Long term, interrelated interventions to increase women's participation in STEM in the Netherlands

C Booij
Managing Director
VHTO, (Dutch) National Expert organization on girls/women and STEM
Amsterdam, The Netherlands
E-mail: booij@vhto.nl

EJM Jansen[1]
Policy Advisor
VHTO, (Dutch) National Expert organization on girls/women and STEM
Amsterdam, The Netherlands
E-mail: jansen@vhto.nl

EJ van Schaik
Policy Advisor
VHTO, (Dutch) National Expert organization on girls/women and STEM
Amsterdam, The Netherlands
E-mail: schaik@vhto.nl

* Corresponding Author

Keywords: Gender mainstreaming, STEM education, career development

INTRODUCTION

Traditionally, the Netherlands lag behind other countries in terms of the percentage of girls opting for STEM-study programs [1-2]. The underrepresentation of girls cannot be attributed to differences in performance in STEM related school subjects or skills: girls perform equally well as boys [3], and this is also the case in the Netherlands [2]. In international research a number of factors leading to the under-representation of girls/women in STEM have been recognized, including girls' lower self-concepts, non-stimulating learning environments, lack of female role models, stereotyped associations

[1] Correponding Author
EJM Jansen
jansen@vhto.nl

in society about girls/women and STEM, fertility/lifestyle factors, and career preferences of girls and women (e.g., [4-8]).

Since the 1980s VHTO has developed approaches, activities and instruments to attract more female students into STEM. In the 1990's VHTO started working with international partners in EU-projects, and joined several European networks (e.g., WiTEC) that are (fully or partly) concerned with gender and STEM. Up until now VHTO has cooperated with many different partners in the Netherlands and abroad, designing and implementing intervention programmes to raise the participation of girls and women in STEM. VHTO has actively drawn on academic literature about gender and STEM to expand knowledge and to validate intervention programmes and instruments. In 2009, VHTO set up the Gender & STEM Network (www.genderandSTEM.com) together with Helen Watt (Monash University in Melbourne, Australia). Its members are researchers from all over the world. Nowadays, VHTO is *the* expert organization regarding women/girls/gender & STEM in the Netherlands. In 2015 VHTO received a second Google Rise Award to organise Code Events especially designed for girls.

Female STEM professionals and students play an important role in boosting the involvement of girls and women in STEM. As role models they can show the broad range of STEM-study programs and professions, demonstrate that they enjoy their work and that it fits their aspirations and attainment. They support the growth of girls' self-confidence and interest in STEM-related subjects. The support of female professionals as role models is integrated in many of VHTO's activities. The women who participate signed up for the role-model data base *Spiegelbeeld* ("Mirror Image") in which more than 2000 female STEM professionals and students participate. VHTO takes great care in selecting role models for speed-dates, guest lectures, work shadowing, mentoring etc. Not all female STEM professionals are good role models; girls have to be able to personally identify with a role model (e.g., [9]). For this reason, VHTO's role models receive a special training to prepare them for their important job. VHTO aims to organize meetings between role models and children through the whole chain of education to provide counter stereotypes the children can identify with [10]. Additionally VHTO has been committed to make teachers, parents and career advisors aware of stereotypical associations and behaviour. VHTO offers them tools to avoid this and helps them encourage girls to develop their talents in a STEM gender-inclusive environment. STEM companies, institutes and universities are also involved. This creates a comprehensive, longitudinal approach.

1 PROGRAMS IN EDUCATION

An outline of the programmes and their implementation is described in this paper (full details are reported by [11-13]. The VHTO approach explicitly focuses on individual talent development (i.e., in primary education), career guidance of girls and on incorporating the gender perspective into school policy. VHTO combines interventions that have proven successful in previous years and has developed them developed into a strong combination of 1) activities for girls, 2) training programmes for teachers and career advisers, and 3) consultations with school/education managers.

1.1 Primary education

VHTO and Amsterdam based Science Centre NEMO have developed and implemented a primary school (grade 5 & 6, 9-12 years) project (*Talent Viewer*) since 2011. Today, more than 3000 school classes in primary education are participating. Talent Viewer aims to: 1) provide pupils (boys and girls, teachers and parents) with a broader and more complete picture of professions in the STEM domain (e.g., by assignments that encourage studying STEM-professions and a guest lecture by a female STEM professional; 2) encourage pupils (boys and girls) to develop their *individual* skills rather than those that fit gender stereotypes and create awareness on this matter among parents and teachers; 3) make pupils (girls and boys), parents, and teachers aware of their (gender) stereotypes about STEM-education and professions; 4) offer role models. Parents and teachers are actively involved in Talent Viewer. VHTO and NEMO also developed a gender awareness training for teachers in primary education. The training focusses on gender awareness in general, with respect to developing STEM-skills, interaction with pupils, etcetera. The training is designed for school teams. The training and the project can be purchased separately. Besides Talent Viewer, girls in the age 10-14 can visit STEM companies and businesses by participating in the annual Girlsday. They can also participate in Code Events that VHTO organises especially for girls.

The first evaluations of Talent Viewer show enhanced gender awareness in teachers, as well as enhanced and more up-to-date knowledge about STEM education and STEM professions among children, teachers and parents. Furthermore Talent Viewer serves as an eye-opener for both pupils and teachers: STEM professionals can be female as well. Fewer pupils value STEM ‘as something for boys’ after participating in Talent Viewer. For more details on Talent Viewer, we refer to [12].

1.2 Secondary Education

Activities for girls in secondary education mainly focus on providing female role models. Female professionals (and students) visit schools for secondary education at defining moments (i.e., in advance of subject-cluster choice, and in advance of a higher education study program). In the Netherlands, students choose a subject-cluster at the age of 14. The subject clusters are either science, health and technology oriented (i.e., science clusters) or society, economics and culture oriented (society clusters). A student choosing a society cluster at this age cannot opt for STEM studies anymore as most of the advanced courses require advanced mathematics and physics. Traditionally girls opt more often for society subject clusters and boys more often for science clusters, leading to clear gender segregation. Meetings with female STEM professionals at moments of choice has a clear effect on the choice process.

Meetings with the role models are usually organised as speed-dates. In a speed-date session female STEM professionals talk with small groups of girls. They talk about their working life, about their aspirations and attainment. The aim is to incorporate STEM in girls’ task values, to show the variety and diversity of STEM and provide girls with an image they could identify with. Female professionals also give guest lectures at VET and universities. Most role models also participate in *Girlsday.*

The training programmes for teachers in secondary education focus on creating gender awareness among (science and math) teachers, on breaking down stereotyped ideas concerning gender and STEM, and on gender-inclusive science teaching and career guidance. Girls' self-confidence, stereotyped associations (e.g., of science with men), and the effect of communication about non-compulsory requirements (e.g., girls with an average grade are often advised not to go into science because it supposedly is too difficult for them) are explicitly dealt with. Recently VHTO developed a lesson series in which girls practice with handling a growth mind set instead of a fixed mindset. Teachers learn how they can make their lectures more gender inclusive and how they can create a positive image of career potential in STEM for girls. VHTO has developed a website with images (photos and films) and stories of male and female STEM professionals for this purpose. Teachers can use the website 'This is what I do in STEM' as a tool explore the possibilities of STEM together with their students (www.ditdoeik.nl).

In consultations with school managers, VHTO and the school management discuss how the theme gender/girls and STEM can be embedded in the school's policy (gender mainstreaming). VHTO promotes monitoring students' results and choices by gender, and that gender policy and activities should be systematically assessed and, if necessary, adjusted.

From 2004-2011 after the Lisbon agreements, VHTO participated in a large programme executed by the Platform for Science and Technology (PBT), funded by the Dutch government. The percentage of *pre-university education* students enrolling in a science-subject cluster increased dramatically in that period. Schools put considerable effort into boosting the students' enthusiasm for science-subject clusters, and they succeeded. The quantitative evaluation of the PBT Program showed that in schools where VHTO-activities had taken place more girls than average opted for a science-subject cluster. Moreover, secondary schools and universities reported a higher level of gender awareness in the evaluation, but how exactly this is reflected in their practice, apart from the support for activities focusing on girls and STEM, is difficult to measure. A more detailed review of VHTO-activities and its effects in the period 2004-2011 in secondary education is provided in [11, 13].

1.3 Higher STEM Education

VHTO has developed the *gender scan* to map the opportunities for optimising policy and activities regarding gender/girls and STEM. The gender scan of STEM-study programmes within VET and universities is performed together with key figures involved in the study programs (e.g., dean, program managers, intake manager, public relations officer) female students and science teachers from secondary schools. The gender scan evolves in a VTHO action plan with a focus on female students, a full day workshop on how to implement proposed actions, and the formation of a gender team. The main aim of a gender scan trajectory is to raise gender awareness, to formulate and implement relevant actions, and to create a group that would feel responsible for pushing the gender theme within the university.

The gender scan includes five themes, which together form the gender compass:

1. Institutional policy (i.e., focus on gender mainstreaming, quantitative awareness on girls in STEM education, staff policy, formation of a team with special focus on gender in STEM education
2. Outreach to female students in secondary education with a focus on science and technology. Special attention is paid to parents and teachers. Universities are encouraged to organise “girls only” activities (e.g., a high tea with female STEM students, speed-date sessions, or guest lectures)
3. Educational innovation (i.e., Educational restructuring or innovation is an excellent opportunity for gender mainstreaming. Impact of changes and their effect on intake, retention and outflow of male and female students should be carefully monitored)
4. Orientation on professions and professional practice (i.e., Information about all career prospects is vital when it comes to recruiting and retaining female students, and in encouraging them in the next step in their (educational) career. Female students profit from contact with female professionals (e.g., in guest lectures and workshops))
5. Regional networks (i.e., Universities could be more successful in reaching out to girls with STEM potential, in intake, retention and successful outflow into the labour market of female students, when they cooperate with partners from their “intake market” of schools for secondary education, and their “outflow market” of companies who might employ their students).

The number of students in pre-university education who opt for a science-subject cluster has increased significantly since 2004. This group of students forms the prospective intake for STEM higher education. We expected the increase in the popularity of science-subject clusters would be reflected in the intake statistics of STEM higher education. At the universities *for applied science,* women’s intake in STEM-study programs increased, whereas male intake decreased. The intake of students in *academic* STEM study programs increased by 62% since 2000. This increase is largely attributable to increasing numbers of female students: since 2000, there has been an increase of 73% of female students in STEM-study programs; in the same period the intake of female students into non-STEM-study programs increased by only 26%. The percentage of women in the Natural sciences sector of academic education is much higher than in the Technology sector (39% versus 19%).

2 CONCLUSIONS

Interventions created by VHTO to increase Dutch women’s participation in STEM are strongly linked to research. Although all interventions should be adjusted as needed to fit different educational systems and cultures, VHTO encourages the following measures:

- Organise meetings with inspiring female role models in STEM.
- Make school personnel and most of all, teachers and counsellors, and parents gender aware and provide them with knowledge and training to eliminate gender stereotypical thinking and acting towards their pupils.

- Incorporate gender awareness into school policies, preferably through a ‘gender team’ which will feel responsible for the creation and sustainability of this awareness.
- Create gender awareness throughout the educational chain (not only primary or only secondary: ongoing process at all levels and years!!).
- Involve and inform parents concerning the choices of their children (since their influence on children’s choices is very great), help them advise their daughters in a non- gender stereotype way.
- Let girls see and experience what working in STEM can be like, through experiences which are interactive and which yield tangible and useful results for the girls (for instance, build a website, make a product, question role models questions) The impressions provided this way are more powerful and accurate than what girls can learn from books.
- Provide information concerning the different types of careers possible in STEM: often unfamiliarity with the possibilities and the lack of realistic and modern images keep girls away from STEM.

3 WHAT IS NEXT?

The number of prospective female STEM students is still increasing. More and more girls in secondary education opt for a science-subject cluster. This is subsequently reflected in an increase in the intake of female students into STEM higher education. Clearly, the efforts made within secondary and higher education did have a positive impact.

Unfortunately, the number of girls opting for an advanced STEM-study program does not match the increased number of girls choosing a science cluster in secondary school. Still more than 70% of boys with a science subject cluster opts for an advanced STEM study course in higher education versus less than 50% of girls. More detailed research could be carried out on the motives of these girls: more effective and more structured career guidance during upper secondary education might encourage more girls to become interested in advanced STEM programs in higher education.

Also, general Dutch statistics show that only a small percentage of women STEM graduates proceeded into a professional career in STEM sectors of the labour market. This does not necessarily mean that these women are not or are no longer employed in STEM-related positions. They could be working in the service sector, at a hospital, in education, or for the government. It would be highly interesting to study in greater detail where women STEM graduates go, and in which areas or branches they find their first jobs.

As long as girls and women are underrepresented in STEM, particularly in STEM education, girls and women should receive specific attention in every government-initiated project that focusses on the STEM area. Specific policy concerning the recruitment of female students, constant attention to gender mainstreaming, and investing in a long term integrated approach may pay off in the (near) future.

REFERENCES

[1] Eurostat (2009). *Education statistics, UOE data collection*. European Commission (online http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/de/educ_esms.htm accessed in 2009)

[2] OECD (2003). *PISA dataset 2003*. Paris, France: OECD.

[3] Hyde, J. S., Fennema, E., Lamon, S. J. (1990). Gender differences in mathematics performance: A meta-analysis. *Psychological Bulletin, 107*, 139-155.

[4] Bøe, M. V., Henriksen, E. K., Lyons, T., & Schreiner, C. (2011). Participation in science and technology: Young people's achievement-related choices in late modern society. *Studies in Science Education*, *47*(1), 7-37.

[5] Ceci, S. J. & Williams, W.M. (2010). *The mathematics of sex. How biology and society conspire to limit talented women and Girls*. New York, USA: Oxford University Press.

[6] Eccles, J. S. (2007). Where are all the women? Gender differences in participation in physical science and engineering'. In S.J. Ceci, & W.M. Williams (Eds.), *Why aren't more women in science: Top researchers debate the evidence* (pp. 199-210). Washington, DC, USA: American Psychological Association.

[7] Eccles, J. S., Barber, B., & Jozefowicz, D. (1999). Linking gender to educational, occupational, and recreational choices: Applying the Eccles et al. model of achievement-related choices. In W.B. Swann, Jr., J.H. Langlois, & L. Albino Gilbert (Eds.), *Sexism and stereotypes in modern society: The gender science of Janet Taylor Spence,* 153-192. Washington DC, USA: American Psychological Association.

[8] Watt, H. M. G., Eccles, J. S., Durik, A. M. (2006). The leaky mathematics pipeline for girls: A motivational analysis of high school enrolments in Australia and the USA. *Equal Opportunities International, 25*(8), 642-659.

[9] Betz, D. E., & Sekaquaptewa, D. (2012). My fair physicist? Feminine math and science role models demotivate young girls. *Social Psychological and Personality Science*, *3*(6), 738-746.

[10] Miller, D. I., Eagly, A. H., & Linn, M. C. (2014). Women's representation in science predicts national gender-science stereotypes: evidence from 66 nations. *Journal of Educational Psychology,* http://dx.doi.org/10.1037/edu0000005.

[11] Booij, C., Jansen, E. J. M., Joukes, G. W. M., & van Schaik, E. J. (2011). *Gender in higher STEM education. Trend analysis.* Amsterdam, the Netherlands: VHTO.

[12] Jansen, E.J.M., Derksen, L.M. (in review) Talent viewer: evaluation of a project aimed at breaking down (gender) stereotypes about STEM and STEM-talents in primary schools in the Netherlands. *International Journal of Gender, Science and Technology*

[13] Jansen, N., & Joukes, G. (2013). Long Term, Interrelated Interventions to Increase Women's Participation in STEM in the Netherlands. *International Journal of Gender, Science and Technology*, *5*(3), 305-316.