

Gender & STEM Network Conference

5 & 6 September 2012

Conference Folder



Hotel Haarlem Zuid
Toekanweg 2
2035 LC Haarlem
The Netherlands



Welcome!

We are very pleased to welcome you all to the **First Gender and STEM Educational and Occupational Pathways and Participation Network Conference**.

The next two days will be entirely in the spirit of gender and STEM (Science, Technology, Engineering, Mathematics) here in the beautiful city of Haarlem.

The idea for a Gender & STEM Network came up in 2007, arising from a fruitful collaboration between VHTO, the Dutch National Expert Organisation on Girls/Women and STEM, and Associate Professor Helen Watt from Monash University in Australia.

In 2007, Helen Watt was invited as a keynote speaker at a VHTO conference. Our discussions centered about the very many research studies and findings concerning gender and STEM participation, but also that different studies tend to focus on one or few aspects. Watt and VHTO agreed it would have surplus value if relevant research results of the last few years could be interrelated, in order to be able to gain a more coherent view on gender and STEM from childhood to the labour market. With this in mind, in 2009 VHTO and Watt started the Gender & STEM Network with members who undertake related research.

Today and tomorrow we have many academics, teachers, policy makers, experts and the public together to explore the missing pieces of the 'jigsaw puzzle': what do we not yet know that we need to, concerning girls/women and STEM?

We hope the next two days to learn, to learn from each other and to share interesting results.

Kind regards,



Jacquelynne Eccles, Professor at the University of Michigan USA
Patron Network Member



Helen Watt, Associate Professor at Monash University Australia
Network Initiator



Noortje Jansen, Senior Consultant at VHTO, Dutch National Expert
Organisation Girls/Women and STEM The Netherlands
Network Secretariat

Table of contents

1. Conference Program	4
2. Keynote Speakers	7
3. Sessions & Presenters	10
4. Discussion Panel: 'The pieces of the jigsaw puzzle: What to focus on for advancing the aims of the network?'	39
5. The Network Gender & STEM	41
6. VHTO, Dutch National Expert Organisation Girls/Women and STEM	42
7. List of Participants	43
8. Locations & Directions	46

1. Program Gender & STEM Network Conference 2012

DAY 1 – September 5

N.B. If no room name is mentioned the room is: Frankrijk

08:45 – 09:15 Welcome
Badge pick-up, tea/coffee
Room: Lounge

09:15 – 09:30 Introduction by Cocky Booy, Managing Director VHTO, The Netherlands

09:30 – 10:30 **Keynote 1:** '*Gender and STEM: Opting in versus dropping out*'
by Jacquelynne S. Eccles, University of Michigan, USA

10:30 – 10:45 BREAK

10:45 – 12:30 **Session 1a, Symposium: STEM socialization**
Chair/discussant: Paul W. Richardson, Monash University, Australia
Room: Frankrijk

Papers:

1. Gniewosz & Noack: *Gendered patterns in parent-to-adolescent transmission of math task values*
2. Richardson, Watt & Devos: *(How) Does gender matter in the choice of a STEM teaching career and later teaching behaviours?*
3. Forgasz: *Public views on the gendering of STEM: What has changed?*
4. Cottaar: *Learning from mistakes; balancing masculine and feminine strategies in learning science*

10:45 – 12:30 **Session 1b, Symposium: Curious minds of boys and girls, differences in 'talent'?**
Chair/discussant: Marijn van Dijk, University of Groningen, The Netherlands
Room: Italië

Papers:

1. Wetzels: *Science for the young: A challenge for the teachers*
2. Van Vondel: *'Girls lack mathematical and scientific abilities'; fact or myth?*
3. Geveke: *Gender differences in the Orion Program: A case study of the Science Center*
4. Meindertsma: *Gender differences among preschoolers during a floating/sinking task*

12:30 – 13:30 LUNCH

13:30 – 14:30 **Keynote 2:** '*Sex differences: All in the brain?*'
by Lydia Krabbendam, VU University, Amsterdam, the Netherlands

14:30 – 14:45 BREAK

14:45 – 15:45 **Keynote 3:** '*Teacher and classroom characteristics of effective STEM education for boys and girls - recent findings and practical implications*'
by Angela Ittel, Institute of Technology, Berlin, Germany

15:45 – 16:15 Summarizing session
by Noortje Jansen, VHTO, The Netherlands

17:30 – 20:30 Conference dinner

DAY 2 – September 6

08:45 – 09:15 Welcome
Late badge pick-up, tea/coffee

09:15 – 09:45 *The Network Gender & STEM; educational and occupational pathways and participation. Why and how?*
by Noortje Jansen, VHTO, The Netherlands

09:45 – 10:45 **Keynote 4:** *'Dimensional comparisons and their consequences for self-concept and motivation'*
by Jens Möller, University of Kiel, Germany

10:45 – 11:00 BREAK

11:00 – 12:30 **Session 2a, Symposium: STEM participation:
Individual motivations, perceptions, and cultural values**
Chair/discussant: Helen M.G. Watt, Monash University, Australia
Room: Frankrijk

Papers:

1. Hayes & Bigler: *The role of values, gender discrimination, and mentoring in men's and women's satisfaction with their STEM graduate training*
2. Robnett & Leaper: *Perceptions of sexism in STEM fields: A cross-sectional examination of students in high school, college, and graduate school*
3. Watt, Shapka, Morris, Durik, Keating & Eccles: *Gender, motivation and mathematics participation: A comparison of samples from Australia, Canada and the USA*
4. Sáinz & Upadyaya: *Are male and female students accurate in the assessment of math abilities? To what extent does it influence the pursuit of technology and ICT-related studies?*

11:00 – 12:30 **Session 2b, Roundtable Discussion:
Program evaluations supporting girls in STEM**
Chair/discussant: Cocky Booij, VHTO, The Netherlands
Room: Italië

Contributors:

1. Schreiber: *What is different in a single sex computer science program? Experiences from a 12 years International Women's Degree Program at the Hochschule Bremen, Germany*
2. Leppävirta & Putila: *Sustaining changes in female participation in ICT studies*
3. Van Breemen & Van Laar: *Encouraging teachers to be gender aware*
4. Putila, Paloheimo & Leppävirta: *TiNA projects from Finland: Tech for girls, support for women*

12:30 – 13:30 LUNCH

13:30 – 14:30 **Keynote 5:** *'The development of science learning from a psychological perspective'*
by Maartje Raijmakers, University of Amsterdam, the Netherlands

14:30 – 14:45 BREAK

14:45 – 16:15

Session 3a, Symposium: Gender & STEM policy considerations

Chair/discussant: Gertje Joukes, VHTO, The Netherlands

Room: Italië

Papers:

1. Lin: *Community awareness: A quality analysis of the working group on women in physics (WGWIP) of the Physical Society of the Republic of China (PSROC)*
2. Best: *Structures and frameworks enhancing female participation and occupational pathways in STEM: A European perspective*
3. Ihnen, Sanwald & Schüle: *Quality management for more sustainability of women-attracting measures in STEM*
4. Szekeres, Nagy, Takács & Vicsek: *Approaches to improve the underrepresentation of women in technology higher education programmes - Results from a Hungarian university study*

14:45 – 16:15

Session 3b, Symposium: Pathways to STEM studies and careers

Chair/discussant: Helen M.G. Watt, Monash University, Australia

Room: Frankrijk

Papers:

1. Lazarides & Ittel: *Gender & STEM: Educational and occupational pathways and participation in a global context*
2. Findlay, Watt & Kronborg: *Socio-motivational determinants for girls' pathways of mathematical enrollment and career choice*
3. Van Soom & Donche: *Gender, academic motivation and self-concept: Profiling of freshmen science and technology students*
4. Korpershoek: *Who opts for STEM courses? Introverted and autonomous girls!*

16:15 – 17:00

Discussion Panel: 'The pieces of the jigsaw puzzle: What to focus on for advancing the aims of the network?'

Chair: Helen Watt

Panelists: Jacquelynne Eccles, Angela Ittel, Rebecca Bigler, Jantina Walraven, Gertje Joukes

17:00 – 18:00

Network reception

2. Keynote Speakers

Keynote 1: 'Gender and STEM: Opting in versus dropping out'

Professor Jacquelynne Eccles, University of Michigan, USA



Jacquelynne Eccles is the Wilbert McKeachie and Paul Pintrich University Professor of Psychology and Education, and a research scientist at the Institute for Social Research at the University of Michigan. She has served as chair of the Advisory Committee for the Social, Behavioral and Economic Directorate at the NSF and the MacArthur Foundation on Successful Pathways through Middle Childhood. She is past president of the Society for

Research on Adolescence (SRA) and was a member of the MacArthur Foundation Network on Successful Adolescent Development.

Dr. Eccles has been the associate editor of *Child Development* and editor of the *Journal of Research on Adolescence*. She is currently the editor of *Developmental Psychology*. She is co-author/co-editor of 15 books/special issues including *Women and Sex-Roles*; *Managing to Succeed*, and most recently, *Understanding Women's Choice of Mathematics- and Science-Related Careers*; and *Gender and Occupational Outcome*. She has received several major awards recognizing her scholarship including life time career achievement awards from SRA, APS, Division 15 of APA, and the Society for Research on Human Development. She was elected to the National Academy of Education in 1998. Her research interests focus on the development and socialization of psychological, particularly self-system, influences on motivation, activity choice, and engagement.

<http://www.rcgd.isr.umich.edu/garp/>

Keynote 2: 'Sex differences: all in the brain?'

Professor Lydia Krabbendam, VU University Amsterdam, the Netherlands



Lydia Krabbendam is Full Professor of Educational Neuropsychology at the VU University Amsterdam. Her research focuses on individual differences in social cognition during adolescence and emerging adulthood and how these relate to school performance and development of psychopathology. Key topics include the development of self-regulation, perspective-taking, empathy and trust, and the neural correlates of these functions.

Lydia Krabbendam obtained her PhD (2000) in cognitive neuropsychiatry at the Department of Psychiatry and Neuropsychology, Maastricht University, and continued working in that area for several years. Meanwhile, she obtained her clinical registrations as health care psychologist and clinical neuropsychologist. In 2009, she joined the Educational Neuropsychology group at the Department of Special Education at VU University in Amsterdam, broadening her research focus to include normal development of neuropsychological functions with a focus on the period of adolescence and emerging adulthood.

<http://www.psy.vu.nl>

Keynote 3: 'Teacher and classroom characteristics of effective STEM education for boys and girls- recent findings and practical implications'

Professor Angela Ittel, Institute of Technology, Berlin, Germany



Angela Ittel is a Full Professor of Educational Psychology at the Institute of Education in the Faculty of Human Science at the Institute of Technology in Berlin, Germany. After receiving a Master of Science Degree and a PhD in Developmental Psychology from the University of California at Santa Cruz, USA, she was a postdoctoral researcher at the Friedrich Schiller University in Jena, Germany and took on an assistant

professorship at the Freie Universität Berlin, as well as visiting professorships in Berlin and Munich. Her work covers a wide range of issues related to psychosocial development and learning of adolescent boys and girls.

In her STEM related research, she is interested in gender specific factors of (academic) interest development, gendered educational and occupational choices, and the development of teacher competencies. In her more applied work, she develops strategies schools and universities implement to foster STEM related interests and examines their effectiveness. She also conducts teacher trainings and workshops to communicate her work directly into teaching practice.

Angela Ittel is currently Associate Editor for the International Journal of Developmental Science, and serves on several national and international review boards. Her latest STEM related publication, titled 'Dealing with diversity in mathematics and science classes' (in German: 'Differenzierung im mathematisch-naturwissenschaftlichen Unterricht'), which she co-edited with her collaborator Rebecca Lazarides, was supported by the De Gruyter Foundation.

<http://www.paedpsy.tu-berlin.de/>

Keynote 4: 'Dimensional Comparisons and their Consequences for Self-Concept and Motivation'

Professor Jens Möller, University of Kiel, Germany



Jens Möller, PhD, is Professor of Educational Psychology and Director of the Teacher Education Centre at the University of Kiel, Germany. His main research interests are: self-concept, reading motivation, and second language learning. He has published in various journals, e.g., Journal of Educational Psychology, Review of Educational Research.

<http://survey.psychpaed.uni-kiel.de/Jens-Moeller.html>

Keynote 5: 'The development of science learning from a psychological perspective'

Professor Maartje Raijmakers, University of Amsterdam, the Netherlands



Maartje Raijmakers is Professor of Cognitive Development at the Psychology Department of the University of Amsterdam, and is affiliated to Science Center NEMO. Her major interest concerns the development of learning, from infancy to adulthood. The focus of her research is on distinct learning processes, such as rational learning (forming explicit, rule-based representations) and associative learning (forming exemplar-based representations).

A major interest concerns individual differences in terms of learning strategies within and between individuals and the way different learning strategies interact in knowledge acquisition. She collaborates in interdisciplinary research groups, such as the priority program Brain and Cognition at the University of Amsterdam. Science learning, especially in informal settings, is a specific case that she studies, because it concerns learning about phenomena that people experienced frequently before studying it in a more explicit way.

For her research on science learning she collaborates with science center NEMO and in the national project Curious Minds (TalentenKracht), financed by the Ministry of Education (OCW and Platform Bèta Techniek).

<http://mraijsmakers.socsci.uva.nl/>

3. Sessions & Presenters

Session 1a, Symposium: **STEM socialization**

Chair/discussant: Paul W. Richardson, Monash University, Australia

5 September: 10.45 – 12.30 h

Conference room: Frankrijk

Introduction

Socialization influences play an important role in the shaping of girls' and women's attitudes and participation in STEM (Science, Technology, Engineering, Mathematics) advanced studies and fields of career. This raises questions like:

- (How) Do mothers and fathers transmit or shape sons' and daughters' STEM-related values?
- Do STEM teachers have gendered motivations and teaching behaviours?
- What views are held by the public these days about gender and STEM?
- Do girls and boys apply different learning strategies in STEM-subjects in school?

Organisation

In this symposium several researchers will present findings to address these questions in their countries, from Germany, Australia, and the Netherlands. Following their presentations, we will collectively discuss the above mentioned questions. Presenters and attendants of the symposium can add more questions that, in their opinion, need to be discussed. After the conference, those who are interested in this matter, can proceed exchanging views in the Forum of the Network website (www.genderandstem.com).

After each presentation (15 minutes) a few minutes are reserved for questions if something in the presentation is not clear. We strongly recommend to save questions of discussion until after the presentations, to contribute to collectively enriched discussion.

- **Gendered patterns in parent-to-adolescent transmission of math task values**
Burkhard Gniewosz (University of Würzburg, Germany) & Peter Noack, (Jena University, Germany)

The present study investigates the intergenerational transmission of the valuing of math within family. We tested if there are groups of students showing differential intergenerational transmission patterns. Based on a two-wave longitudinal sample of 1198 German fifth graders, their mothers (N=874), and fathers (N=733), structural equation mixture models showed two groups of students. In the first group, only the mothers' valuing of math predicted the students' own values in this domain, while in the other group the fathers' valuing of math was the only significant predictor. Parental school involvement and parenting styles were ruled out as causes for this pattern. Dyad gender composition, however, predicted group membership. The results are discussed in terms of parent and student characteristics affecting patterns in intergenerational values transmission.

Keywords: math task values, intergenerational transmission, dyad gender composition

Burkhard Gniewosz currently works as assistant professor at the University of Würzburg in the department of educational research. In 2002, he received a diploma in Psychology of the University on Jena, Germany. In 2005, Burkhard Gniewosz finished his dissertation with the doctoral thesis on 'Intergenerational transmission and projection processes of political attitudes within family', also at the University of Jena. From 2002 until 2010, he worked in an interdisciplinary research group on 'Discrimination and Tolerance in Intergroup Relations'. The work during that time was mostly on socialization effects on adolescent political development. At the same time, his research focus opened towards contextual effects (parents, schools etc.) on adolescents' development of beliefs, values, and attitudes in a broader sense. Recently, his major research topics are in the field of contextual influences on academic beliefs, values, and attitudes.

➤ **(How) Does Gender Matter in the Choice of a STEM Teaching Career and Later Teaching Behaviours?**

Paul W. Richardson, Helen M. G. Watt (Monash University, Australia) & Christelle Devos (Catholic University of Louvain, Belgium)

Objectives & Framework

There is concern in Australia and elsewhere to attract sufficient numbers of high-quality STEM teachers (Science, Technology, Engineering, Mathematics). Fewer men and women are pursuing STEM fields of study, with women dropping out of these fields of study earlier and at a greater rate. Of those studying advanced STEM, relatively few wish to teach, likely because of competing high-status and salary career options. At the same time, teaching continues to be a feminised career, posing particular challenges to recruit sufficient quality teachers to STEM fields. Who is choosing a teaching career in STEM?; for what reasons, and, do those reasons differ for men and women future STEM teachers?; also, does it matter in terms of their later teaching style once they have commenced in the profession? These are the core questions addressed by our longitudinal study.

Methods & Data

Participants at Time 1 ($N=245$) were beginning STEM teacher education candidates, from the FIT-Choice sample (www.fitchoice.org). There were substantially fewer women (53% vs. 67-84%) and ESB [English speaking background] future STEM teachers, relative to proportions from the general sample (78% vs. 81-90%). Motivations were assessed using the FIT-Choice scale (Watt & Richardson, 2007) tapping intrinsic value, perceived teaching abilities, positive prior teaching and learning experiences, social utility values (shape future of children/adolescents, enhance social equity, make a social contribution, work with children/adolescents), social influences, personal utility values (job security, time for family, job transferability) and teaching as a 'fallback' career. At Time 2 following degree completion, 98 of the participants who remained in the study were currently teaching, and completed surveys assessing their teaching style measured by our new Teaching Style Scale (TSS) which taps: Positive expectations, Relatedness, Structure, and Negativity.

Results

Highest rated motivations were intrinsic value, perceived teaching abilities, positive prior teaching and learning experiences, and social utility values (shape future of children/adolescents, enhance social equity, make a social contribution, work with children/adolescents). MANOVA identified statistically significant gender differences for 3 factors: women rated the motivation to work with children/adolescents higher, whereas men rated their desire for a transferable job higher, and were also more motivated to teach as a 'fallback' career ($p<.05$). Intriguingly, these motivations rated higher by men subsequently predicted negative teaching behaviours: being motivated to teach as a transferable job predicted lower relatedness with students ($r=-.252$, $p=.020$), and teaching as a fallback career predicted greater negativity towards students ($r=.228$, $p=.037$). There was also a gender difference in reported teaching behaviours: women held more positive expectations for their students ($M=6.10$, $SD=.77$ vs. $M=5.77$, $SD=.70$ for men), $F(1,82)=.21$, $p=.045$.

Implications

To increase the supply of well-qualified youth through the STEM pipeline during schooling and into university, member countries of the OECD have developed targeted policies. Many of these countries are experiencing acute shortages and serious challenges in attracting high quality STEM teachers. Promises of a technological revolution and rapid economic development will seem hollow if children and adolescents are dissuaded from scientific / mathematical fields of career by teachers who chose teaching as a fallback career when they were not able to get into their preferred degree program.

Motivations for choosing teaching as a career are multidimensional and complex. Identifying highest rated motivators for future STEM teachers offers the possibility to enhance targeted recruitment efforts. Understanding different motivations for men and women offers possibilities to attract more men into STEM teaching, if that is a goal. Working with children/adolescents was a lower attractor for men, who were more motivated by travel opportunities and to teach as a 'fallback' career. Neither of those motivations should be encouraged, however, because they subsequently lead to poorer relationships with students and higher negativity in the classroom.

Keywords: Gender, STEM teaching choice, Career motivations

Paul W. Richardson, PhD, is an Associate Professor of Education at Monash University, Australia. He has previously worked at the University of Sydney, the Gippsland Institute of Advanced Education, and the University of Michigan. He was Associate Dean (Teaching) and is currently Associate Dean (Research) in the Faculty of Education. A current program of research seeks to use theory, methods and knowledge from human development and psychological science to better understand and improve teacher career engagement and development. He is engaged in a longitudinal study of the motivations related to the choice of teaching as a career, teacher self-efficacy, and the career trajectories of different types of beginning teachers. Gender and equity issues are central to research on teaching, a highly feminised profession around the globe. His work is particularly concerned with the 'fit' between person and environment in the workplace and the processes by which the personal dimensions of an individual in terms of goals, expectations, values and beliefs in one professional context may flourish, while in another these hoped for teacher selves may become barriers to positive professional development. He has received substantial research funding for this research from the Australian Research Council (2006-2012).
Home page: <http://users.monash.edu.au/~paulr/>
FIT-Choice Research Project: www.fitchoice.org

Helen M.G. Watt is an Associate Professor in the Faculty of Education, Monash University, and an Australian Research Council Research Fellow 2011-2015. Previously she has served on the Faculties of the University of Michigan, University of Western Sydney, University of Sydney, and Macquarie University. Her interests include motivation, gendered educational and occupational choices, motivations for teaching, teacher self-efficacy, longitudinal research, and quantitative methods. Her current research work has implications for redressing the gender imbalance in mathematics- and science-related careers, and for supporting the career and professional development of beginning teachers. Helen is currently Associate Editor for *Educational Research Review*, and has served on the Editorial Boards for the *Journal of Research on Adolescence*; *Equity, Diversity and Inclusion*; *Journal of Experimental Education*; *Equal Opportunities International*; and the *Australian Journal of Education*. She has received national and international research awards, attracted substantial external funding, and co-edited recent books and journal special issues including *Gender and Occupational Outcomes*; *Understanding Women's Choice of Mathematics- and Science-Related Careers*; and *Motivation for Teaching*.

Christelle Devos is working as a researcher at the Université catholique de Louvain (Belgium). After her degree in the faculty of Psychology and Education, she completed a PhD focusing on beginning teachers' well-being. She investigated how self-related and working environment variables are likely to influence novice teachers' self-efficacy and feelings of depression in the face of difficulties and challenges. Her current work focuses on the completion of the PhD process and aims at identifying why some PhD students successfully complete their PhD while others lose their motivation and give up. Her broader research interests relate to teachers' motivation and emotions, in relation to their gender and teaching subjects. She is currently working in the Motivation and Learning lab of her university, with Mariane Frenay and Benoit Galand. She also went on a post-doctoral stay in Monash university with Helen Watt and Paul Richardson.

➤ **Public views on the gendering of STEM: What has changed?** **Helen J. Forgasz (Monash University, Australia)**

The STEM disciplines have historically been gender stereotyped as male domains, that is, considered more suited to males than to females. At the upper levels of high school and in tertiary institutions, more males than females are enrolled in the most challenging mathematics subjects offered, the physical sciences, engineering programs, and IT courses. The prevalence of males in these areas spills over into related career paths and employment.

In the 1980s, the situation was similar to today. At that time, however, there was government support for interventions to promote mathematics and science to girls. In Victoria, Australia, the Department of Labour (not the Department of Education) initiated the 'Maths multiplies your choices' media campaign which targeted parents.

The aim was to raise awareness of the impact of not taking mathematics at high school, that is of 'pigeon-holing' daughters and limiting their career options. The slogan used was 'Don't pigeon hole your daughters'.

For those around at the time, the slogan conjures up the image of the TV advertisement showing girls languishing in pigeon holes from which they emerge. The campaign was evaluated by surveying the general public. The impact was clear; awareness had been raised and enrolment numbers in non-compulsory mathematics subjects at grade 11 increased dramatically. So successful was the campaign that it was deemed unnecessary to fund it the following year. In only a few short years enrolments returned to their former patterns.

In the context of a world where gender equality is high on UNESCO's agenda, and STEM was the focus of the 55th Commission on the Status of Women in 2011, the time was right to conduct a survey of the general public to determine whether traditional gendered views of the STEM fields were still prevalent. Adopting an innovative recruitment technique – advertising on Facebook for participants to complete an online survey – the views of 784 respondents representing 84 countries were gathered. To maximise completion rates, only 15 items were included on the survey, with the option of providing explanations to the closed responses to each question.

In this paper, the focus will be on findings from eight items aimed at garnering views on the importance of the mathematics, the enabling STEM subject, and the gendering of STEM fields. Analyses by respondent gender will also be presented. The questions and response formats are:

1. Should students study maths when it is no longer compulsory? Yes/No/Unsure
2. Do you think that studying maths is important for getting a job? Yes/No/Unsure
3. Who is better at maths, girls or boys? Girls/Boys/Same/Unsure
4. Is it more important for girls or boys to study maths? Girls/Boys/Same/Unsure
5. Who are better at using calculators, girls or boys? Girls/Boys/Same/Unsure
6. Who are better at using computers, girls or boys? Girls/Boys/Same/Unsure
7. Who are more suited to being scientists, girls or boys? Girls/Boys/Same/Unsure
8. Who are more suited to working in the computer industry, girls or boys?
Girls/Boys/Same/Unsure

Helen J. Forgasz is an associate professor, Faculty of Education, Monash University, Australia. She has a strong research record on gender issues in mathematics, science, and technology education. She focusses on affective and contextual factors contributing to gender differences in learning outcomes – enrolments, achievements, and attitudes. Current projects include: evaluating a school-based intervention program, *Digital Divas*, aimed at stimulating girls' interest in computers and related careers, and teachers' conception of numeracy across the curriculum and how this is manifest in classrooms. Helen has published widely. Her most recent book is *Towards equity in mathematics education: Gender, culture and diversity* (Springer).

➤ **Learning from mistakes; balancing masculine and feminine strategies in learning science.**

Alice Cottaar (Eindhoven University of Technology, The Netherlands)

The literature (Jackson, 2002; Dutch Advisory Council for Education, 2009; Cottaar, 2012) and teachers (Cottaar, submitted) agree that in general, female students have a much better work attitude than male students. This is often associated with over-representation of female students in higher education (Blondal & Adalbjarnardottir, 2012; Jackson & Dempster, 2009; Younger, Warrington, & Mclellan, 2002). However, in the Dutch academic STEM fields of study female students are a minority and in high school advanced physics, these students still lag behind in achievement (Meelissen & Drent, 2009; Cottaar, 2012). Therefore, I have investigated gender differences in (the interrelationships between) work attitude and achievement in a diversity of science related fields of academic study in order to measure the effectiveness of a more feminine compared to a more masculine learning strategy.

Two surveys are conducted both involving academic freshman science students at 12 universities throughout the Netherlands (around 18 years old).

The first survey (N=3230), conducted at the start of the academic year of 2008-2009, is used to measure the science capability of the students; the second survey (N=1558), conducted at the end of the same year, measured their perceived work attitude at university and their academic success. Structural equation modeling and T-tests are used to analyze the male and female samples resulting in two separate but comparable models on Academic Success; additional information is gathered through interviews with 29 carefully selected high school physics teachers throughout the country (Cottaar 2012; Cottaar, submitted).

In general, the data show that females report to work significantly harder in all 'traditional' aspects of work, e.g. time investment, working on problem solving exercises, quantity and quality of reading. However, females do not perform any better (Cottaar, submitted). I conclude that the way females work in order to learn (feminine learning strategy) is significantly less effective in science related fields of study than the masculine learning strategy. I argue that female students should be challenged to take more risks in order to find their own optimal learning strategy for science related subjects as males show to do in my study. Unfortunately, a tendency in female students to avoid risks (of failure) prevents them from using more effective strategies (Carlone, 2004; Yestrumskas, 2004).

With Dai (2002), I want to argue that balancing the feminine and masculine learning strategies in students could benefit them all. After my presentation, I would like to discuss the increasingly popular idea that our western school system 'kills creativity' essential for STEM subjects and Arts (STEAM) (Sir Ken Robinson). Recall from the introduction that this high school system tends to benefit females more than males. I argue that in physics and later on in science related courses of study this creativity (associated with the male learning strategy) is essential and that female students would benefit from being taught to be more 'creative' and less 'docile'. I propose that in order to 'teach creativity' effectively, all students should be taught to focus on their mistakes rather than to avoid them, as females tend to do, or deny them, as males tend to do.

Keywords: Gender; Achievement; High School; Academic; Learning Strategy.

Alice Cottaar. MSc Applied Physics, Eindhoven University of Technology (1984); qualified teacher for senior high school students; teaching and coaching experience in a diversity of high schools and advanced education in different subjects related to math and physics (1999-...); independent science education research focusing on physics education in pre-academic high school and freshman students in science related fields of study (2007-...); www.zetce.nl; Publication in Journal of Research in Science Teaching (Cottaar, 2012) + review activities for JRST (2012). Papers for ORD 2010 + 2012; Poster presentation ESERA 2009; Two articles submitted at JRST.

Session 1b, Symposium Curious minds of boys and girls, differences in 'talent'?

Chair/discussant: Marijn van Dijk, University of Groningen, The Netherlands.

5 September: 10.45 – 12.30 h

Conference room: Italië

Introduction

The project 'Curious Minds' ('Talentenkracht' in Dutch) is a national initiative to stimulate STEM talent in young children (see: www.talentenkracht.nl). In this program, seven different universities participate, each with their own specific topics and research focus. The department of Developmental Psychology at the University of Groningen argues that the role of the teacher is essential in the children's scientific acting and thinking and mainly studies the development of STEM talent within the interaction between teachers and children. In this symposium, we aim to present some initial results of the Groningen Curious Minds project with regard to gender. The symposium offers a mix of theoretical and empirical contributions, and addresses both fundamental and applied aspects of STEM teaching. In the discussion, we argue the relevance of studying gender in a large research project.

Key words: STEM teaching, teacher education, gender-stereotypical attitudes, stimulating learning environments, role models, interaction patterns

Marijn van Dijk (1972) studied Developmental Psychology at the University of Tilburg. In 2004, she defended her PhD thesis at the University of Groningen, on variability and ambiguity in early language acquisition. She currently works as an Assistant Professor (tenure track) in Developmental Psychology. Her research themes are: early interaction and development (language, feeding) and the dynamics of learning in primary education. Most studies are focused on change processes and the observation of interaction behaviors in naturalistic circumstances. Marijn is a staff member in the Groningen *Curious Minds project* and supervises several PhD students as such.

➤ Science for the young: a challenge for the teachers Annemie Wetzels (University of Groningen, The Netherlands)

Teachers' attitudes towards science are an important factor that co-determines the quality of their teaching, which in turn greatly influences pupils' academic performances (Barber & Moursched, 2007). The aim of this presentation is to report about the *Video Feedback Coaching for teachers* (VFC-t) (Wetzels, Steenbeek & Van Geert, submitted), that gives teachers the knowledge and skills to teach science to young children, age 5-8. This is important because teachers of this age group are mostly women, who are less likely than men to declare to like science (Osborne, Simon & Collins, 2004) and whose interests in science decline more over time than men's do (Hoffmann, Häussler & Peters-Haft, 1997). Many of them are somewhat resistant to teaching Science and Technology, whereas others have no idea how they can teach this in a proper way. To help these teachers overcome their anxiety for teaching science, the VFC-t provides them with the empirical cycle (De Groot, 1969) as a framework for science teaching. The teachers also receive information about scaffolding and questioning. After an introduction lesson, the participating teachers are coached during four S&T lessons while reviewing video recordings of their own science lessons.

A qualitative pilot study was carried out on the basis of semi-structured interviews with twelve elementary school teachers (two male, ten female) of kindergarten and grade 1-2. The results showed that VFC-t has a positive effect on the teachers' attitude towards teaching S&T. Based on these results a more structured quantitative study --with the aim of providing data about changes in the real interactions in the classroom-- was performed. Seven elementary school teachers (one male, six female) working with children in kindergarten and grades 1-2 participated.

Prior to the coaching, two regular lessons in science and technology were recorded on video, as well as two lessons after the coaching took place. A part of the teacher behavior in the video recordings of those lessons was coded using video analysis techniques.

The results of both studies together showed that teachers reported a higher level of intrinsic motivation for teaching science. They enjoyed lessons more and had a better interaction with their pupils by asking more questions, in particular more questions related to the empirical cycle and more follow up questions. These results demonstrate that a relatively simple intervention based on video coaching, can stimulate (male and female) teachers to spark interest in STEM in preschool children.

Annemie Wetzels (1960) gained a master's degree in Clinical and Developmental Psychology at the University of Groningen in 2009. She now works as a PhD student at the University of Groningen where she has developed a Video Feedback Coaching program for kindergarten and grade 1-2 teachers. This project is part of the Curious Minds program and aims at improving teachers' skills for stimulating children's talented science learning. By using a dynamic systems approach she studies the effects of this coaching program on teachers and children.

➤ **'Girls lack mathematical and scientific abilities'; fact or myth?**

Sabine van Vondel (University of Groningen, The Netherlands)

This presentation deals with gender differences in STEM reasoning in the upper grades of elementary school. The aim is to provide a theoretical background of what is known about the (development of) scientific reasoning of 9-11 year-olds during STEM lessons, and differences in boys and girls development. In the upper grades of primary education, STEM topics become advanced and more challenging. Also --or perhaps because of this-- gender differences in both performance and attitudes typically increase during these years (Jones et al, 2001). But are these differences really that profound?

After reviewing the literature, it becomes clear that there are in fact mixed results. Whereas some studies show boys outperforming girls on science (Steinkamp & Maehr, 1983; The Nation's Report Card, 2005; 2011), others do not find such results (Hyde, 2005; Hyde & Linn, 2006) or only for smaller subdomains (visuo-spatial ability (Sanchez & Wiley, 2010); mechanical reasoning (Smail & Kelly, 1984). The discrepancies between these studies might be due to the use of different topics and tasks or the type of analyses conducted (mean comparison versus effect size analyses). According to Hyde (2005), a 'Gender Similarity Hypothesis' suits the available data better, meaning that boys and girls have similar psychological traits and cognitive abilities. Developmental studies on scientific reasoning show that boys and girls do seem to develop in quite similar ways (Haworth, Dale & Plomin, 2008). Therefore other factors may play a role in development of scientific reasoning and (assumed) gender differences. Additionally aspects like motivation, task affordances and the role of the environment (teachers/parents) might strengthen differences.

Recently, a Curious Minds project has started on gaining insight in the co-construction process of scientific reasoning between teachers and upper grade children. A video feedback program for teachers of grade 3-6 (group 5-8 in the Dutch system) will be developed in order to stimulate teachers to increase the quality level of children's reasoning (based on Wetzels, Steenbeek & van Geert, submitted). The literature review suggests that we should pay attention to the complex but subtle interplay between gender and other relevant aspects, such as motivation, differences in performance in subdomains and the behavior of teachers.

Sabine van Vondel (1988) is a graduate of the Research Master of Behavioral and Social Sciences in the specialization Education and Development at the University of Groningen. Recently she started a PhD trajectory in the Curious Minds project focusing on the co-construction of talented STEM-reasoning in 9-12 year olds and their teachers. The aim will be to analyze the role of the teacher in stimulating 9-12 year old children's science talented acting and thinking in naturalistic classroom situations, and at studying the effects of a Video Feedback Coaching program for this group of teachers.

➤ **Gender differences in the Orion Program: a case study of the Science Center**
Carla Geveke (University of Groningen, The Netherlands)

Primary school teachers are crucial in determining a positive attitude of children towards science and technology (Osborne, Simon & Collins, 2003). However, it has been shown that teachers' attitude towards science and technology is often negative (Palmer, 2004), and gender differences have been perceived. Denessen et al. (2011) state that male teachers reported significantly higher scores on enjoyment for teaching science and technology than female teachers, and also score higher levels of perceived competence. This probably has to do with the implicit gender stereotypes and gender differences in scientific engagement, which are mutually reinforcing (Nosek, et al., 2009). Many teachers think they are unbiased towards boys and girls. However, it has been demonstrated that many teachers associate science and technology more with boys than with girls (Denessen, et al., 2011). The lack of a positive attitude towards science and technology in female teachers underscores the importance of providing children with environments that provoke curiosity. Girls can benefit from those environments with (female) role models who are enthusiastic, well equipped and unbiased. The science networks in the north of the Netherlands aims to provide schools with a stimulating learning environment by means of the *Orion Program* in which talent can emerge and unfold. The results of this program are evaluated within the Curious Minds project.

A selected group of schools (n = 20) participated in a study on the effect of this program. This case study describes qualitative and quantitative results on gender differences in the Science Center, one of the stimulating environments of the Orion Program. One finding is that school managers and teachers who were interviewed before joining the Orion Program quoted some stereotyped examples. Preliminary results also show that male educators in the Science Center are more enthusiastic and feel more competent than female educators do. Nevertheless, children judge their visit at the Science Center positively, girls even more positively than boys (Veenker, 2010). The initial findings of interaction patterns show that when the educator is male, girls are less likely to take part in the interaction, compared to when the educator is female. In further research, we closely study the existence of gender roles and their impact on children's enjoyment of scientific and technological activities. This way, we can be able to provide them with the best possible learning environment, ensuring that the boys' and girls' interest in science and technology extends beyond their primary education.

Carla Geveke (1972) studied Educational Sciences at University of Groningen. In 2001, she finished her master thesis, titled 'Choosing processes of learning methods in primary education'. At that time, she was also doing research at Gender Studies on sexual harassment and safety at school. After her graduation, she started working at the Hanze University of Applied Sciences as a teacher and recently also as a researcher within the Lectorship Integrated Youth Policy. Currently, she works as a PhD student in Developmental Psychology. Her research concerns the effect of the Curious Minds approach in stimulating science and technology activities, the Orion program.

➤ **Gender differences among preschoolers during a floating/sinking task**
Heidi Meindertsma (University of Groningen, The Netherlands)

The Curious Minds program in the Netherlands states that all young children do have some natural interest in science, technology, engineering and mathematics (STEM), but is this equal between boys and girls? Some studies suggest that with increasing age, the differences between girls and boys get more and more distinct (e.g. Rocard et al., 2007), but even at the preschool age, parents and teachers react differently to boys than to girls regarding science education (e.g. Crowley, Callanan, Tenenbaum & Allen, 2001). The question remains whether this also means that there are gender differences in the performance of these children on STEM-tasks during preschool.

The aim of this study was to increase our knowledge about the performance levels of boys and girls on a scientific reasoning task in early childhood. Therefore, 38 children (Mean age = 63 months, SD = 6.43; 20 boys, 18 girls) were interviewed about the floating or sinking of fourteen objects. Each child had to predict and explain what would happen and after seeing each object being placed in the water tank, explain why the objects floated or sank. The explanations were coded for their complexity based on skill theory (Fischer, 1980) and for their content. Although visual inspection showed that boys might perform better than girls, there were no differences in overall percentage correct predictions, mean explanation level or maximum explanation level. However, girls had a higher percentage of explanations at the lowest (sensorimotor systems) level, whereas boys had more explanations on the middle (single representation) level. There were no differences at the highest (representational mapping) level. Even at this age, girls more often did not give an explanation compared to the boys. Regarding the content, no gender differences were found at the lowest level of explanation. At the middle and highest level, the boys significantly more often referred to the weight of the object than the girls. At the middle level, girls more frequently explained the behavior of the object as due to the size of the object.

In conclusion, there appear to be some gender differences in scientific reasoning in early childhood. Since it is known that differences between the genders on science are not caused by biological differences, we assume that even at this age, experiences in and out of school have shaped children's behavior resulting in different behavior patterns for boys and girls.

Heidi Meindertsma (1980) studied Human Movement Sciences and Brain & Behavior, both at the University of Groningen. She now works as a PhD student at the department of Developmental Psychology at the University of Groningen and hopes to defend her PhD thesis in the summer of 2013. Her project is part of the Curious Minds project and aims at describing short-term interaction processes between adults (teachers and parents) and preschoolers using a dynamic systems approach.

Session 2a, Symposium STEM participation: Individual motivations, perceptions and cultural values.

Chair/discussant: Helen M.G. Watt, Monash University, Australia

6 September: 11.00 – 12.30 h

Conference room: Frankrijk

Introduction

In many countries girls and women are underrepresented (or men are overrepresented) in STEM (Science, Technology, Engineering, Mathematics) advanced studies and fields of career. This raises questions like:

- What is the role of girls' and women's own motivations and self-beliefs?
- Are these self-beliefs accurate?
- What gender discrimination is encountered or perceived?
- How do different cultural values play a role?

Organisation

In this symposium several researchers will present findings to address these questions in their countries, from the United States, Australia, Canada, and Spain. Following their presentations, we will collectively discuss the above mentioned questions. Presenters and attendants of the symposium can add more questions that, in their opinion, need to be discussed. After the conference, those who are interested in this matter, can proceed exchanging views in the Forum of the Network website (www.genderandstem.com). After each presentation (15 minutes) we will have a few minutes for questions if something in the presentation is not clear. We strongly recommend to save questions of discussion until after the presentations, to contribute to collectively enriched discussion.

➤ **The Role of Values, Gender Discrimination, and Mentoring in Men's and Women's Satisfaction with their STEM Graduate Training.**

Amy R. Hayes & Rebecca S. Bigler (University of Texas at Austin, USA)

Despite decades of efforts aimed at increasing women's representation in STEM fields in the United States, girls and women remain stubbornly under-represented in STEM disciplines, especially within academia. For example, women received 37.7%, 20.3%, and 21.3% of Ph.D.s awarded by U.S. colleges and universities in 2009 within chemistry, physics, and engineering, respectively (Digest of Education Statistics, 2009).

Furthermore, among women who earn Ph.D.'s in STEM fields, disproportionate numbers of women fail to obtain tenure at research institutions. Explanations for women's underrepresentation include: (a) their valuing of family over career, (b) experiences with gender discrimination, and (c) poor mentoring. We sought to examine individuals' perceptions within these domains during graduate school, a critical time in the process of pursuing an academic STEM career. Specifically, we examined whether women and men enrolled in a STEM doctoral program in chemistry and biochemistry show differing occupational values, perceptions of gender discrimination, and perceptions of mentor support. We then tested hypotheses concerning the utility of these variables for predicting students' satisfaction with their graduate training.

Participants included 136 doctoral students (59 women, 77 men) in the Department of Chemistry and Biochemistry of a major research-oriented institution in the Southwestern United States. Participants ranged in age from 22 to 38 years old ($M = 26.1$, $SD = 2.6$). Additionally, 51 participants (19 women, 39 men) completed the same survey one year later. Surveys were completed at the end of the 2009-2010 academic year (Time 1) and, for longitudinal participants, at the end of the 2010-2011 academic year (Time 2). At both time points, participants completed measures of their: (a) occupational values, (b) value-career fit, (c) perceptions of gender discrimination in their department, (d) perceptions of mentor support, and (e) overall satisfaction with their graduate training.

Results from Time 1 revealed sex differences in students' occupational values. Specifically, women valued family flexibility in their future careers more than men, and men valued money and power in their future careers more than women. Additionally, women perceived there to be a better fit between their occupational values and *teaching* careers than men. Conversely, men perceived there to be a better fit between their values and *research* careers than women. Women also perceived females to be the target of gender discrimination within the department more often than men. Importantly, the factors that predicted satisfaction with graduate training differed by gender. Perceptions of gender discrimination and the fit of their values with research careers were significant predictors of women's (but not men's) satisfaction with their training (Table 1).

Longitudinal data revealed that students' occupational values, value-career fit, and perceptions of mentor support were stable over time. However, perceptions of discrimination towards women increased significantly from Year 1 to Year 2. The factors that predicted women's satisfaction with their training at Year 1 continued to predict satisfaction at Year 2. Qualitative analyses of the forms of gender discrimination that students reported observing and the implications of the findings for graduate training programs will be discussed.

Table 1

Multiple regression analysis predicting women's satisfaction with graduate training

Predictors of Women's Satisfaction	β	Model R^2
Value-career fit: Research	.26**	.44***
Value-career fit: Teaching	-.29**	
Mentor Support	.38**	
Perceptions of Discrimination Towards Women	-.18	
Predictors of Men's Satisfaction	β	Model R^2
Value-career fit: Research	-.05	.13*
Value-career fit: Teaching	.05	
Mentor Support	.37**	
Perceptions of Discrimination Towards Men	.08	

* $p < .05$, ** $p < .01$, *** $p < .001$

Key words: graduate training, values, gender discrimination, mentoring

Amy Roberson Hayes is a graduate student in Developmental Psychology at the University of Texas at Austin. She works with Dr. Rebecca Bigler to study the development of gender-differentiated occupational values and interests among children, adolescents, and adults. Her recent work examines the values and experiences of women in STEM graduate programs and the effects of single-sex education on academic achievement and gender role development among girls and boys. She is recipient of numerous departmental teaching and research awards.

Rebecca S. Bigler is Professor of Psychology and Women's and Gender Studies at the University of Texas at Austin. She studies the causes and consequences of social stereotyping and prejudice among children, with a particular focus on gender and racial attitudes. She has studied the consequences of gender and racial stereotypes on children's educational and occupational choices and achievements. She has also worked to develop and test intervention strategies aimed at reducing children's stereotyping and biases. Her work has appeared in top journals in the field of developmental psychology (*Monographs of the Society for Research in Child Development*, *Developmental Psychology*), and has been covered by major U.S. media outlets (*Newsweek*, *NBC Dateline*). Her recent work examines the effect of single-sex schooling on girls' academic performance and gender role development, as well the roles of gender and race in civic engagement.

➤ Perceptions of Sexism in STEM Fields: A Cross-Sectional Examination of Students in High School, College, and Graduate School

Rachael. D. Robnett & Campbell Leaper (University of California, Santa Cruz, USA)

Research shows that girls and women become more poorly represented in STEM as they progress toward higher levels of educational and occupational prestige (AAUW, 2010). For example, women currently earn over half of all bachelor's degrees in the field of chemistry, but their share of degrees drops to one-third at the doctoral level (NSF, 2008). This phenomenon is widely referred to as the *leaky pipeline*. Despite the prevalence of the leaky pipeline metaphor, it is uncommon for research to systematically examine the challenges that girls and women encounter at different points in the pipeline.

The present study aims to fill this gap in the literature by examining girls' and women's experiences with sexism in STEM at three phases of education: high school, college, and graduate school. Qualitative and quantitative methods were used to test for age differences in (a) the amount of sexism experienced, (b) the specific domains in which sexism is experienced, and (c) the sources of sexism.

The present study also examined boys' and men's perceptions of sexism in STEM. Little is known about whether boys and men perceive sexism in STEM to be a barrier for girls and women. Therefore, we utilized qualitative methods to assess gender differences in participants' perceptions of the severity of sexism in STEM.

Participants were recruited from three points along the STEM pipeline. Specifically, participants included STEM-oriented high-school students (152 girls, 125 boys); undergraduates who had declared a STEM major (117 women, 92 men), and graduate students who were working toward an advanced STEM degree (100 women; 50 men). The sample was ethnically diverse, and most participants reported being raised in middle-class households.

Quantitative analyses indicated that women and girls who had progressed further through the pipeline perceived more sexism in STEM than did women and girls who had not progressed as far. Specifically, female graduate students perceived more sexism than did female undergraduates, who in turn perceived more sexism than did female high-school students ($F = 7.09, p < .001$). Similar trends were observed in participants' responses to questions about the domains in which they experienced sexism. For instance, relative to other participants, female graduate students were more likely to report that others in their field made them feel like they needed to work harder than men to be respected ($F = 3.07, p = .047$). Across the age groups, male peers were the most common source of sexism (see Leaper & Brown, 2008).

Qualitative analyses revealed that many participants characterized women's underrepresentation in STEM as both a cause and a consequence of sexism. Although women and men tended to share this sentiment, they differed in the extent to which they perceived it to be a serious problem. Notably, many participants pointed out that women's isolation (or 'token status') in STEM fields is a more serious barrier than over forms of sexism. Discussion will focus on integrating the qualitative and quantitative findings to paint a nuanced picture of the challenges girls and women face in STEM.

Keywords: STEM education, sexism, developmental trajectories, mixed-methods

Rachael D. Robnett is a doctoral candidate in developmental psychology at the University of California at Santa Cruz. Ms. Robnett's research program examines the causes and consequences of gender bias across a variety of domains. With respect to girls' and women's representation in STEM, Ms. Robnett's research assesses the link between membership in a supportive peer network and STEM retention.

Campbell Leaper is professor of psychology at the University of California at Santa Cruz. Professor Leaper's research program examines the developmental and social psychology of gender and sexism. He also co-organizes the biennial Gender Development Research Conference.

➤ **Gender, Motivation and Mathematics Participation: A comparison of samples from Australia, Canada and the USA**

Helen M. G. Watt (Monash University, Australia), Jenna D. Shapka (University of British Columbia, Canada), Zoe A. Morris (Monash University, Australia), Amanda M. Durik (Northern Illinois University, USA), Daniel P. Keating & Jacquelynne S. Eccles (University of Michigan, USA)

Objectives & Framework

We explored gender differences and relationships among mathematical motivations within the Eccles et al. expectancy-value framework, high school math participation, educational aspirations and career plans.

Key objectives were to, i) contrast the roles of expectancies and kinds of values (intrinsic, importance) for girls and boys in schooling contexts providing varying degrees of choice; ii) test evidence for the pipeline metaphor, wherein degree of mathematical preparation has flow-on effects to educational/occupational outcomes; and iii) examine possible non-mathematical outcomes (aspired level of education, job prestige).

Methods & Data

Participants were from Australia, Canada, and the USA ($N_s=358, 471, 418$) in grade 9/10 at Time 1, grade 11/12 at Time 2, from separate projects. All samples came from suburban middle to upper-middle socioeconomic backgrounds, primarily Anglo-European descent.

Math-related motivations were measured at T1 using expectancy-value survey measures, tapping expectancies, intrinsic, and importance values. High school math participation was measured at T2: by chosen difficulty level in the Australian sample, number of advanced courses in the Canadian, and total courses in the USA, reflecting different curricular structures. Educational aspirations were coded on 4-point scales. Open-ended questions asked about aspired careers, subsequently coded from 1(no) to 4(high) math-relatedness, and 1(lowest) to 5(highest) prestige based on wages and education.

Multiple-group mean and covariance structures is an extension of structural equation modelling, where mean-level information is analysed as well as the covariance matrix. Strong factorial invariance implies constructs are comparable; only in this case is it justified to compare gender differences, and interpret gendered relationships, which could otherwise be due to differences in measurement models.

Results

In the Australian sample, which provided for a high degree of early specialisation, boys had higher intrinsic value, enrolled in more advanced math, and aspired to more math-related careers. Intrinsic and importance values predicted both math and non-math outcomes, with more significant paths for girls. In the Canadian and USA samples, which require college-bound youth to take specific numbers of math courses, there were no significant gender differences in educational or occupational outcomes; boys had higher expectancies, perhaps related to a cultural emphasis on test regimes that focus attention on ability rather than interest. Intrinsic value did not predict to outcomes, but expectancies and importance value did, again more for girls than boys. The pipeline metaphor was generally supported, with consequences for math and non-math outcomes.

Significance

Our findings lead us to conclude that contexts which promote early choice and specialisation may serve to amplify gender differences in stereotyped domains. Perhaps choice structured by topics as in North America, may enhance girls' interest. The test culture in North America may increase the risk of girls' lower ability beliefs, although further study of diverse settings is required to test these speculations.

The greater role of values in girls' choices resonates with socialisation practices towards girls being happy, and boys successful. Mathematical motivations not only predicted math-related outcomes, but also level of aspired education and career prestige; long-term data are required to test whether and how aspirations become enacted.

Keywords: Gender, Mathematics, High school enrolments, Career Plans

Helen M.G. Watt is an Associate Professor in the Faculty of Education, Monash University, and an Australian Research Council Research Fellow 2011-2015. See page 12 for full biographical sketch.

➤ **Are male and female students accurate in the assessment of math abilities? To what extent does it influence the pursuit of technology and ICT-related studies?**

Milagros Sáinz (Universitat Oberta de Catalunya (UOC), Spain) & Katja Upadyaya, (University of Michigan, USA)

Self-concept of domain ability is a strong motivational factor involved in different academic and career-choice related decisions (Pajares & Miller, 1994; Wigfield & Eccles, 2002). For instance, self-concept of math ability is an antecedent of STEM careers (Eccles, 2007; Simpkins, Davis-Kean & Eccles, 2006; Sáinz & Eccles, 2012; Watt, 2008). But to what extent are students realistic in the assessment of their math ability? Does self-concept of math ability reflect students' actual performance in math? To what extent does the accuracy or bias in students' self-concept of math ability predict their future STEM-related career plans?

The capability to calibrate one's abilities reaches maximum relevance during the secondary education years, when young people frequently make career-related choices based on inaccurate or insufficient information about themselves and/or the requirements to have access to various careers (Eccles, 2007). Nonetheless, these inaccurate beliefs lead students to wrong-headed academic decisions and to subsequent low performance.

The present longitudinal study was therefore carried out with a fourfold purpose: 1) to analyze the accuracy in students' self-concept of math ability 2) to explore how parents' educational level predicts the accuracy of students' math ability self-concept, 3) to examine how accuracy or bias in students' math ability self-concept predicts their computer ability self-concept. 4) to analyze the role played by gender and track of studies in the prediction of technology related studies.

424 Spanish secondary students participated in two consecutive time points: when they were enrolled in the last course of junior education and one year later when they were in the first course of high school. Most of them belonged to families with middle social class background and Spanish background (89.4%). 55.6% of those 424 students are enrolled in the track of Science and Technology whilst 42.3% in Humanities and Social Sciences.

The results of the cluster analysis run with ISOA identified 4 groups of students according to the accuracy or bias in their math ability self-concept (e.g. high accurate, low accurate, optimistic, and pessimistic math ability self-concept). Likewise, ANCOVA analyses proved that the education of the parents predicted the accuracy in young people's perception of their math ability at time 2. Similarly, linear and logistic regression analyses demonstrated that the accuracy in students' math ability self-concept at time 1 predicted their self-concept of computer ability and the choice of technology-related studies at time 2.

These results reproduce similar research carried out in other international contexts and highlight the importance of studying accuracy and bias in academic self-beliefs in different domains and with non-elementary students (Bouffard et al., 1998; Rytönen et al., 2007). In particular, the results point to the extension of the scope of analysis to students who are in transition to a higher level of educational studies (Eccles, 2007).

Keywords: Self-concept of math ability, accuracy and bias, math achievement, studies, transition to high school.

Milagros Sáinz is working as a postdoctoral Researcher at the Internet Interdisciplinary Institute in the Universitat Oberta de Catalunya in Barcelona (Spain). Her research interests are related to psychosocial and motivational factors involved in girls' and boys' differential academic and occupational aspirations. She is also interested in analyzing stereotypical portrayals and beliefs about women, science and technology and how this influences the development of women's self-concept of ability and academic engagements.

Katja Upadyaya is working as a research investigator at the Institute of Social Research, University of Michigan. Her research interest are parent-child and teacher-student interaction, and particularly how these relationships influence children's and adolescents' learning and motivation at school (e.g., students' task motivation, interest values, task-avoidant behavior, self-concept of ability and performance in different domains). Recently Katja has been also conducting research on adolescents' school engagement during the transition to work and higher education, and the development of Spanish adolescents STEM-related self-concepts.

Session 2b, Round table Discussion: Program evaluations supporting girls in STEM

Chair/discussant: Cocky Booij, Dutch National Expert Organization on Girls/Women and STEM, the Netherlands

6 September: 11.00 – 12.30 h

Conference room: Italië

Introduction

Roundtable discussions allow maximum interaction among presenters and with attendees, and encourage substantive exchange and interaction among researchers working on a common set of research issues, problems, or themes. Because the emphasis is on interaction, there will be no formal paper presentations, but 5 minutes sequentially per participant followed by extended interactive discussion among them around the shared theme.

Organisation

Questions for discussion of the programs:

- How does the program account for the fact that everybody should have the opportunity to develop their abilities, including girls with a flair for STEM? In other words: how does the program deal with social norms, gender stereotypes and expectations that form a barrier between women and STEM?

In the discussion we will refer to the following preconditions for sustainable gender inclusive programs:

- Does the program involve collaboration with all relevant parties and if so how is it organized? If not, how can the program achieve sustainable changes in the unbalance of girls/women versus boys/men in STEM education and/or professions?
- Does the program involve an approach that simultaneously tackles all fronts designed to attract and retain female students and ensure the successful progression onto the STEM labor market?
- How does the program account for gender expertise? Is anyone responsible for gender issues in the organization? Does the board/management support the program? Is gender awareness part of the curriculum? How is the program embedded in the curriculum and the organization?

Outcome

The outcome should focus on what makes a program attractive for girls and how the program opts for sustainable change in the underrepresentation of girls/women in STEM education, occupation and participation.

➤ **TiNA projects from Finland: tech for girls, support for women**

Pirjo Putila, Aura Paloheimo, Johanna Leppävirta (Aalto University School of Electrical Engineering, Finland)

The STEM subjects have for a long time been unattractive to teenagers, especially to girls. In general, girls consider that they don't manage or understand, for example, mathematics. This is not true: according to the Finnish Ministry of Education and Culture girls are as competent in mathematics as their boy peers. Our interpretation is that girls can perform as well as boys in STEM subjects – if we are able to sell them the idea that a STEM career is worth it. We had two key incentives in our projects: inspire girls to technology and support women in their careers.

One visible problem with girls' tech education is that when certain technology or some experiment kit is brought to class, the boys will go for it while girls stand aside and watch. We need support for girls in form of single sex science lessons or hands on tech courses. Unfortunately, this is often taken as non-equal or discrimination of boys, as egalitarianism is the cornerstone of our educational system. It would be more constructive to view this as intent to arrange the optimal learning environment for the students including their sex. It follows that boys' special needs are addressed as well, but this is out of the scope of our study. In our projects the girls-only education was performed in two ways:

- We arranged upper secondary school girls computer club activities with some of our female engineering students acting as teachers.
- We arranged girls only study visits into our university's School of Electrical Engineering. During a study visit the school girls accomplished easy electronics exercises, for example, how to light a light-emitting diode with a potato or how to make a magnet out of a nail.

Both our courses and study visits got a very good reception. Nevertheless: after our project funding ran out, the clubs and study visits ended.

The other aim of our work was to support and strengthen the professional identity of female researches in our School of Electrical Engineering. We arranged seminars, discussions and sauna evenings. We created a professional identity group for young researchers and research assistants. In this group the discussion was guided and professional career coaching sessions were arranged. The themes in this group included, for example, personal values, occupational motivation and career or work community challenges.

It is again a controversial question: are the female researchers eligible for this kind of extra support? Are we just wasting the university funding? We claim the opposite to be true. Our activities were to raise women researchers' comfort level. According to earlier research, women fare better when their comfort level is high. Feeling comfortable is more important for female than for male students, because according to previous studies, the comfort level affects women much more than men: women can outperform themselves with high comfort level or perform significantly worse than normal because of low-comfort level. Similar results observed with men were, however, insignificant in measure. (Men are more likely to outperform themselves in competitive environments.)

➤ **Sustaining changes in female participation in ICT studies**

Johanna Leppävirta & Pirjo Putila (Aalto University, School of Electrical Engineering, Finland)

In order to equip future engineers to solve complex challenges of the 21st century, we need a steady flow of competent young people well-prepared in science and mathematics. Although still strongly underrepresented in engineering degree programs, especially in information and communication technology (ICT) fields, women who do enroll in engineering programs tend to do well and are less likely to switch to non-engineering programs (Huang, Taddese, Walter, & Peng, 2000).

How then to influence the choice-behavior of girls in the area of STEM?

In 2001-2007, a set of gender and education projects were launched at Aalto University (former Helsinki University of Technology), School of Electrical Engineering (ELEC), Finland. The aims of the projects were to increase the proportion of female students and develop more co-operative learning practices in order to help women feel accepted and welcomed. Various activities were conducted during the projects, including interdisciplinary courses, mentoring programs, occupational coaching, elementary school co-operation, best-practice material delivery and subject-related websites.

The results were encouraging, the proportion of female applicants accepted into the School of Electrical Engineering increased from 14% to 20% (Paloheimo, Putila, & Sipanen, 2010).

Have changes been sustained and what is the situation today? One key element of success was that the conducted projects served as drivers for change. The climate was fruitful for changes in the engineering curriculum. For example, an entirely new degree programme in Bio-Information Technology started in 2003, which is a multidisciplinary program combining bio-engineering, biological chemistry, computational and cognitive biosciences, and biotronics. After 2003, the number of female students applying for the school doubled. In 2011, the proportion of female students starting the BioIT programme was 47%. For comparison, the proportion of female freshmen in the Programmes of Electrical Engineering and Communications Engineering in the same year was respectively 13% and 11%. The same phenomena can be seen in the School of Science, where the degree programme on Information Networks attracts women as well. In 2011, 36% of the female freshmen were women. Whereas in more traditional programmes, Computer Science and Engineering, the proportion of female students was only 15%.

While the projects have clearly succeeded in attracting more women into ICT fields, they have also created a positive and friendly atmosphere where girls feel welcomed.

The University Career Services became aware of the importance of role models when recruiting new researchers and professors. In 2001 the ELEC had one female professor; today three, and a female dean.

Our current new project aims to support and advance studies of mathematics, science, and technology in upper secondary education.

The LUMA (on STEM) Resource Centre at Aalto University offers high quality courses for students in order to increase young people's interest in STEM and attract talented future engineers. The LUMA Center provides also a high technology laboratory environment for school groups to visit and conduct experiments that they cannot carry out in their home schools.

Johanna Leppävirta received the MA (Education) degree in Adult Education from the University of Helsinki, Finland, in 2005 and PhD in Engineering Education from the Aalto University School of Electrical Engineering in 2011. Her research interest lies in studying factors that influence the development of engineering students' mathematical proficiency, as well as academic and scientific expertise. She is currently working in the EPOP - project that aims to create a fully interactive engagement (IE) course that combines the domains of circuit analysis and dynamic field theory in order to examine the possible growth of conceptual and procedural knowledge.

➤ **What is different in a single sex computer science programme?
Experiences from 12 years of the International Women's Degree Programme
at the Hochschule Bremen, Germany**
Gerlinde Schreiber (HS Bremen, Germany)

In the year 2000 the International Women's Degree Programme in Computer Science was established at the Hochschule Bremen (university of applied sciences), Germany. The Programme is unique being the only single sex programme in computer science at a coeducative university (at least) in Germany. After its successful evaluation in 2005 the programme now constitutes part of the regular study courses at the Hochschule Bremen. The programme has got a history of 12 years of recruitment and education of female students in computer science. The presentation provides an overview on the starting conditions, the concept of the Women's Programme and the experiences made. The questions and results of our evaluations are outlined as well as the Programme's activities to recruit new students. We end with a section on the lessons learned so far that hopefully prove useful for teachers and professors in the STEM area.

Single sex education is often treated with suspicion. Therefore some remarks on our basic assumptions should be added: Our curriculum is not built on the assumption that students have gender-specific skills, deficiencies or prior knowledge. We do not think that adding a soft skill module and some foreign languages helps to attract women to and retain them in computer science. Of course our programme comprises soft skills and foreign languages – because they belong to a highly qualified computer science education.

The curriculum reflects the diversity of students that join our programme: There are students with excellent prior knowledge learned at school or in a job, there are highly qualified students with a migrative background and a degree that is not acknowledged in Germany, and there are others with little experience and little computer-specific knowledge. This situation is quite the same in coeducative computer science programmes.

What is different in our programme is the following: We do not simply define a standard the students have to adapt to. We teach step by step how to get there, the level of detail depending on the group. We can do so because our groups are small, and we know the students and their background quite well.

'There are no silly questions – it's silly not to ask', is the traditional encouragement for the new students. We do not consider missing prior knowledge as a problem. Studies show that women are less confident in their technical knowledge and abilities. The implicit definition of a standard is a problem to both male and female students. But females seem to be concerned more substantially with it in the technical area. That is what is gender-specific about the International Women's Programme in Computer Science in Bremen.

Keywords: single sex education, gender and computer science, computer science education in Germany, gender and STEM

CV Gerlinde Schreiber

(1985) Diploma Degree in Computer Science, University Kiel, Germany; (1985-1988) Employee at Siemens AG, Erlangen; Software Development for Distributed Systems; Delegate to DIN (German Standards Institution) and ISO (Network Management); (1988-1994) PhD at the University Oldenburg; Formal Specification of Distributed Systems; 1994-2003 Different teaching positions at different universities; Software Development (freelancer); (2003-...) Professor at Hochschule Bremen, Computer Science; (2011-...) Head of the International Women's Degree Programme in Computer Science, Hochschule Bremen.

➤ **Encouraging teachers to be gender aware**

Marjolein van Breemen & Meie van Laar (Science Learning Center (SLC) NEMO, The Netherlands)

Background

The gender dimension of research implicates that the share of women in research is extremely low in all European countries and associated countries. Throughout Europe there is a fear that interest in science and technology is declining, while at the same time demands for science and technology graduates grows (Rocard Report 2007).

The TWIST project

The TWIST project addressed this challenge with an ambitious program of coordinated activities to raise awareness on the role and representation of women in science and technology throughout science centers and museums in Europe, targeted at young people and their teachers and parents as well as the general public, with focus on the outdated stereotypes and prejudices on societal roles for men and women and career paths.

Professional development programme for teachers

NEMO has gathered expertise in the last several years about gender in several projects and developed a professional development program aimed at primary school teachers for all the European partners. Although the program had to be suitable for a short 4 hours program, it was possible to have a positive impact on teachers awareness of gender and science. The result one month after the training: 89 % of the participants intend to change their way of teaching.

Inspiration for other science centres and museums

As a source of inspiration, the findings, guidelines and good practices of all the partners are collected in a (digital) inspiration book. The activities are available in six different languages: Danish, Swedish, Dutch, English, Italian and Hebrew.

Marjolein van Breemen is Manager of NEMO's Science Learning Center (SLC) since 2011. Within science center NEMO she worked since 2006 as (senior) Project Manager on several educational projects involving inquiry based science education. In that role she was also involved in the European (gender) projects GAPP and TWIST. Marjolein holds a Master of Science (Biology), and specialized in Science Education and Communication. She has a background as a Publisher at Elsevier Science Publishers for portfolio of scientific journals and books.

Meie van Laar is Project Manager at NEMO's Science Learning Center (SLC) since 2011. Within science center NEMO she worked since 2008 as Educational Developer and as Project Manager on several educational projects and involved in the European (gender) project TWIST. Meie holds a Master of Science (Biology), and a Master of Science teaching Biology. Before joining NEMO she worked as a Biology, Physics and Mathematics teacher at several secondary schools.

Session 3a, Symposium: Gender and STEM policy considerations

Chair/discussant: Gertje Joukes, Dutch National Expert Organization on Girls/Women and STEM, The Netherlands

6 September: 14.45 – 16.15h

Conference room: Frankrijk

Introduction

In many countries policy makers of national governments, educational institutions, research foundations, associations of STEM scientists or professionals etc. make an effort to raise the participation of girls and women in STEM and foster professional careers of women in STEM. This raises questions like:

- How to design/choose interventions/approaches that can meet these aims?
- How to design/choose interventions/approaches which are likely to be effective?
- What are preconditions for effective interventions/approaches?
- What infrastructure is needed for effective interventions/approaches?
- What is preferred: interventions/approaches aimed at girls/women, gender mainstreaming of policies and actions, or both; and what is decisive to choose for one of these approaches?

Organisation

In this symposium several researchers will present approaches in their countries. Following their presentations, we will make a start discussing the above mentioned questions. Presenters and attendants of the symposium can add more questions about policy that, in their opinion, need to be discussed. After the conference, those who are interested in this matter, can proceed exchanging views in the Forum of the Network website (www.genderandstem.com).

After each presentation (15 minutes) we will have a few minutes for questions if something in the presentation is not clear. We strongly recommend to save questions that may contribute to the discussion until after the presentations.

- **Community awareness: a quality analysis of the Working Group on Women in Physics (WGWIP), The Physical Society of Republic of China (PSROC)**
Keng-Ching Kathy Lin (Fu Jen Catholic University, Taiwan)

Since the 6th resolution from the 23rd General Assembly of International Union of Pure and Applied Physics (IUPAP) was established in 1999, the physics community has initiated various programs to improve the situation for Women in Physics. In this report, the actions taken by WGWIP, PSROC, and the impact of these actions on the background society are open for discussion through interviews with individual group members. Action items are characterized by three categories: recruitment, retention, and promotion. All the working group members (Table A.1) can express their views on the action items, their professional preferences on research topics, community service, career plans, or their gender concept. By exploring the common consensus of the members, we anticipate the practice of democracy and scientific principles on developing the substantiality of the working group.

Women physicists value their professional growth in the community as the ballot indicated in table A.2. Discrepancy is found between male members and female members when they envision the possible changes of the current situation for female physicists.

Table 1. The demographic numbers of GWIP committee members (2001-2010)

	Conductor	Female	Male
Northern area	3	6	3
Southern area	2	4	
Mid-island	1	8	2
Public Institute	6	14	5
Private Institute	0	4	0
total		18	5

Table 2. What issues relating to Women in Physics should the working group focus on?

1. Personal professional development	12
2. Attracting girls to physics	3
3. Improving the climate for women	6
4. Successful proposals, project leadership and fundraising	11

(17 women committee members; two votes per person; one declined to vote)

Key words: gender awareness, community of practice, professional development, family-friendly policy

Keng-Ching Kathy Lin earned her Ph. D. in experimental condensed matter physics from the Physics and Astronomy Department, Michigan State University, USA, 1996. She is an associate professor of the Department of Physics, Fu Jen Catholic University, Taiwan, the Republic of China (ROC), and currently the department head. Her professional expertise includes scanning probe microscopy and the introductory courses of modern physics. She has been participating in activities of the Working Group on Women in Physics, the Physical Society of ROC since 2001, an acting consultant of the Committee of Women in Physics, and holds a life-long membership of the Society of Taiwan Women in Science and Technology.

➤ **Structures & frameworks enhancing female participation and occupational pathways in STEM- A European perspective**

Kathinka Best (Berlin Institute of Technology (TUB), Germany)

To shed light on the gender development and female participation in STEM, the author combines a quantitative analysis of STEM students' data with a qualitative analysis of the framework for gender equality in higher education. She depicts the recent development in Germany and compares it to the situation of other selected European countries.

- *Quantitative analysis:* A comparison of the gender-distribution in STEM subjects in selected European countries is provided as base for the comparison. Whereas the participation of women in STEM careers was relatively low in Germany some years ago, female participation in STEM subjects and science has been increased in recent years (Eurostat, SHE figures). A benchmark is provided through the European perspective.
- *Qualitative analysis:* One reason for the rise in female STEM participation is the modified (political and) scientific framework, requiring more gender-equality. The author discusses the effects of the 2008-published *DFG's Research-Oriented Standards on Gender Equality* (German Research Foundation, DFG). Moreover, she depicts other incentivising measures like gender-equality rankings (CEWS, DFG), gender-equality awards (Total E-Quality, Audit 'family-friendly university') and political initiatives.

- These initiatives have been especially effective to foster female participation and gender-equality in STEM subjects, and careers in STEM institutes and organisations, where the underrepresentation of women was striking and has been diminished slightly. In other European countries, different frameworks and initiatives are at work, in line with the nations' socio-political background. The European perspective is thus taken to put the recent development and the German approach to improve female STEM participation and careers into a broader perspective.

This paper contributes to the analysis of structures and frameworks favouring a higher female participation in STEM fields. The European perspective of the analysis provides a benchmark and shall as well enhance the evaluation of possible cross-European transfers of current approaches in STEM.

Kathinka Best, born in Essen, Germany, spent one year in Argentina during the economic crisis in 2001/02. Thereof, her interest in economics grew and she decided to study the BA Philosophy & Economics in Bayreuth and Warsaw (with DAAD scholarship); and the MSc Economics & Management (Humboldt University Berlin). Kathinka was intern at Roland Berger, KPMG Poland, Stollberg do Brasil and Zeche Zollverein. Currently, she is PhD candidate at Berlin Technical University, responsible for the European gender-equality project GeCo, and supporting the Total E-Quality awarding process. Her research interest is the 'Effects of Gender Diversity Management'.

➤ **Quality Management for more Sustainability of Women attracting Measures in STEM**

Susanne Ihlen, Ulrike Sanwald, Meike Schüle (Technische Universität München (TUM), Germany)

There are plenty of measures to motivate and promote STEM subjects at German universities. Even when looking only at the TU9, Germany's nine largest and oldest technical universities, more than 120 programmes and offers are made (see www.tu9.de/projekte/2538.php). Eleven years ago the nationwide Girls' day started and grows continuously each year: industry, schools and universities work together to show girls attractive technical workfields. The Pact for Women in MINT Careers (Mathematics, Informatics, Natural Sciences and Technology, the German equivalent to STEM), founded by the Federal Minister of Research in 2008, integrates all single activities around the topic to a linked offer for girls between eight and eighteen years old. Both activities are evaluated and show how the publicity about 'women in STEM' grows.

All projects incorporated want to increase the proportion of female students in STEM subjects at least to European level and help to recruit women in STEM careers at least as many as proportionally graduate in the relevant subjects (see www.komm-mach-mint.de).

The number of women in Science and Engineering grows: between 2007 and 2010 in all Engineering study programmes in Germany from 32% to 37% and in Mechanical or Electrical Engineering the rate is at 28% / 20% in the same time (see www.kompetenzz.de). Also the female engineering employee rate grew during the same time from 7,8% to 24,4%. This seems to be good news, but: No one could say right now how this worked and if the tendencies are stable and sustainable. When we asked the students from TU9 in 2009, nearly no one of these students decided for Science and Engineering because of the several motivating and attracting measures, but because of internet, teachers and family (see Ihlen et al.: Spurensuche!, München 2010). On the other hand we found a lot of female students from abroad. They hadn't been motivated 'as girls' because in their cultures it is nothing special for women to study Engineering programmes.

Most of the projects to attract more girls and women for STEM are placed outside the 'normal' engineering culture. This culture in Germany is traditional male dominated, has solid rules, borders and an idea of 'real' membership. Here, female engineers are still 'special'. This hidden curriculum is taught in not reflected (non) verbal communication processes and attitudes. This specific professional culture leads women into an 'imposter phenomenon' (see Langford and Clance 1993): at each grade and also during their professional phase female engineers leave their profession. Here a gender oriented quality management system, including further education measures, has to be drawn up to make the equity in engineering really sustainable.

Prof. Dr. Susanne Ihsen, Sociologist, gained her diploma in 1994 and her PhD (Dr.Phil) in 1999 at RWTH Aachen University. Since that time she works scientifically in the fields of women in technology and organisational change. From 1999 until 2004 she was scientific employee and manager at the Association of German Engineers (VDI) in the department for profession and career. Her main field was career consulting for the more than 130000 VDI members from all fields of engineering. In December 2004 she became Germany's first professor for Gender Studies in Science and Engineering at Technische Universität München (TUM).

Dipl.-Soz. Ulrike Sanwald, Sociologist, works as research assistant at Gender Studies in Science and Engineering since 2012, mainly in the field of gender oriented quality management.

Dipl.-Soz. Meike Schüle, Sociologist, works as research assistant at Gender Studies in Science and Engineering since 2011, mainly in the field of motivating projects for more women in STEM.

- **Approaches to improve the underrepresentation of women in technology higher education programmes – results from a Hungarian university study**
Valéria Szekeres (Óbuda University, Hungary) Beáta Nagy (Institute of Sociology and Social Policy, Corvinus University of Budapest, Hungary) Erzsébet Takács (KROLIFY Institute of Opinion and Organizational Research, Hungary) Lilla Vicsek (Institute of Sociology and Social Policy, Corvinus University of Budapest, Hungary)

The ratio of women specialized in the fields of electronic and mechanical engineering and informatics does not reach 10% in Hungary. The number of female students graduating from technology programmes at universities thus needs to be increased. One possible way to increase the number of female applicants is to understand the conditions under which they opt for such programmes. We conducted a comprehensive qualitative and quantitative study at a university in 2012 to investigate what possible barriers stand in the way of getting more female students to apply to academic programmes in technology and what means could be utilized to potentially get more girls to apply. As part of the study, focus groups and semi-structured interviews with female students were conducted at the faculties of Electronic Engineering, Mechanical Engineering and Informatics. There were also semi-structured interviews conducted with five professors from each of the three faculties. The professors, among them at least one woman from each faculty, are responsible for teaching either science or special subjects. The presentation of the results of the research will focus on the means that can be useful in motivating girls to choose technology academic programmes. Results showed that most female students have friends or acquaintances who work in the field of technology. Our findings thus suggest the possible importance of obtaining personal impressions of an academic programme/profession in the process of making decision on a career. The students in the sample rated more favourably the options of promoting more girls to apply to technology studies such as taking part in Girls' Day programmes or listening to a lecture by a female student from the faculty of Engineering or Informatics. At the same time they dismissed non-personal ways, such as poster adverts, and the male-centred presentations of academic programmes on the homepage of the internet. The university should invite female technicians as role models and multinational companies that have committed themselves to equal opportunities.

It is also important to encourage an opening towards the issues of combating gender stereotypes and promoting equal opportunity in education both for the teaching staff and for the students.

Key words: gender equality, higher education, technology, qualitative study, focus groups

Valéria Szekeres, Ph.D. conducts research on gender budgeting, gender mainstreaming, and gender issues in technology higher education. She has written on these topics both in Hungarian and in international publications, including the Japanese Economic Research Annual and has written a manual on gender budgeting.

Session 3b, Symposium: Pathways to STEM studies and careers

Chair/discussant: Helen Watt, Monash University Australia

6 September: 14.45 – 16.15h

Conference room: Italië

Introduction

In many countries girls and women are underrepresented (or men are overrepresented) in STEM (Science, Technology, Engineering, Mathematics) advanced studies and fields of career. This raises questions like:

- Which girls pursue advanced STEM studies and aspire to STEM fields of career?
- Do they come from different 'types' of learning environments?
- Do they have distinct motivational and self-concept profiles?
- What is the role of personality?

Organisation

In this symposium several researchers will present findings to address these questions in their countries, from Germany, Australia, Belgium, and the Netherlands. Following their presentations, we will collectively discuss the above mentioned questions. Presenters and attendants of the symposium can add more questions that, in their opinion, need to be discussed. After the conference, those who are interested in this matter, can proceed exchanging views in the Forum of the Network website (www.genderandstem.com). After each presentation (15 minutes) we will have a few minutes for questions if something in the presentation is not clear. We strongly recommend to save questions of discussion until after the presentations, to contribute to collectively enriched discussion.

➤ **Gender & STEM: Educational and Occupational Pathways and Participation in a global context**

Rebecca Lazarides & Angela Ittel (Technische Universität Berlin, Germany)

Empirical studies repeatedly highlight the decline in students' mathematical self-concept during secondary school, with female students' reporting particularly lower self-concepts in mathematics compared to their male classmates (Marsh & Yeung, 1998; Nagy, Watt, Eccles, Trautwein, Lüdke & Baumert, 2010). Studies examining teaching and learning factors which enhance motivational learning outcomes, revealed that indicators of mathematics classroom quality such as structuredness, teacher support, and participation opportunities are associated with students' self-concepts (Demaray, Kerres, Malecki, Rueger, Brown & Summers, 2009; Wackermann, Trendel & Fischer, 2010). The present study is based in these empirical findings and states additional research questions concerning gender differences and variances within single gender subsamples concerning students' evaluation patterns of mathematics classroom quality. Using a Latent Class Analysis approach (LCA), we first explored gender specificities in students' evaluation patterns.

Referring to a theoretical model of Waldis, Grob, Pauli and Reusser (2011) the study used *structuredness*, *teachers' social support* and *participation opportunities* as indicators for students' perceived classroom quality. Further, due to the lower mathematical self-concepts of female students, we focused on the female subsample. Thereby, factors that predicted female students' evaluation patterns, their mathematics self-concept and achievement in mathematics were examined. Addressing theoretical frameworks pointing to the relevance of students' perceptions of socializers' domain-specific stereotypes for students' domain-specific self-concepts and achievement (see Wigfield & Eccles, 2002), we expected that female students' perceptions of their teachers' stereotyping attitudes towards mathematics will be related to their evaluation patterns of classroom quality, their self-concept and achievement.

Concerning the full sample of 425 female (46.2%) and male (53.2%) eighth to tenth graders (Mean age = 14.93; SD=1.04) in ten secondary schools in Berlin/Germany, analyses revealed four distinctly varying evaluation patterns: a) students' who perceived an overall high quality in math class (c1: 8.2%); b) students' who perceived high structuredness (c2: 22.4%); c) students' who perceived high teachers' support (c3:24.4%) and d) students' who perceived overall low quality in math class (c4: 45%). Results further revealed gender differences in the proportions of latent classes.

Subsequent single-group analyses showed that *female* students who perceived high stereotyping math-related attitudes of their teachers were significantly less likely to perceive high quality in their math classes (OR = 0.12, $p < .001$) than female students who perceived low stereotyping attitudes. Additionally, it was shown that the relation between perceived high stereotyping math-related attitudes of teachers and female students' self-concept differed across females' evaluation patterns. For female students who evaluated their classroom quality as high, teachers' high stereotype math-related attitudes were positively associated to their mathematics self-concept ($\beta: .57^{**}$, $SE=.25$). Focusing on female students' self-perceptions in math, implications for educational practice such as self-concept-enhancing teaching strategies will be discussed.

Keywords: Mathematics classroom quality; mathematics self-concept; gender-differences; Latent Class Analysis

Rebecca Lazarides; (2009 -...) Research Assistant (PhD Level) Department of Educational Psychology - Prof. Dr. Angela Ittel (TUB); Dissertation Topic: Secondary School Mathematics Classrooms: Associations between social factors and male and female students' interest. Research Interests: Classroom quality dimensions and motivational learning outcomes (interest, self-concept, motivation); Families', teachers' and peers' attitudes and students' motivation and interest in math and science classes; Person- and variable-centered approaches in quantitative educational research.

Angela Ittel is a Full Professor of Educational Psychology at the Institute of Education in the Faculty of Human Science at the Institute of Technology in Berlin, Germany. See page 8 for full biographical sketch.

➤ **Socio-Motivational Determinants for Girls' Pathways of Mathematical Enrolment and Career Choice**

Caroline Findlay, Helen M. G. Watt, Leonie Kronborg (Monash University, Australia)

Gender differences in advanced mathematics participation, including in educational and career paths of both men and women, appear remarkably robust in Western world countries. This is problematic because mathematics has been identified as a 'critical filter' (Sells, 1980) that can limit access to high status and high salary occupations. This matters from a social equity standpoint, because women do not share equally in the advantages enjoyed by those who are mathematically qualified, and because women are more likely than men to be financially vulnerable (see Meece, 2006).

In response to these issues the following questions were investigated. How do girls' plans for advanced mathematics change from middle to upper secondary school? Are enrolment choices associated with mathematical career plans? What is the impact of perceived mathematical talent and interest, and, perceived parents' and teachers' beliefs, beyond the impact of mathematical achievements? These questions were examined in a longitudinal study of 152 girls from grades 9-11, in 3 middle-class government coeducational schools from metropolitan Sydney, as part of the *Study of Transitions and Educational Pathways*: www.stepsstudy.org.

Enrolment choices were assessed via tick-boxes, for planned (grade 9) and actual (grade 11) senior high courses. Mathematics-related planned careers were coded using O*NET98™ (see Watt, 2008). Four pathways were created, for each of educational and career choices. For enrolments, *high-high* were girls who at grade 9 aspired to, and at grade 11 undertook, advanced mathematics. *High-low* aspired to advanced mathematics, but at grade 11 undertook basic. *Low-high* aspired to basic, but later undertook advanced. *Low-low* maintained low mathematics course choices. For career pathways, four groups were similarly created, dependent on mathematics-relatedness of aspired career. Chi-square revealed a significant relationship between educational and career pathways.

Self-report surveys assessed mathematics externally- (compared with other students), and internally-referenced talent perceptions (compared with other subjects; based on I/E model of Marsh and colleagues), and interest, at both time points. Talent and interest beliefs are proximal predictors of achievement choices in Eccles et al.'s expectancy-value model (1983; Eccles, 2005). Student-perceived mother, father, and teacher beliefs were measured at the first time point, when standardised mathematics achievement tests were administered.

For school and career choice pathways, repeated-measures MANCOVA compared talent perceptions and interest trajectories grades 9-11, to determine distinguishing motivations beyond mathematical achievement. There were main effects of educational pathway and time: *low-low* was significantly lowest on talent external; *high-high* significantly highest in interest. For career pathways, *high-high* had significantly highest talent external and interest, but lowest talent internal. The *low-high* group showed highest talent internal at grades 9 and 11, and lowest interest at grade 11. *High-low* held lowest talent external at grade 9; *low-low* had lowest interest at grade 9, and lowest talent external at grade 11. Subsequent MANCOVAs compared student-perceived socialisers' beliefs controlling for mathematical achievement. For educational pathway *high-high* group was highest for student-perceived mother perceptions of their talent and intrinsic value.

Open-ended questions elicited reasons for each choice, emergent themes were analysed by pathways. 'Suited to my abilities' predominated for all pathways; overwhelmingly for *high-low/low-low*. For *high-high* groups 'desire for success' came next; then 'what I need for future'; also 'challenge' for educational pathway. 'What I need for future' was additionally important for the *low-high* career pathway. We conclude high interest and parental perceptions distinguish *high-high* school pathways; whereas low talent external distinguishes *low-low*, beyond effects of achievement. Talent external was additionally implicated in *high-high* career pathways, and low interest for *low-low*. *Low-high* exhibited high talent internal with low interest, but a clear perceived need for mathematics towards their future plans.

Caroline Findlay completed her Bachelor of Arts, Graduate Diploma of Psychology and Post-Graduate Diploma of Psychology at Monash University Melbourne. She is currently living in Singapore whilst completing her Masters of Psychology (Educational and Developmental) under the supervision of Associate Professor Helen Watt and Dr Leonie Kronborg. She has been registered as a Provisional Registration by the Psychology Board of Australia since 2008, and most recently worked as a Counsellor/Case Manager in Melbourne with clients whose health and psychological problems including depression, bi-polar, schizophrenia, anxiety, obsessive compulsive disorder, agoraphobia, trauma and torture, sexual and spousal abuse, drug and alcohol issues, financial difficulties, gambling issues, adjustment to the general community after being in prison, lack of family support, language barriers, literacy/numeracy barriers, low self esteem, self harm. The services client groups were diverse and included refugees from Iraq, Iran, Macedonia and Vietnam.

Caroline is associated with the STEPS program of research: <http://www.stepsstudy.org/>. Her MPsych (Ed & Dev) thesis was titled: Socio-motivational influences on adolescent girls' mathematics engagement. In future, Caroline would like to gain experience in working with children in an educational setting. She is further interested in supporting families on a range of issues including managing developmental challenges with children, relationship issues, conflict resolution, supporting co-parenting, self-esteem and motivation.

➤ **Gender, academic motivation and self-concept: profiling of freshmen Science and Technology students**

Carolien van Soom, University of Leuven & Vincent Donche, University of Antwerp, Belgium

Academic Science & Technology (S&T) bachelor programs in Flanders (Belgium) have a free entry policy and no specific admission procedures: only a general high school diploma is required to be admitted. As in other countries (Seymour, 1995) female students are underrepresented and freshmen students in general have a low academic achievement.

Autonomous motivation and academic self-concept are two motivational constructs that have been repeatedly associated with academic achievement (Guay, Ratelle & Chanal, 2008; Marsh, 2007).

To better understand the factors that determine study success of S&T students, we explored the relationship between autonomous motivation, academic self-concept and early academic achievement of male and female freshmen S&T students. By means of person centered data analyses, we examine how different motivational and academic self-concept profiles among freshmen S&T students are present and how these profiles are related with early academic achievement.

The sample consisted of 1488 freshmen bachelors of the Faculties of Sciences, Engineering and Bioscience Engineering, of which 23% were female. Autonomous motivation and academic self-concept were measured at the start of the academic year by means of self-report questionnaires, respectively an adapted version of the Academic Self-regulation Questionnaire (Ryan, 1989) and 3 items on general academic self-concept. First term exam results were used as indicators of early academic achievement. Overall and between male and female student groups, Pearson correlations were calculated to determine the associations between the motivational variables under study, and early academic achievement.

Based upon the correlation results, cluster analyses (a combination of hierarchical and nonhierarchical methods, as described by (Vansteenkiste, Sierens, Soenens, Luyckx, Lens, 2009) were carried out to identify student groups with distinct academic motivation and self-concept profiles. ANOVA were used to determine the associations between cluster groups and achievement scores.

Results show that within both male and female student groups positive correlations were found between autonomous motivation and academic self concept, and between academic self-concept and early academic achievement. For male students, there was also a positive correlation between autonomous motivation and early academic achievement, while this was absent for female students. Four distinct profiles could be discerned, based on the dimensions of autonomous motivation and academic self-concept: two groups that scored respectively and relatively high or low on both dimensions, a group with a high autonomous motivation and low academic self-concept, and a group with a low autonomous motivation and high academic self-concept. Girls were overrepresented in the high autonomous motivation- low self-concept group, whereas boys were overrepresented in the low autonomous motivation- high self-concept group. Students who are more autonomously motivated and have a high academic self-concept obtained higher early academic achievement scores than students who are low autonomously motivated and have a low academic self-concept.

The results confirm the expected associations between autonomous motivation and academic self-concept and early achievement. For practice, it seems that coaching interventions should take into account these distinctive student profiles. For female S&T students, raising more self-awareness through adequate feedback provision might be an effective approach.

Carolien van Soom is Associate Professor at the Faculty of Science of the University of Leuven and connected to LESEC (Leuven Engineering and Science Education Centre). She is responsible for Tutorial Services in Sciences and Biomedical Sciences. Her research interest focuses on academic self-concept, motivation and achievement of freshmen bachelors.

Vincent Donche is Assistant Professor at the Institute of Education and Information Sciences of the University of Antwerp in Belgium. He is responsible for pre-master and master courses on educational research methodology and statistics in the master programme 'education and training sciences'. His research interests focus on individual differences in cognitive, metacognitive and affective components of student learning and development in higher education.

➤ **Who opts for STEM courses? Introverted and autonomous girls!**

Hanke Korpershoek, Groningen Institute for Educational Research (GION), University of Groningen, the Netherlands

Boys and girls in Dutch secondary education largely differ in their school subject preferences. Whereas boys either prefer economics or science-oriented subjects such as advanced mathematics, chemistry, and physics, girls usually opt for more socially-oriented courses such as biology, foreign languages and arts (Korpershoek, 2010). In light of the imbalance between boys and girls in math/science choice in upper secondary education and, consequently, the underrepresentation of women in science-oriented studies and careers, the present study examined whether the sex-differences in school subject choices were (partially) explained by students' personality characteristics. Despite the numerous studies that investigate the role of personality in educational contexts, few studies are focused on the relationship between personality and students' subject choices in secondary education. Several studies have shown that there are significant differences in personality characteristics between the sexes. On average boys score higher on the personality factor Emotional Stability and lower on the factors Agreeableness and Extraversion than girls (Hendriks, Kuyper, Offringa, & Van der Werf, 2008). In addition, from research of Boone, Van Olffen, and Roijackers (2004) we know that different personality characteristics are related to different professional interests and preferences.

Assuming that students are attracted to school subjects that provide them with career perspectives that in their perception 'fit them', students' subject choices in secondary education are likely to be related to their personality (De Fruyt & Mervielde, 1996). The present study was based on a sample of 1,740 9th grade pre-university students. We used the Five-Factor Personality Inventory (FFPI) of Hendriks, Hofstee, and De Raad (1999) to measure the students' personality characteristics. We found several associations between personality characteristics and students' subject choices. Although the relationship between sex and students' subject choices was slightly attenuated after the inclusion of the personality characteristics in the analyses, sex remained an important predictor of the students' choices. The personality factor Extraversion partially mediated the relation between sex and students' choice of advanced mathematics, chemistry, and physics versus a more language and culturally-oriented set of school subjects. Furthermore, sex was found to moderate the relation between the personality factor Autonomy and students' choice of advanced mathematics, chemistry, and physics versus a more language and culturally-oriented set of school courses.

Hanke Korpershoek is university lecturer at the Groningen Institute for Educational Research (GION) at the University of Groningen. Her research focuses on the utilization of (science) talent in education. Moreover, her research aims at understanding the impact of student motivation and school commitment on educational outcomes. In 2011, she published her PhD thesis 'Search for Science Talent in the Netherlands' including six empirical studies. Keywords: science talent, sex-differences, personality differences, school motivation, school commitment, educational outcomes.

4. Discussion Panel: 'The pieces of the jigsaw puzzle: What to focus on for advancing the aims of the network?'

Chair: Helen Watt, Monash University Australia.

Panellists: Jacquelynne Eccles, Angela Ittel, Rebecca Bigler, Gertje Joukes, Jantina Walraven

6 September: 16.15 – 17.00 h

Conference room: Frankrijk

Jacquelynne Eccles



Jacquelynne Eccles is the Wilbert McKeachie and Paul Pintrich University Professor of Psychology and Education, and a research scientist at the Institute for Social Research at the University of Michigan.

She has served as chair of the Advisory Committee for the Social, Behavioral and Economic Directorate at the NSF and the MacArthur Foundation on Successful Pathways through Middle Childhood.

She is past president of the Society for Research on Adolescence (SRA) and was a member of the MacArthur Foundation Network on Successful Adolescent Development.

Angela Ittel



Angela Ittel is a Full Professor of Educational Psychology at the Institute of Education in the Faculty of Human Science at the Institute of Technology in Berlin, Germany.

After receiving a Master of Science Degree and a PhD in Developmental Psychology from the University of California at Santa Cruz, USA, she was a postdoctoral researcher at the Friedrich Schiller University in Jena, Germany and took on an assistant professorship at the Freie Universität Berlin, as well

as visiting professorships in Berlin and Munich.

Her work covers a wide range of issues related to psychosocial development and learning of adolescent boys and girls.

Rebecca Bigler



Rebecca S. Bigler is Professor of Psychology and Women's and Gender Studies at the University of Texas at Austin.

She studies the causes and consequences of social stereotyping and prejudice among children, with a particular focus on gender and racial attitudes.

She has studied the consequences of gender and racial stereotypes on children's educational and occupational choices and achievements.

She has also worked to develop and test intervention strategies aimed at reducing children's stereotyping and biases. Her work

has appeared in top journals in the field of developmental psychology (Monographs of the Society for Research in Child Development, Developmental Psychology), and has been covered by major U.S. media outlets (Newsweek, NBC Dateline).

Her recent work examines the effect of single-sex schooling on girls' academic performance and gender role development, as well the roles of gender and race in civic engagement.

Gertje Joukes



Gertje Joukes has a university degree in Pedagogy. She has been working for VHTO for 16 years now, building VHTO's body of knowledge and monitoring the quality of VHTO's output. Mrs. Joukes is (co-)author of many VHTO publications. Most recently: Trend analysis gender in higher STEM education (in The Netherlands, 2011).

Jantina Walraven



Jantina Walraven is head of the Directorate for Gender and LGBT Equality, Ministry of Education, Culture and Science, Directorate Emancipation. She has a number of years of experience in the field of gender equality. She is a member of the Dutch delegation of the 56th Commission on the Status of Women (CSW) in 2012 in New York.

5. The Network Gender & STEM



Introduced by Professor Jacquelynne Eccles, in 2007, Associate Professor Helen Watt from Monash University Australia was invited as a keynote speaker at a VHTO conference. Our discussions centered about the very many research studies and findings concerning gender and STEM participation, but also that different studies tend to focus on

one or few aspects. We agreed it would have surplus value if relevant research results of the last few years could be interrelated, in order to be able to gain a more coherent view on gender and STEM (Science, Technology, Engineering, Mathematics) from childhood to the labour market. With this in mind, together we have started a Network on this subject with members who undertake related research.

The 'Gender & STEM Educational and Occupational Pathways and Participation Network', is developed to gain better insight into the various, closely connected aspects of career choices and pathways in STEM fields.

The Network's core objectives are:

- to gain more insight into the various, closely connected aspects of STEM career choices of girls/women and boys/men; and
- to identify approaches to improve participation, especially for girls/women.

Relevant research will span early childhood, primary/elementary, secondary, and post-secondary settings, as well as outside-school settings, and within the workforce. Diverse researchers who contribute to this field can provide concentrated information to target engagement in the various subfields of STEM, if we integrate our research findings to gain a coherent view from childhood to labor market. VHTO policy workers and academic researchers will work in close association on these subjects.

Secretariat

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6. About VHTO, Dutch National Expert Organisation on Girls/Women and STEM



VHTO, the Dutch National Expert Organization on Girls/Women and STEM, makes an effort in many different ways to increase the involvement of women and girls in science, technology, engineering and mathematics. Although research over the past decade has made clear that girls are no less talented than boys in STEM, girls and women are still underrepresented in these fields in education and on the labour market. This is inconvenient for both girls/women and for society. Girls/women have equal rights as boys/men to develop their STEM talents, and society would benefit from fully exploiting all available talent.

Projects and Networks

VHTO participates in a great variety of international projects and networks and uses knowledge gained from working with partners abroad to bring best practice into the Netherlands as well as sharing Dutch experiences with international relations.

Trend analysis gender in higher STEM education



Since the early 1980s, VHTO has been building up knowledge and experience of the participation of girls and women in the world of STEM and deploying this expertise in areas such as education.

As well as many activities in the field of secondary education, VHTO has in more recent years intensified its activities within higher STEM education. For instance, over the period 2005-2011 VHTO carried out gender activities focusing on STEM study programs at universities of applied sciences and research universities in the context of the National

Platform Science & Technology's Sprint Programme (with additional funding from the Ministry of Education, Culture and Science, Department of Equal Opportunities). The conclusion of this programme seemed a good time to examine the current state of affairs with regard to gender and STEM, and what is still needed in the future to improve the gender balance in STEM.

Read more in the publication 'Trend analysis gender in higher STEM education'. You can also order this publication by sending an e-mail to vhoto@vhoto.nl.

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English page: <http://www.vhoto.nl/over-vhoto/engelse-pagina.html>



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8. Locations & Directions

Conference location: Hotel Haarlem Zuid

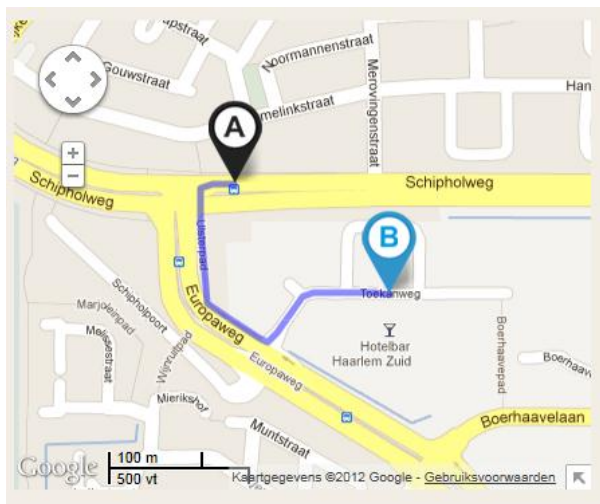
Hotel Haarlem Zuid
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2035 LC Haarlem
Tel +31(0)23 536 75 00
E-mail: haarlemzuid@valk.com

By public transport, by bus coming from Schiphol Center:

- Zuidtangent bus 300 direction Haarlem CS.
Travel time: 32 minutes
Monday through Friday: every 7 minutes.
Saturday/Sunday and holidays: every 15 minutes.
Haarlem: get off the bus at busstop Europaweg

Haarlem CS:

- Bus 70 or 71. Get off the bus at busstop Europaweg/Schipholweg.
- Zuidtangent bus 300 direction Amsterdam-Bijlmer. Get off the bus at busstop Europaweg



A: busstop Europaweg
B: Hotel Haarlem Zuid

How to get back to Schiphol airport:
Bus 300 direction Amsterdam
Travel time: 32 minutes
Monday - Friday: every 7 minutes.
Saturday/Sunday: every 15 minutes.

Two beautiful cities: Haarlem and Amsterdam



Haarlem is a lovely historical city, located on the river Spaarne at no more than 20 kilometres from Amsterdam. International tourism finally seems to have discovered the town's many charms, and an increasing number of visitors find their way here each year. A quick glance at the city centre makes it obvious why. Haarlem boasts a magnificent old centre with plenty of monumental buildings. As the city was home to several first class Dutch painters, including Frans Hals, there's a lot of art to go around. And if you're into shopping, a day in Haarlem is a day well spent too, as it was best shopping city of the country several times. Other towns may lay claims to that title, but Haarlem's centre undisputably offers a colorful mix of large chain stores, specialty shops, boutiques and art galleries. A broad range of bars and restaurants makes the picture complete.

The famous New York City neighbourhood of

Harlem is named after this once powerful Dutch city.

Flowers

Haarlem is the centre of a flower-growing district and a major export point for flower bulbs. However, with some 750.000 people visiting the city each year, tourism makes up an increasingly important part of the town's economy. With about 150.000 inhabitants, Haarlem is 13th on the list of largest cities in the Netherlands but when it comes to tourism, it's the 4th most visited city. As for most popular places, this may mean the incidental line and some crowds around main attractions in high season. However, the town is fairly quiet in off season and its growing popularity does come with ample opportunities to eat and sleep.

History

The first record of the name 'Haarlem' dates from the 10th century. Located on a busy north/south connection route, the city became the seat of the Counts of Holland. In 1245 the city was granted city rights by Count William II of Holland. Due to the heroic acts of knights from Haarlem during the fifth crusade and their contributions to the siege of Damiate in 1217, Haarlem was granted permission to show a cross and a sword in the city's coat of arms. Originally known for its flower growing district, Haarlem in the beginning was also known for its textiles, shipyards, engineering plants and textile mills. In 1573, the Spanish ended its charter. Then, in the 16th and 17th centuries, Haarlem became known as a mecca for dutch painting. Frans Hals, Jacob van Ruisdael, and Adriaen van Ostade were all located here. Also in the 17th century it became a refuge for Huguenots.



In the beginning, all of the city's buildings were wooden and the risk of fire was always present. Unfortunately for Haarlem, in 1328 most of the city was burnt down. When rebuilding began, yet again in 1347, another fire spread through Haarlem. This time though, it engulfed the Counts' castle and city hall. However, the Count decided that he no longer needed a base in Haarlem and decided to move to Den Haag (Hague). With that, he donated the land to Haarlem and later a new city hall would be built in its place. It would take over 150 years for the city to be rebuilt.

[Source: <http://wikitravel.org/en/Haarlem>]



From its humble beginnings as a 13th-century fishing village on a river bed to its current role as a major hub for business, tourism and culture, **Amsterdam** has had a strong tradition as a centre of culture and commerce. Resourceful beginnings When the last millennium was still quite young, a handful of adventurers came floating down the river Amstel in hollowed-out logs. Out of the marshlands and

swamps surrounding the Amstel River, a structure of dams and dikes was forged - the first of which is marked by the Dam square at the heart of the city today. These canny 'Aemstelledammers' began exacting toll money from the passing beer and herring traders of the roaring Eastern Sea Trade of the Baltics. They quickly became expert boat builders and brewers; attracting more interest in the emerging town. In 1275, Count Floris of Holland formalised these activities by granting special toll privileges to the merchant town and in 1300 the town got its first charter.

Trade

The right to free passage proved to be crucial for the economic development of Amsterdam. Free passage meant that traders could operate cheaply. In particular, beer and herring proved popular commodities. For example, in 1323 Amsterdam owned the exclusive right to import beer from Hamburg. And the herring trade grew rapidly after the invention of herring curing - a technique that involved removing the fish's intestines directly after they were caught in order to keep them fresh longer. This allowed fishermen to catch more fish and thus make more profit.

Golden Age

By the end of the 15th century, the city developed rapidly. After the Spaniards conquered Antwerp, many rich Jews fled to Amsterdam. The money they brought with them was used to organise trips to India, which proved a huge commercial success. Then in 1602, the Dutch East India Company was founded. The city of Amsterdam had a majority share in the organisation, which was to become the first multinational company in the world. The result was a period of unprecedented prosperity, causing the 17th century to become known as the Golden Age. During this period, the city underwent two massive urban expansions, and for the first time both functionality and beauty were taken into consideration. The results were the now-famous canals and the Jordaan district. The art scene was also flourishing at this time. In the first half of the 17th century, the number of artists grew enormously and there was an explosion of art and art dealers in Amsterdam. Within just thirty years, Amsterdam became a thriving cultural city, leaving a legacy of Rembrandt van Rijn, Johannes Vermeer and Jan Steen.

Industrialisation

At the end of the 17th century, the Amsterdam economy came to a standstill, resulting in a period of decline and increasing poverty. But with the construction of the North Sea Canal (1876), Amsterdam finally had a direct connection to the sea.

From that moment on steamships became part of everyday life in Amsterdam's port. It was a turning point for the city. Thanks to trade with the Dutch East Indies (Indonesia), Amsterdam acquired an important position in the world spice trade. The diamond trade with South Africa also began to evolve at this point.

That new period of prosperity is reflected in the construction of monumental, architectural masterpieces. In 1889, Amsterdam's Central Station was completed. A few years later, the Concertgebouw, Theatre Carré and Hotel Americain followed.

Past century

The 20th century began well. The Amsterdam School, an idealistic architecture movement, provided low-cost housing around the old city. The city also expanded to include Schiphol Airport, which still remains the home of Dutch national carrier KLM - the oldest airline in the world.

Although the Netherlands remained neutral during World War I, a serious food shortage befell the country and products had to be rationed. In 1917, a ship arrived containing potatoes intended for the army. However, the local population were dismayed by this, resulting in the 'potato riots'. This began a turbulent period in the history of Amsterdam.

During the crisis years (1934) a revolt broke out. Protests took place against the reduction of unemployment benefits; for many people the only source of income. In particular, residents from the Jordaan participated, throwing rocks at the police. This uprising became known as the Jordaan riots, and as a result, all streets in the area became paved so that the stones could no longer be pulled up and used as weapons. World War II caused little physical damage to the buildings and infrastructure of Amsterdam. But starvation during the period did take many lives, and as a result of the persecution of the Jews, the city lost ten percent of its inhabitants.

After the war, the composition of the Amsterdam population changed rapidly. Many original Amsterdammers left for satellite towns like Purmerend, Hoorn and Almere. At the same time, an influx of Surinamese, Turkish and Moroccan immigrants boosted the city's population. Amsterdam is now home to more than 780,000 residents from 180 different countries.

Source: www.iamsterdam.com