decrease with age it is often still present in the initial choice of study. Therefore, this study explores the role of the parents on girls’ choice for a career in STEM. Qualitative individual semi-structured interviews with parents of girls in the last grade of primary education were conducted. Results show that specific characteristics of the parents can possibly have a positive influence on their children’s school career and choice for STEM.

Keywords: parents, stem, girls

INTRODUCTION

Several countries, including Belgium, are faced with a lack of students and skilled professionals in the STEM-field. This problem will become even more acute in the coming years, due to an increasing number of technicians, engineers, and scientists who will retire and need to be replaced. This shortage could hinder economic growth and the further development of the knowledge society (e.g., Van den Berghe and De Martelaere, 2012). One of the causes of this shortage in STEM-professionals is the gender gap in STEM (Hammond et al., 2020).

Although girls are just as talented (e.g., Blickenstaff, 2005; Ceci and Williams, 2010; Eddy and Brownell, 2016), they are remarkably less likely than boys to choose a discipline in different domains of science, technology, engineering and mathematics (STEM) (Dasgupta and Stout, 2014; Hammond et al., 2020). Girls are already less interested in a future in STEM than boys, when they are just twelve years old (Denessen et al., 2015). This untapped potential talent is a waste on a personal, social, and economic level (Van den Hurk et al., 2019).

A student who chooses her/his courses based on strengths will not only have a better chance of success but will also be a richer and better addition to the work field. Especially in times of STEM shortages, a society cannot afford to leave this much professional talent behind. To cope with current global challenges (e.g., viruses, climate change, artificial intelligence) new answers and insights are required, and most likely a different approach of these challenges. Gender equality within STEM (science, technology, engineering and mathematics) can be a solution as it can bring more diverse perspectives, talent and insight into the field.

On top of this it leads to missed opportunities for economies and an inefficient allocation of labor and talent (Hammond et al., 2020).

In the academic year 2019-2020, there were hardly any girls (5%) in vocational STEM education in Flanders (Vlaamse overheid, 2019). Girls are also underrepresented in most STEM disciplines in higher education, in 2019-2020 less than one in five students in engineering and technology was a girl (AHOVOKS, 2020).

The reasons for this dropout of girls in STEM courses and careers are multifaceted and sometimes difficult to trace. Cultural and social beliefs, policies, school systems, economic and work-related developments all, directly and indirectly, influence student behavior. Other possible causes of this so-called STEM-gap are the lower self-image of girls within STEM subjects, a learning environment that does not stimulate enough, the lack of female role models and the stereotypical image of only white men and 'geeks' who seem to fit within STEM professions (e.g., Bøe et al., 2011; Ceci and Williams, 2010; Eccles, 2007; Watt, 2006). For these reasons, girls and women often do not feel at home in a STEM-related study (Cheryan et al., 2009; Murphy, Steele and Gross, 2007; Stout et al., 2011).

The low representation of girls in STEM, and more specifically in technology, is a common and certainly not recent phenomenon (Chesky and Goldstein, 2018; Eccles and Jacobs, 1986; Rosenwald, 2006). Over the past 30 years, researchers have dedicated themselves to studying these differences in career choice (Wang, 2012). Many initiatives and measures already taken were found to be ineffective in addressing this problem. As there is no single cause for the underrepresentation of girls and women in STEM and technology directions and professions, it has become clear that there is no one-size-fits-all solution to solve this problem.

A variety of factors seems to contribute to the lack of interest from girls and women in studies and careers in STEM fields. Following Eccles' (1983) expectancy-value theory we could distinguish three major components, psychological factors, biological factors and socialization factors such as the influence of school and teachers, peers and family. These socialization factors have an influence on the development of self-beliefs, goals, interests, and values (Wang and Degol, 2013), and are therefore relevant for further investigation.

From previous studies (Wang and Degol, 2013; Eccles et al., 1990) we know parental influence has a significant impact on children's study choices. Therefore, this study will focus on parental influence on girls' decision for a STEM domain when starting secondary education, in their own words.

Parental Influence

The influence of parents does decrease with age but is often still present in the initial choice of study options in higher education. Research has shown that teenagers are also usually open to the opinion of their parents (Van den Berghe and De Martelaere, 2012). On top of this, in regions where the vast majority of students are financially dependent on their parents during their studies, parents can even prevent their son or daughter from following a specific course of study.

Jacobs et al. (2006) have also shown that the professional expectations of 15-year-olds are significantly related to their parents' expectations. A study by David et al. (2003) showed that boys 'allow' their parents less to interfere with school, while girls are more open to talk about school and choice of study with their parents. Another study (Van Langen et al., 2006) found that girls' choice of math and science was influenced by their family background, whereas the study choices of boys were not. In any case, the influence of the parents on the choice of study is greater than that of teachers and friends. Hauttekeete (2007) says three out of four young people indicated that their parents had influenced their choice of study.

As youngsters under 12 spend a lot of time at home, and their parents are still a larger influence than their peers, the home life consists of several aspects that directly or indirectly influence the interests or disinterest of girls. It is the most important setting outside of the school in shaping student motivational beliefs (Wigfield et al., 2006; Xie and Shauman, 2003). From childhood, cultural influences often unconsciously reinforce traditional role patterns. Parents influence the academic motivation, achievement, and educational and career interests of their children through the home environments they create, the values they endorse, and the experiences they provide (Spera, 2005).

Parents' education and profession

From an early age, children form an image of what a scientist or engineer should look like. If they do not recognize themselves in this, their motivation decreases (Blickenstaff, 2005). Regularly bringing female and counter-stereotypical role models into the classroom has a positive influence on girls' and boys' attitudes towards women in STEM (Galdi et al., 2014; McGuire et al., 2020; Shin et al., 2016). People need multiple and mutually reinforcing examples to see counter-stereotypes as evidence of trends (Miller et al., 2014; Richards and Hewstone, 2001). The use of female role models can also improve that important feeling of belonging in STEM (Blickenstaff, 2005). The most effective role models are those with a similar background to the participants; this similarity can encourage girls to imagine they might one day end up in those positions (Zirkel, 2002).

Sjaastad (2012) found that teachers and parents were the main source of inspiration for Norwegian university students' STEM-related educational choice. Parents who engaged in STEM themselves were models for their children making the STEM-related choices familiar to them.

A large-scale quantitative study (Ardies et al., 2015a) showed how when mothers have a technological job, their children, both male and female students, are more likely to pursue a technological career. This effect is not stronger for female than for male students. Having a parent in a STEM profession increased a child's chances of majoring and working in STEM, this effect was greater for girls (between 10-17%). Moreover, girls with mothers with a STEM profession were 7% more likely to work in the 'hard sciences' (Cheng et al., 2017), which is comparable to the results of Ardies and colleagues (2015c). Mothers who obtained a higher education degree have a significant negative effect on the technological career ambitions of students (Ardies et al., 2015c). Maternal role models and growth mindsets can help close the gender gap.

Toys and leisure

Boys and girls are often encouraged by parents to play stereotypical male and female games that are consistent with their gender (Kollmayer et al., 2018), but boys and girls also prefer different types of toys themselves (Hines, 2015). Caplan and Caplan (1994) have argued that many stereotypical male toys and activities encourage the practice and development of spatial skills, while traditional female play enhances other culturally valued attributes such as communication and collaboration.

On average, girls play less with spatial toys than boys (Jirout and Newcombe, 2015), so they have fewer opportunities to practice these skills. Even if the effect of differential exercise of spatial skills provides only a modest initial benefit for boys, the effect may increase as children enter adolescence and start to select leisure activities and hobbies that they enjoy and are skilled at performing.

Parental attitudes and gender-stereotypes

A largescale survey (n=2197) into the mastery of the attainment targets for technology in the first stage of Flemish secondary education also examined students' interest in technology, among other things (Ardies et al., 2015c). The parental attitude towards technology was also questioned. The attitude of the parents towards technology was positively related to both the performance and the interest of the students. However, the relationship between parents' attitude and interest is less pronounced for girls than for boys (Willem et al., 2019).

Already over 30 years ago Eccles and colleagues (1986; 1990) found that mothers' gender stereotypes about math ability affected their perception of their children's skills. If mothers thought gender stereotypically about girls and STEM, their rating of their daughter's ability was lower than would have been predicted by the teacher's ability rating. In particular, Eccles and Jacobs (1986) found that maternal beliefs had a greater impact on children attending additional math courses than their children's actual performance. They concluded; "these data suggest that the stereotypes of parents by sex are a major cause of gender differences in students' attitudes towards mathematics." (Eccles and Jacob, 1986).

How parents think (positively or negatively) about STEM affects their children's math skills and performance in STEM. Cheng, Koptic, and Zamorro (2017) found that this effect influences girls twice as much as boys. Science-oriented professions are still, stereotypically, seen as male (e.g., Struyf et al., 2017). This might be one of the reasons for the fact that women perceive STEM domains as a hobby, in contrast of a possible future job (Van Houte et al., 2013).

Acknowledging all of the above findings in the literature we wish to further explore the role of the parents on girls' choice for a career in STEM.

METHODOLOGY

The present study extends existing work related to parental influences on gendered STEM study choices by determining parental characteristics and their relationship to the process of the daughter's decision making for a STEM course in secondary education. We held individual interviews with parents of girls in the last grade of primary education who already subscribed for a future study course in secondary education. For the planning of the interview, the interview itself, its transcription and analysis, the guidelines described in Cohen, Manion and Morrison (2007) were followed. We chose an informal conversational interview where questions emerge from the immediate context and are asked in the natural course of things. This method increases the salience and relevance of questions (Patton, 1980).

In Flanders students are free to choose any type of course when they are transferring from primary to secondary education at age 12. Next to the general courses which all students receive in secondary education (math, sport, biology, language, etc.), schools offer different 'packages' of courses from which students have to choose one.

Participants

Participants are parents of girls from 6th grade (age = 12) who have opted for a course of study in secondary education. They were recruited after they filled in a short initial questionnaire about the choice of study of their daughter and their own professional background. We made two subgroups of girls: those who chose a STEM course (4) and girls who did not choose a STEM course (5). We strived for similarities in family situation among both groups. All parents interviewed are in a traditional heterosexual relationship. Different family compositions are included. Some girls have only brothers, only sisters, both siblings or are only children.

For this research we opted for an equal spread of girls that have chosen either a 'STEM-package' (science, technology...) or a 'non-STEM package' (e.g., classic or modern language, art, extra sport...).

Interviews and Data-analysis

The interviews were conducted at the parents' home. In most cases, both parents were present, once only the mother and once the daughter was also present at the conversation. General questions were asked at the beginning, such as the level of education and the current profession of the parents. Afterwards, open questions were asked, to deepen our understanding about family characteristics and attitudes, with the interviewer recording the answers.

The authors analyzed the data using the steps of thematic analysis to identify, analyze and report patterns in the data (Howitt and Cramer, 2008). The interviews were analyzed by adding codes to the answers on the interview. All authors independently worked through the data and labeled "units of meaning" as codes. After this we collaboratively grouped similar codes into thematic categories, which became our codebook for systemically combing through the data (Howitt and Cramer, 2008). We distinguished (1) parental characteristics like parents' educational level and profession; (2) family characteristics such as toys present in the house and leisure activities and (3) parental attitudes and gender roles in the family, including how household tasks are divided between the parents. Of course, we also measured the extent to which the girls chose a STEM-related study.

The answers of the parents in these different categories were divided into a table to determine similarities and differences between the answers. Different respondents were presented in the columns, as we put the different categories in the rows. By doing so we obtained a clear picture of the different answers per category and a short summary of the answers of the respondents could be made per category. These summaries are shown below.

RESULTS

Parent Influence

Parents' education and profession

We examined whether the educational level of the parents had an influence on whether or not girls chose a STEM course in secondary education. We first looked at the mother's level of education. Here we see that both with the girls who chose STEM and those who did not, the majority of the mothers had a degree of higher education.

Concerning the father's level of education, we found that the majority of the fathers from the girls who chose STEM did not attend higher education. In the other group we see the opposite. Here the majority of fathers have a degree in higher education.

In the interview, parents themselves often made the link with their profession. For example, a parent of a girl who chose a STEM direction replied: "Because of our profession (veterinarian and chemistry process operator) we both have an interest in STEM." A parent of a girl who did not choose a STEM direction replied: "We ourselves have an interest in technology and science. We express this by using technology in our lessons (parents are kindergarten teacher and primary school teacher). And we also make a lot of technical things with our daughters."

Nevertheless, when looking at parents' profession and the interest in STEM, we found that in our case study the parents of girls who chose STEM did not necessarily have more interest in STEM than the other parents.

Toys and leisure

We also questioned which leisure activities were offered by the parents which could possibly arouse interest in STEM. We examined what kinds of toys were offered to their daughters, whether they were technical or non-technical and how they were or will be played with. We also asked the parents about their gendered ideas of these toys and whether they think they are something for boys or girls or both. Subsequently we focused on the participation in extracurricular workshops and the influence of STEM related family trips.

In both groups the majority of the girls possessed technical toys. All parents in the group of girls that opt for a STEM-course believed that technical toys are suitable for both boys and girls. One of the parents said: “Our daughter mainly has technical toys such as construction toys. She likes building according to plan.”

All participating parents told us they take their daughters to museums or technological and scientific theme parks. Therefore, no significant influence was found.

When it comes to participating in an extracurricular STEM workshop, we see that this seems to be related to the perceived interest of girls in STEM. The majority of girls who chose for a STEM course already participated in an after-school workshop on STEM. The majority of girls who did not choose a STEM course have never participated in an after-school workshop on STEM, and if they came in contact with such a workshop it was at a birthday party of a friend.

Parental attitudes and gender stereotyped thinking

In our study, we examined whether the parents consciously deal with gender expectations and awareness in the education of their children and whether this has an influence on girls to choose a STEM direction in secondary education. Half of the parents of girls who chose STEM did not explicitly provide a gender neutral or conscious upbringing. The parents who took it into account, in all areas, replied: “Our daughter plays football, is member of a youth club and mainly wears boys’ clothes.” and “Our daughter plays with football as well as dolls. This has happened automatically. We are more inclined to be gender neutral in our upbringing, but find it difficult to convey this. When she was even younger, we bought neutral clothes for her. We ourselves were raised fairly gender-neutral. For example, the father did ballet and I myself was not a ‘skirt-wearer.’”

Almost all parents of the girls who did not choose STEM take gender neutral or conscious upbringing into account, at least in some areas. These parents specifically name boys or girls toys: “Her older brothers brought her into contact with boy toys a lot. Girl toys were offered, but she was more interested in “neutral” toys.” Or define their daughter as “girly”. “She used to be more of a ‘girl-girl’”. On the other hand, these parents noted that children must learn to make their own choices and these choices are not necessarily gender specific.

We also examined the division of roles within the families who participated in the study, because we wanted to find out if there could be a link between growing up with more traditional role patterns or with a more progressive example and whether this has an influence on the choice of girls for a STEM course in secondary education. We made a subdivision into different, common household tasks and questioned the parents as to which they usually perform.

First, we looked at the more problem-solving tasks like chores in and around the house. There seemed to be no clear distinction between the families. In half of the families of girls who choose STEM, chores are mainly done by the father: “I do this because I have the most time, because I work in shifts.” In one family this is done by both the mother and father and in one family chores are done by the whole family: “We do this together as a family, the roles are divided.” In two families of girls who did not choose a STEM course, chores are mainly done by the mother. In one family mainly by the father, in one family by both mother and father and in the other family this is done as a joint activity.

Who fixes computer problems in the household seems also to be divided, sometimes the mother takes care of this (as an ICT-teacher), sometimes the father or external help is sought. Similar results are found when it comes to repairing a bicycle. Mothers and fathers do this, or this is outsourced. Nevertheless, for the majority of girls who did not choose STEM, the bicycle is repaired by the father.

Secondly, we asked about the more daily tasks: For the majority of girls who did not choose a STEM course, the mother cooks the meal and does the laundry. One family prefers to cook together with the family. The parent of the latter family replied, “Our daughter loves to cook.” When both mother and father prepare dinner or do the laundry, their daughters in this study are 50/50 divided over STEM and non-STEM courses.

Choosing for STEM

Finally, we look at the direct influence that parents have on their daughter’s choice process. Earlier research shows that parents influence the choice of study both directly and indirectly. Young people are open to the opinion of their parents, and girls in particular would be open to discussing school and study options with them. The influence of the parents on the choice of study is even greater than that of teachers and friends (David et al., 2003; Hauttekeette, 2007; Van den Berghe and De Martelaere, 2012).

We noted that the majority of parents whose daughters chose a STEM course said their daughter made this choice on their own. One girl did this in consultation with the parents. The latter replied: “We consulted on the basis of all the study options available. We have taken her interests into account.”

In the case of two girls who did not choose a STEM direction, the choice of study course was made by the parents. One other girl made this choice alone, and another girl did this in consultation with her parents: “She can

choose something herself, but she has to start at a high level. We did make the decision together by asking her what profession she wants to do.”, another girl got a recommendation from her teacher. The parents of the latter girl replied: “The teacher recommended this to her. We want her to follow a general course for the first 3 years and afterwards she can choose for herself.”

CONCLUSION AND DISCUSSION

The focus of this study was to determine the parental influence on girls' decisions to choose a STEM course in secondary education. As was already known from previous research (e.g., David et al., 2003; Hauttekeette, 2007; Van den Berghe and De Martelaere, 2012) our study confirms that parents do have an influence on their children's school career. By conducting in-depth interviews, we determined specific parental characteristics of girls who chose STEM and tried to clarify how the decision process ran. All participating girls have a present mother and father figure and thus have both a female and male role model in their lives. In this study we chose to interview both parents together. For further research we suggest to explore a different approach where parents are interviewed separately and the daughter as well. This to overcome socially desirable answers.

In this case study, we first looked at the education and professional characteristics of the parents and their influence on the decision of their daughter for a course in secondary education. We did not find a relation between mothers' level of education and daughters' choice for a STEM course. However, highly educated fathers in our respondents seemed to be less inclined to opt for a STEM course for their daughters. The fathers' profession does not appear to be a major factor in the choice of study, since some of the participating fathers have a STEM profession and some do not.

Girls in our study who chose a STEM course tend to have a mother with a STEM profession, which could possibly indicate that girls are influenced by the profession of their mother in making a study choice. The participating girls see their mothers as role-models, which is in line with research from Ardies et al. (2015a) and Sjaastad (2012).

Most of the participating parents indicated that they were interested in STEM. This was mainly reflected in their profession, and in the use of home automation, technical gadgets at home, activities during holidays, literature available, etc. No direct relation was found with the girls' choices.

Children learn about gender roles and gender expectations at a very early age (e.g., Eccles et al., 1990). The stereotypical role of a woman teaches girls to focus on having and caring for children and family (Konrad et al., 2000) and according to the male stereotype, boys are expected to focus on their hands and are primarily engaged in activities that focus on problem-solving thinking (Buck et al., 2002).

Nevertheless, when inquiring parents whether they take into account a gender-neutral or -conscious upbringing, it is striking that especially the parents of girls who did not opt for a STEM course made a more conscious decision. Especially parents with girls who have one or more brothers opted for a gender-neutral approach. These girls automatically came into more contact with “boy toys” and play along with their brothers. These parents also stated they wanted children to make their own choices that are not necessarily linked to their sex. This could indicate that a gender-neutral or conscious education is therefore no guarantee that girls will develop more interest in technical and scientific professions. In this modern age, most households are still mostly done by the mother and chores are done by the father or in some cases these tasks are shared between both parents (Islam and Asadullah 2018; Blumberg, 2015). However, there is a slight tendency towards a non-traditional division of labor between the parents within the group of girls who opt for a STEM direction. This could mean that girls who grow up in a household with a less traditional chores division look at gender expectations differently and are therefore less inhibited in their choice for STEM.

Most girls in this case study who did not choose a STEM course did not make this decision alone. It was either their parents who decided or it was recommended by someone in the school environment. For one of the girls, the decision was made by the parents because, as they stated, she has autism and a familiar environment with her friends is important for her well-being. With another girl, the parents want her to follow a more general course for the first three years, after which she can choose for herself. The other parents want their daughters to start ‘high’, in a more academic and general course in order to offer them some challenge.

In the group that did choose a STEM-course, the girls more often made the decision more autonomous, whether in consultation with their parents or environment. They did this mainly based on interest.

Because the majority of girls who did not choose STEM have not chosen themselves, we do not know where their interests lie and whether they would have chosen a STEM direction in other circumstances. We suggest that the influence of parents seems to influence the school career and later professional career of girls. The results of our case study suggest a link between girls who choose STEM, mothers with a STEM profession, and less stereotypical gender roles in the household at home. These girls could be more likely to make independent decisions in their choice of study.

It is striking how in the group of girls who chose STEM all parents provided toys for their daughter that are (stereotypically seen as) for both boys and girls. The majority of these parents also mainly offered technical toys. The parents of these girls indicated that their daughters mainly played with science and test boxes, looking for things themselves to copy and build with construction toys according to plan. Girls in our study who did not choose a STEM-course were offered toys mainly for girls during their childhood. This is in line with previous research of Ardies (2015c) that stated that the presence of construction toys is a predictor of the interest of girls in technology. As discussed earlier, offering stereotypical male toys can encourage spatial skills development (Caplan and Caplan, 1994). This spatial learning can be a reason for the increased interest in STEM disciplines.

More than half of the girls in our study who chose a STEM course have previously followed an after-school workshop compared to a minority of girls who did not choose a STEM direction. They did this on their own initiative or out of interest in their parents' profession. This confirms the research by Anderson and Gilbride (2003) that participation in a program with a STEM focus increases girls' interest in science and technology. Boeve-De Pauw and colleagues (2020) also found that even a one-day intervention (visiting technology and science workshops) can have a positive impact on girls' interest in a STEM career. By focusing more on design and technology workshops and making them more accessible to girls by letting them develop their own design, opportunities can be created to make the hard sciences more attractive (Ardies et al., 2015b; Boeve-De Pauw et al., 2020).

First of all, it is noticeable that all parents who participated in the study come from a white, western and middle-class background, so there is nothing to conclude about the cultural influence of families on girls' interest in STEM. Because of the limited number of respondents in this qualitative study one should be conscious to extrapolate the conclusions given. Nevertheless, we can conclude that there are a number of aspects which one can focus on to motivate more girls and their parents to choose a technical or scientific direction.

REFERENCES

- AHOVOKS. (2020). Hoger onderwijs in cijfers Agentschap voor Hoger Onderwijs, Volwassenenonderwijs, Kwalificaties en Studietoelagen – AHOVOKS.
- Anderson, L. and Gilbride, K. (2003). *Bringing engineering to K-12 classrooms: Initiatives and results*. Proceedings of the 2003 American Society for Engineering Education Annual Conference. <https://doi.org/10.18260/1-2--11774>
- Ardies, J., De Maeyer, S. and Gijbels, D. (2015a). A longitudinal study on boys' and girls' career aspirations and interest in technology. *Research in Science & Technological Education*, 33(3), 366-386. <https://doi.org/10.1080/02635143.2015.1060412>
- Ardies, J., De Maeyer, S. and Gijbels, D. (2015b). The effect of classroom activities on students' interest and career aspirations towards technology. *Australasian Journal of Technology Education*, 2(1). <https://doi.org/10.15663/ajte.v2i1.30>
- Ardies, J., De Maeyer, S., Gijbels, D. and van Keulen, H. (2015c). Students' attitudes towards technology. *International Journal of Technology and Design Education*, 25, 43-65. <https://doi.org/10.1007/s10798-014-9268-x>
- Blickenstaff, J. C. (2005). Women and science careers: leaky pipeline or gender filter? *Gender and Education*, 17(4), 369-386. <https://doi.org/10.1080/09540250500145072>
- Blumberg, R. L. (2015). Eliminating gender bias in textbooks: Pushing for policy reforms that promote gender equality in education. Paper commissioned for the EFA Global Monitoring Report 2015, Education for All 2000-2015: achievements and challenges.
- Bøe, M. V., Henriksen, E. K., Lyons, T. and Schreiner, C. (2011). Participation in science and technology: young people's achievement-related choices in late-modern societies. *Studies in Science Education*, 47(1), 37-72. <https://doi.org/10.1080/03057267.2011.549621>
- Boeve-de Pauw, J., Ardies, J., Hens, K., Wullemen, A., Van de Vyver, Y., Rydant, T., ... and Verbraeken, H. (2020). Short- and long-term impact of a high-tech STEM intervention on pupils' attitudes towards technology. *International Journal of Technology and Design Education*. <https://doi.org/10.1007/s10798-020-09627-5>
- Buck, G. A., Leslie-Pelecky, D. and Kirby, S. K. (2002). Bringing female scientists into the elementary classroom: Confronting the strength of elementary students' stereotypical images of scientists. *Journal of Elementary Science Education*, 14, 1. <https://doi.org/10.1007/BF03173844>
- Caplan, P. J. and Caplan, J. B. (1994). *Thinking critically about research on sex and gender*. New York: Harper Collins.
- Ceci, S. J. and Williams, W. M. (2010). Sex Differences in Math-Intensive Fields. *Current Directions in Psychological Science*, 19(5), 275-279. <https://doi.org/10.1177/0963721410383241>
- Cheng, A., Kopotic, K. and Zamorro, G. (2017). *Can Parents' Growth Mindset and Role Modelling Address STEM Gender Gaps?*. Department of Education Reform, University of Arkansas, EDRE Working Paper 2017-07. <https://doi.org/10.2139/ssrn.2920623>

- Cheryan, S., Plaut, V. C., Davies, P. G. and Steele, C. M. (2009). Ambient belonging: How stereotypical cues impact gender participation in computer science. *Journal of Personality and Social Psychology*, 97(6), 1045-1060. <https://doi.org/10.1037/a0016239>
- Chesky, N. and Goldstein, R. (2018). Packaging Girls for STEM or STEM for Girls? A critique on the perceived crisis of increasing female representation in STEM education. *Critical Education*, 9(16). <https://doi.org/10.14288/ce.v9i16.186415>
- Cohen, L., Manion, L. and Morrison, K. (2007). Interviews. *Research methods in education*, 6, (349-383). Routledge. <https://doi.org/10.4324/9780203029053-27>
- Dasgupta, N. and Stout, J. G. (2014). Girls and Women in Science, Technology, Engineering, and Mathematics: STEMing the Tide and Broadening Participation in STEM Careers. *Policy Insights from the Behavioral and Brain Sciences*, 1(1), 21-29. <https://doi.org/10.1177/2372732214549471>
- David, M. E., Ball, S. J., Davies, J. and Reay, D. (2003). Gender issues in parental involvement in student choices of higher education. *Gender and Education*, 15(1), 21-36. <https://doi.org/10.1080/0954025032000042121>
- Denessen, E., Vos, N., Hasselman, F. and Louws, M. (2015). The relationship between primary school teacher and student attitudes towards science and technology. *Education Research International*, 2015, 534690. <https://doi.org/10.1155/2015/534690>
- Eccles, J. (1983). Expectancies, values and academic behaviors, in J. T. Spence (ed.), *Achievement and achievement motives: Psychological and sociological approaches* (pp. 75-146). San Francisco, CA: Free man.
- Eccles, J. S. (2007). Where are all the women? Gender differences in participation in physical science and engineering, in S. J. Ceci and W. M. Williams, *Why Aren't More Women in Science? Top Researchers Debate the Evidence*. Washington, DC: American Psychological Association.
- Eccles, J. S. and Jacobs, J. E. (1986). Social Forces Shape Math Attitudes and Performance. *Signs: Journal of Women in Culture and Society*, 11(2), 367-380. <https://doi.org/10.1086/494229>
- Eccles, J. S., Jacobs, J. E. and Harold, R. D. (1990). Gender Role Stereotypes, Expectancy Effects, and Parents' Socialization of Gender Differences. *Journal of Social Issues*, 46(2), 183-201. <https://doi.org/10.1111/j.1540-4560.1990.tb01929.x>
- Eddy, S. L. and Brownell, S. E. (2016). Beneath the numbers: A review of gender disparities in undergraduate education across science, technology, engineering, and math disciplines. *Physical Review Physics Education Research*, 12(2), 020106. <https://doi.org/10.1103/PhysRevPhysEducRes.12.020106>
- Galdi, S., Cadinu, M. and Tomasetto, C. (2014). The roots of stereotype threat: When automatic associations disrupt girls' math performance. *Child Development*, 85(1), 250-263. <https://doi.org/10.1111/cdev.12128>
- Hammond, A., Rubiano Matulevich, E., Beegle, K. and Kumaraswamy, S. K. (2020). *The Equality Equation: Advancing the Participation of Women and Girls in STEM*. The International Bank for Reconstruction and Development / The World Bank. <https://doi.org/10.1596/34317>
- Hauttekeete, L. (2007). *Are you ready for the future? De visie van jongeren op technologie, industrie en werk*. Onderzoeksgroep MICT UGent, Agoria Vlaanderen.
- Hines, M. (2015). Gendered development, in R. M. Lerner and M. E. Lamb (eds.), *Handbook of Child Development and Developmental Science* (7th ed). Hoboken, NJ: Wiley. <https://doi.org/10.1002/9781118963418.childpsy320>
- Howitt, D. and Cramer, D. (2008). *Introduction to Research Methods in Psychology*. Harlow: Pearson.
- Islam, K. M. M. and Asadullah, M. N. (2018). Gender stereotypes and education: A comparative content analysis of Malaysian, Indonesian, Pakistani and Bangladeshi school textbooks. *PLOS ONE*, 13(1), e0190807. <https://doi.org/10.1371/journal.pone.0190807>
- Jacobs, J. E., Chhin, C. S. and Bleeker, M. M. (2006). Enduring links: Parents' expectations and their young adult children's gender-typed occupational choices. *Educational Research and Evaluation*, 12(4), 395-407. <https://doi.org/10.1080/13803610600765851>
- Jirout, J. J. and Newcombe, N. S. (2015). Building blocks for developing spatial skills Evidence from a large, representative US sample. *Psychological Science*, 26, 302-310. <https://doi.org/10.1177/0956797614563338>
- Kollmayer, M., Schultes, M. T., Schober, B., Hodosi, T. and Spiel, C. (2018). Parents' judgments about the desirability of toys for their children: Associations with gender role attitudes, gender-typing of toys, and demographics. *Sex Roles*, 79(5-6), 329-341. <https://doi.org/10.1007/s11199-017-0882-4>
- Konrad, A. M., Ritchie, J. E., Lieb, P. and Corrigall, E. (2000). Sex differences and similarities in job attribute preferences: A meta-analysis. *Psychological Bulletin*, 126, 593-641. <https://doi.org/10.1037/0033-2909.126.4.593>
- McGuire, L., Mulvey, K. L., Goff, E., Irvin, M. J., Winterbottom, M., Fields, G. E., ... and Rutland, A. (2020). STEM gender stereotypes from early childhood through adolescence at informal science centers. *Journal of Applied Developmental Psychology*, 67, 101109. <https://doi.org/10.1016/j.appdev.2020.101109>
- Miller, D. I., Eagly, A. H. and Linn, M. C. (2014). Women's representation in science predicts national gender-science stereotypes: Evidence from 66 nations. *Journal of Educational Psychology*, 107(3), 631-644. <https://doi.org/10.1037/edu0000005>

- Murphy, M., Steele, C. M. and Gross, J. (2007). Signaling threat: How situational cues affect women in math, science, and engineering settings. *Psychological Science*, 18, 879-885. <https://doi.org/10.1111/j.1467-9280.2007.01995.x>
- Patton, M. Q. (1980). *Qualitative evaluation methods* (Vol. 381). Beverly Hills, CA: Sage publications.
- Richards, Z. and Hewstone, M. (2001). Subtyping and subgrouping: Processes for the prevention and promotion of stereotype change. *Personality and Social Psychology Review*, 5(1), 52-73. https://doi.org/10.1207/S15327957PSPR0501_4
- Rosenwald, M. (2006). Exploring the political diversity of social workers. *Social Work Research*, 30(2), 121-126. <https://doi.org/10.1093/swr/30.2.121>
- Shin, J. E. L., Levy, S. R. and London, B. (2016). Effects of role model exposure on STEM and non-STEM student engagement. *Journal of Applied Social Psychology*, 46(7), 410-427. <https://doi.org/10.1111/jasp.12371>
- Sjaastad, J. (2012). Sources of inspiration: The role of significant persons in young people's choice of science in higher education. *International Journal of Science Education*, 34(10), 1615-1636. <https://doi.org/10.1080/09500693.2011.590543>
- Spera, C. (2005). A review of the relationship among parenting practices, parenting styles, and adolescent school achievement. *Educational psychology review*, 17(2), 125-146. <https://doi.org/10.1007/s10648-005-3950-1>
- Stout, J. G., Dasgupta, N., Hunsinger, M. and McManus, M. A. (2011). STEMing the tide: Using ingroup experts to inoculate women's self-concept in science, technology, engineering, and mathematics (STEM). *Journal of Personality and Social Psychology*, 100, 255-270. <https://doi.org/10.1037/a0021385>
- Struyf, A., Boeve-de Pauw, J. and Van Petegem, P. (2017). 'Hard science': A career option for socially and societally interested students? Grade 12 students' vocational interest gap explored. *International Journal of Science Education*, 39(17), 2304-2320. <https://doi.org/10.1080/09500693.2017.1376259>
- Van den Berghe, W. and De Martelaere, D. (2012). De invloed van ouders en familie. Kiezen voor STEM. De keuze van jongeren voor technische en wetenschappelijke studies, 122-123.
- van den Hurk, A., Meelissen, M. and van Langen, A. (2019). Interventions in education to prevent STEM pipeline leakage. *International Journal of Science Education*, 41(2), 150-164. <https://doi.org/10.1080/09500693.2018.1540897>
- Van Houte, H., Merckx, B., De Lange, J. and De Bruyker, M. 2013. *Zin in wetenschappen, wiskunde en techniek. Leerlingen motiveren voor STEM*. Leuven/Den Haag: ACCO.
- Van Langen, A., Rekers-Mombarg, L. and Dekkers, H. (2006). Sex-related differences in the determinants and process of science and mathematics choice in pre-university education. *International Journal of Science Education*, 28(1), 71-94. <https://doi.org/10.1080/09500690500338920>
- Vlaamse overheid, Dept. onderwijs en vorming, (2019), *STEM-monitor 2019*, Vlaamse overheid.
- Wang, M. T. and Degol, J. (2013). Motivational pathways to STEM career choices: Using expectancy-value perspective to understand individual and gender differences in STEM fields. *Developmental Review*, 33(4), 304-340. <https://doi.org/10.1016/j.dr.2013.08.001>
- Wang, M.-T. (2012). Educational and career interests in math: A longitudinal examination of the links between classroom environment, motivational beliefs, and interests. *Developmental Psychology*, 48, 1643-1657. <https://doi.org/10.1037/a0027247>
- Watt, H. M. (2006). *The role of motivation in gendered educational and occupational trajectories related to maths*. *Educational Research and Evaluation*, 12(4), 305-322. <https://doi.org/10.1080/13803610600765562>
- Wigfield, A., Byrnes, J. P. and Eccles, J. S. (2006). Development During Early and Middle Adolescence. *Handbook of educational psychology* (p. 87-113). Lawrence Erlbaum Associates Publishers.
- Willem, L., Ardies, J., Carpentier, N. and Janssen, R. (2019). *Prestaties en interesse van 14-jarigen in techniek: effect van geslacht en de rol van de ouders*. Onderwijs Research Dagen, 2019/06/26-2019/06/28, Location: Heerlen, Nederland.
- Xie, Y. and Shauman, K. A. (2003). *Women in science: Career processes and outcomes* (Vol. 26, No. 73.4). Cambridge, MA: Harvard university press.
- Zirkel, S. (2002). Is there a place for me? Role models and academic identity among white students and students of color. *Teachers College Record*, 104(2), 357-376.