5th GENDER & STEM BIENNIAL CONFERENCE

Book of Abstracts

STEM Education for the New Work Order:
Policy, Practice and Partnerships

The University of Sydney, 29–30 July 2021

NETWORK GENDER & STEM
educational and occupational pathways and participation

VhTo
NATIONAL EXPERT ORGANISATION ON GIRLS/WOMEN AND SCIENCE/TECHNOLOGY

THE UNIVERSITY OF SYDNEY

All presentations were recorded and are available on our unlisted YouTube channel.

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Symposia: https://www.youtube.com/playlist?list=PLAkWe-yltlpxQJn4zCzH213sQRc_PBVsG

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2. Select specific recording links

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All presentation abstracts, both 'in-person' and 'pre-recorded', are included in this booklet.
Presentation abstracts are organised according to the presentation types below,
alphabetised within each according to lead author's surname.
Symposia are alphabetised by Chair's surname.

KEYNOTES

The power of partnerships to promote engagement of young people in STEM, international and local perspectives

Sarah Chapman
Live recorded keynote: https://youtu.be/_I-39hE71Xw

Sarah Chapman was awarded a Barbara Cail STEM International Fellowship in 2016 to research and identify effective and innovative ways for promoting participation of young people, particularly girls, in STEM fields during their education and subsequent careers. In 2017, the report Engaging the Future of STEM, was published. The research included visits to schools, businesses, universities, government departments and communities all over the world, to find out what other OECD countries were doing that was having an impact on the rate of engagement in STEM education. This presentation will focus on best practice for engaging and sustaining young people in STEM, including:

- understanding an effective STEM ecosystem & the importance of each stakeholder,
- embedding key strategies to engage girls in STEM,
- exploring the key role partnerships play in empowering students in STEM.

Presenter biography: Sarah Chapman is the Head of Department of Science at Townsville State High School and is in her sixteenth year of teaching. Sarah commits extensive portions of her own time lifting the profile of science education, by working with students, teachers and the broader community. She is the Founder of the Townsville STEM Hub. Sarah is an Executive Committee member of Women in Science Australia, and Director on the Board of Australian Girls ESTEAMME Collaborative, a subsidiary of Global Girls Collaborative, bringing together organisations that are committed to information and encouraging girls in Entrepreneurship, Science, Technology, Engineering, Arts, Mathematics and Maker Education.
| chapmansar@hotmail.com

Women in engineering in academia: Are we there yet?

Ana Deletic
Live recorded keynote: https://youtu.be/AAaynFVwdHA

The participation of women in engineering practice is one of the lowest of all the professions. This is mirrored by the low participation of women in undergraduate and postgraduate engineering studies, but it is particularly evident in the teaching and research staff of engineering faculties at universities across Australia. This talk will outline the key issues that result in low rates for women lecturers and researchers, discuss why we are still facing this problem, and propose some actions that can help us to overcome barriers to greater participation.

Presenter biography: Professor Ana Deletic is Executive Dean of the Faculty of Engineering at Queensland University of Technology, Brisbane Queensland (QUT). Until February 2021 Ana was the Pro Vice-Chancellor (Research) at the University of New South Wales, Sydney

(UNSW). Prior to that, until mid-2017 Ana was Associate Dean of Research Engineering Faculty and the Founding Director of Monash Infrastructure research institute at Monash University. Ana is also an urban water researcher, focusing on stormwater management and socio-technical modelling. She led the development of a number of green nature-based water treatment systems which are now widely adopted in Australia and abroad. Ana is an Honorary Fellow of Engineers Australia, a Fellow of Australian Academy of Technological Sciences and Engineering (ATSE), and Editor of Water Research. In 2012, the Victorian State Government awarded Ana the Victoria Prize for Science and Innovation (Physical Sciences) for her lifelong achievements in stormwater research. | ana.deletic@qut.edu.au

So what have we learned!

Jacquelynne S. Eccles
Pre-recorded keynote & live recorded discussion: https://youtu.be/puxVuEZ0a7U

Professor Eccles will recap the highlights of what she and her colleagues have learned about both the Eccles et al. Expectancy-Value Theory of Achievement-Related Choices, and Engagement and Gendered STEM Educational and Occupational Choices, over the last 40 years. She will:

1. Critique the continuing stereotypical research narratives about female versus male participation in "STEM", including what should be included in the category of STEM and the extent to which that very definition of STEM shapes the stereotypes we hold about how gendered STEM professions are.
2. Provide an overview of the shift from EEVT to SEVT (the Eccles et al. Expectancy-Value Theory, to the Situated Expectancy-Value Theory) as it relates to STEM in particular.
3. Suggest important next steps for both research and policy-making related to gender and STEM.

Presenter biography: Jacquelynne S. Eccles is Distinguished Professor of Education at UC-Irvine and formerly the McKeachie/Pintrich Distinguished University Professor of Psychology and Education at the University of Michigan, and Senior Research Scientist and Director of the Gender and Achievement Research Program at the Institute for Social Research at the University of Michigan. Over the past 30 years, Professor Eccles has conducted research on topics including gender-role socialisation, teacher expectancies, classroom influences on student motivation, and social development in the family and school context. One of the leading developmental scientists of her generation, she has made seminal contributions to the study of achievement-related decisions and development. Most notably, her expectancy-value theory of motivation and her concept of stage-environment have served as perhaps the most dominant models of achievement during the school years, contributing to extensive research and reform efforts to improve the nature of secondary school transitions. Professor Eccles also has been a major figure in the study of after-school activities, authoring a seminal National Research Council report that outlined the most effective ways for such activities to meet the developmental needs of adolescents. | jseccles@uci.edu

Do atypical leaders legitimise or delegitimise (STEM) workforce diversity?

Mustafa F. Özbilgin

Pre-recorded keynote: https://youtu.be/sf5jSPg8xnE

Live recorded discussion: https://youtu.be/BLQlXcJLqjU

Atypical leaders are those coming from disenfranchised, underrepresented, excluded, and nontraditional sociodemographic backgrounds (Samdanis & Özbilgin, 2019). Women, minority ethnic, working class, LGBTIQ+, young, and disabled leaders are mostly considered atypical in STEM leadership. Because of their often pioneering presence in leadership positions, atypical leaders, such as women leaders in STEM, are often heralded as signs of progress towards wider equality and fair representation. However, change in leadership demography does not automatically translate into leadership support for equality. I explore the curious role atypical leaders play to demonstrate how atypicality presents a dual structure in terms of leadership support for diversity and inclusion at work, and a gradual change in their politics of identity as they join the STEM elite of non-diverse and prototypical backgrounds.

Presenter biography: Mustafa F. Özbilgin is Professor of Organisational Behaviour at Brunel Business School, London. He is also Co-Chaire Management et Diversité at Université Paris Dauphine, as well as Visiting Professor of Management at Koç University in Istanbul. His research focuses on equality, diversity and inclusion at work from comparative and relational perspectives. His empirically grounded field studies in the UK and internationally are supported by international and national grants from the ESRC, EU, CIPD, ACE, ACCA, British Academy among others. His work has a focus on changing policy and practice in equality and diversity at work. He is an engaged scholar, driven by values of workplace democracy, equality for all, and humanisation of work. He is serving as the editor-in-chief of the European Management Review (EMR), the official journal of the European Academy of Management (EURAM) since 2014. He has authored and edited 18 books and published over 200 papers in academic journals such as the Academy of Management Review, Academy of Management Learning and Education, British Journal of Management, Journal of Vocational Behavior, Human Resource Management, Human Relations, Gender Work and Organization, and Social Science and Medicine among others. He has done research, consultancy and training at a large number of organisations including the House of Commons, Barclays Bank, The Bank West Australia, Halifax, the CIPD, the National Health Service, the NHS Employers, Tesco, the Probation Services, The UK Fire Service, the Economist Research Unit, the OECD, the WRVS, DTI, Rio Tinto, PwC, Linklaters and ACCA. He served as the editor-in-chief of the British Journal of Management, the official journal of the British Academy of Management, for four years from 2010 to 2014, and holds multiple editorial roles. | mustafa.ozbilgin@brunel.ac.uk

STEM participation, achievement & beliefs

Sue Thomson

Live recorded keynote: https://youtu.be/ck9hzJavxgE

While the 20th century saw women stride ahead in their participation in education and the workforce, there are still gender differences apparent in some areas. In particular, females do not enrol in higher mathematics, science or ICT, or move into STEM-based careers to the same extent as males. For example, while the number of people employed as ICT specialists in the EU grew by 36% during the period from 2007 to 2017 (more than 10 times higher than the corresponding increase of 3.2% for total employment), the proportion of women employed in these fields has stagnated. This presentation will address three broad areas that may hold females back from participation in these subjects in school and in entering STEM careers: 1. whether men are better at maths, science, ICT than women; 2. perceived ability – self-confidence and self-efficacy; and 3. cultural beliefs.

Presenter biography: Dr Sue Thomson is the Deputy CEO (Research) for the Australian Council for Educational Research (ACER). Her research is in the area of analysis and reporting of large-scale and longitudinal data sets, with a focus on gender and socioeconomic equity. She provides senior leadership at ACER for about 80 research staff in a range of educational research areas from early childhood to adult education and all points in between. In her 21 years at ACER Sue has been involved in a wide variety of projects, including as co-investigator on the ARC funded Australian Child Wellbeing Project, and a Chief Investigator for the Science of Learning Research Centre, a Special Initiative of the Australian Research Council. Currently she is the National Project Manager for Australia for the OECD's Programme for International Student Assessment (PISA) and the National Research Coordinator for the IEA Trends in International Mathematics and Science Study (TIMSS) and the IEA Progress in International reading Literacy (PIRLS), and the International Project Manager for the OECD's Study on Social and Emotional Skills. She has published widely on findings from these studies, including translational pieces on the outcomes of education and equity issues in the provision of education in Australia. | Sue.Thomson@acer.org

INVITED PANEL: 'SUPERSTARS OF STEM'

A beginner's guide to STEM Superstardom

Moderator: Walker, Kylie
Panelists: Griffiths, Kalinda; Macgregor, Melanie; Mitchell, Madeline; Sizeland, Katie

Live recorded feature panel: https://youtu.be/En4ICuedgm4

What does it take to be a Superstar of STEM? Hear from some of Science & Technology Australia's Superstars of STEM as they explore the challenges, opportunities and triumphs of building a growing public profile as a woman in STEM. In a Q&A-style discussion moderated by the program's creator, the Superstars will talk about why deliberate visibility is important, and share advice for aspiring stars, employers and allies, on how to work meaningfully towards equal representation of women and men on the STEM stage.

Presenter biographies:

Ms Kylie Walker @Kylie_Walker1
Kylie is the Chief Executive Officer of the Australian Academy of Technology and Engineering, where she works with expert Fellows to lead crucial national conversations and strategy towards a thriving, healthy and connected Australia supported by technology. She specialises in connecting technologists, engineers and scientists with governments, business, media and society – skills built over many years in senior federal communication and advocacy roles in the science, technology and health sectors. As the immediate past CEO of Science & Technology Australia, Kylie led campaigns to increase investment in Australian research and development, and created the acclaimed Superstars of STEM program, championing Australian women in science, technology, engineering and mathematics. Kylie is also a visiting Fellow at the Australian National Centre for the Public Awareness of Science. She was Chair of the Australian National Commission for UNESCO and in 2019, she was named in the 100 Women of Influence list by the Australian Financial Review, for her work on improving equity, diversity and inclusion in STEM. https://www.linkedin.com/in/kylieawalker/
| kylie.walker@atse.org.au

Dr Kalinda Griffiths @Klick22
Kalinda is a Yawuru woman of Broome, born and living in Darwin, Australia. She is an early career Scientia Lecturer at the Centre for Big Data Research in Health at UNSW. Kalinda also holds honorary fellowships at Menzies School of Health Research as well as the University of Melbourne and is Deputy Editor of the Health Promotion Journal of Australia. As an epidemiologist, her work addresses complex health disparities in populations through the use of existing data. Kalinda's research focuses on Indigenous Data Governance and the measurement of health disparities with a particular interest in improving health services and disease outcomes for Aboriginal and Torres Strait Islander people, as well as building health research capabilities in regional and remote Australia. She is on the steering committee for the Indigenous Data Network in Australia and holds a number of national and international committee roles, including in the Cancer Council Australia Health Services Research Group and the International Group for Indigenous Health Measurement. Kalinda is the recipient of a

number of awards. Notably, she was awarded the 'Northern Territory Young Australian of the Year' in 2011 and more recently, the 2019 Lowitja Institutes 'Emerging Researcher Award'. She was also a 2019-2021 Science and Technology Australia 'Superstar of STEM' and is currently the Australian Health Promotion Associations 'Thinker in Residence'.
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Dr Melanie Macgregor @mumdoesscience
Dr Melanie Macgregor is an ARC Future Fellow at the University of South Australia's Future Industries Institute. She obtained a Master of Chemical Engineering in France before moving to Australia and completing a PhD in Minerals and Material Engineering in 2013. She works on industry-driven translational research in close partnership with end users, clinicians, industry and academics from complimentary disciplines. Her research focus is the interaction between (bio) materials and their environment, primarily to address challenges faced by the biomedical and energy industries. Melanie has, for instance, worked on developing medical devices for non-invasive cancer diagnostic. The quality of her research and innovation have been recognised through several awards, including the 2016 Engineers Australia John A. Brodie Medal for achievement in Chemical Engineering, the 2017 Winnovation awards in the Engineering category, and a 2018 SA Young Tall Poppy Science Award. In 2019, she joined the SuperStar of STEM program hosted by Science Technology Australia. As a mum of two, Melanie is eager to promote STEM careers to the younger generations and devoted to help reform workplaces to better support primary carers. Her community engagement extends through participation to public events such as *Science Alive*! or *For the love of Science*, media interview, and the organisation lab tour and on-site visits for schools.
| Melanie.MacGregor@unisa.edu.au

Dr Madeline Mitchell @MaddiePlantSci
Dr Madeline Mitchell is a plant scientist interested in the economic, social and environmental sustainability of agriculture. She works at RMIT University and the Food Agility Cooperative Research Centre where she manages a research program to better understand the value of natural capital in farming systems. The program aims to support farmers to manage their natural capital (e.g. plants and animals, soil and water) for sustainability, profitability and climate resilience. Madeline has a PhD from the University of Cambridge where she contributed to an international collaboration to increase crop yields by reengineering photosynthesis. She joined CSIRO in 2015 as a postdoctoral fellow and helped develop novel vegetable oil crops, which are now in field trials. She then led a synthetic biology project to enhance cotton fibre properties to make renewable and biodegradable alternatives to artificial fibres. Madeline enjoys mentoring and connecting with the next generation of scientists. She has been a tutor and demonstrator in settings ranging from university practical classes and residential colleges to a homework club for disadvantaged students. She was part of the second cohort of Homeward Bound, a global leadership initiative for women in STEM, and in 2019 she received an ACT Young Tall Poppy Award. https://www.linkedin.com/in/dr-madeline-mitchell-6b326983/ & https://www.foodagility.com/projects/natural-capital-constellation-for-climate-resilient-farm-systems | madeline.mitchell@rmit.edu.au

Dr Katie Sizeland @katie_sizeland

Dr Katie Sizeland is a Strategic Projects Leader at the Australian Nuclear Science and Technology Organisation, ANSTO (www.ansto.gov.au). She is passionate about science, technology, engineering and mathematics (STEM) focused on innovative solutions to industry problems and ensuring that STEM can have a real impact, creating a better future for everyone and the world we live in. Katie has a strong track record developing the interface between research and industry with 8 years' experience across science, innovation, and strategic program management roles with a focus on medical and agricultural industries. Katie holds a PhD in Engineering and a Bachelor of Chemical Engineering and Nanotechnology (Honours) both from Massey University in New Zealand. Katie is passionate about science communication and inspiring the next generation in STEM. She has coached and mentored secondary school students and undergraduate students through the Australian Science Innovations program 'Curious Minds' and the AINSE 'Women in STEM and Entrepreneurship (WISE)' program. Katie was a 2019-2020 Science and Technology Australia 'Superstar of STEM' and a 2020 NSW Young Tall Poppy. In 2019, Katie was selected for the fourth Homeward Bound cohort, a global leadership program for women in STEMM, and she received an Australian Academy of Science Lindau Nobel Laureate Meeting Fellowship (a Science and Industry Endowment Fund). | katheris@ansto.gov.au

SYMPOSIA

S1: Motivational Processes in the STEM pipeline

Chair: Harackiewicz, Judith
** Live recorded Paper 1:* https://youtu.be/ZYK8bLoL2AA
** Live recorded Paper 2:* https://youtu.be/0dUJ1BMJmRA
Pre-recorded Papers 3—5: https://youtu.be/b64ng05KsiQ

This symposium addresses recent research about motivational processes in the STEM pipeline, with a focus on adolescents and college students making decisions about course-taking and future careers. Each of five speakers will present findings that address gender differences (and similarities) in values, expectancies and sense of belonging, interest, using different analytic methods to address issues of common concern. Samples range from adolescents in Australian high schools, university students in STEM courses, and cross-cultural PISA data.

Keywords: motivation; expectancy-value; belonging; interest; interventions.

* Paper 1: Positive attitudes towards mathematics and science are mutually beneficial for student achievement: A latent profile analysis of TIMSS 2015

Berger, N.; Mackenzie, E.; Holmes, K.

Australia has seen declining numbers of students choosing mathematics and science subjects in the senior secondary years, running counter to economic projections of accelerating need for STEM skills. Many students become less engaged with these subjects in the junior secondary years but attitudes like self-concept, utility value, and intrinsic value are important for subject selection decisions. In recent years, person-centred data analytic approaches have become increasingly important in the study of attitudes towards STEM education, as different subgroups may have particular needs, strengths, and outcomes. Such subgroups may go unobserved in variable-centred approaches. Therefore, in this study we investigate (i) what attitudinal profiles exist in Australian early adolescents towards mathematics and science, and (ii) how these attitudinal profiles vary by gender, parental education, and academic achievement. Data for this study come from the Trends in International Mathematics and Science Study (TIMSS, 2015), a major international comparative study of student achievement and attitudes. We used latent profile analysis in R to examine the relationship between attitudes towards both subjects using data from 10,051 Australian Year 8 students sampled by TIMSS 2015. The model fit statistics pointed to six discrete groupings of students in the data. We named the groups (in italics): 1) Resistant to both subjects, 2) Receptive to both subjects, 3) Enthusiastic about both subjects, 4) Very Enthusiastic about both subjects, 5) Prefer mathematics, and 6) Prefer science. While most students were at least attitudinally receptive to both subjects, there were a number of students who either resisted both or expressed a strong preference for one over another. Positive attitudes towards both subjects were mutually beneficial – better attitudes towards both was associated with higher achievement in each – but boys tended to be more positive towards both subjects and so benefitted from this relationship more than girls. These findings contribute to our understanding of student attitudes and experiences in mathematics and science, and emphasise the practical role teachers play in supporting positive outcomes. The study also demonstrates how large-scale person-centred

quantitative analyses can help researchers and educators to more thoroughly understand and support the needs of specific groups of students.

*** Paper 2: Cross-cultural and gender differences in predicting career aspirations in different STEM-related fields: An Expectancy-Value perspective**
Guo, J.; Hu, X.; Pekrun, R.; Marsh, H. W.

While expectancy-value theory (EVT) has been suggested to explain various students' aspirations and choices in STEM-related fields, few studies have compared cross-cultural differences in respective effects of students' science expectancies and subjective values. By analyzing data on 472,242 15-year-old students from 72 countries using generalized linear models, the present study aims to examine the relationship between different motivation factors (i.e., science self-efficacy, enjoyment and utility value) and STEM aspiration, controlling for academic achievement in science, reading, and mathematics, gender, grade, and family socio-economic status. The results showed that 1) on average, science utility value is a stronger predictor of 15-year-old students' career aspirations in STEM than self-efficacy, enjoyment, and performance, particularly when predicting aspirations in life science-related fields; 2) however, there is a substantial country-by-country variation in the effect of utility value – the effects are stronger in more developed countries; 3) for gender differences, girls aspire more to life science than to physical science, and vice versa for boys; 4) utility value plays a more important role for girls than for boys in aspiring to STEM-related fields, particularly in more gender-equal countries. This is among the first study to provide a comprehensive test of the generalizability of the EVT predictions, which brings practical implications for motivation interventions targeting EVT motivational processes to promote STEM aspirations in a wider context.

Paper 3: Should I stay or should I go?: Studying changes in university students' biomedical career plans
Harackiewicz, J.; Rosenzweig, E.

Biology is the one STEM field where woman have achieved parity. Across several intervention studies where we have examined performance in gateway biology courses, we have found no gender differences in course performance, intervention efficacy, or persistence in the biomedical track. However, we found evidence of gender differences in an interview study. Specifically, we identified 1193 students intending to pursue biomedical fields early in college, collected data about their beliefs and performance throughout college, and interviewed them near graduation about their future plans. When we consider change within the pipeline (i.e., staying in biomedical fields, but changing goals and paths), we start to see some intriguing gender differences. Female students weren't more likely to leave the biomedical field compared to male students, but they were more likely to lower their educational aspirations within the biomedical field compared to male students during the period that we followed them (e.g., changing plans from doctor to physician assistant). They were also more likely than men to say that they changed plans in order to combine multiple interests together. These results highlight the importance of continuing to explore gender differences in motivational patterns, even when parity appears to have been achieved.

Paper 4: Navigating STEM pathways: Benefits of broadening perceived goal opportunities

Diekman, A.

I will review evidence for a goal congruity perspective on engagement with STEM fields. In particular, this perspective posits that individuals seek to align the roles that they enter with their values. As such, whether different career fields are seen as affording these goals is critical in attracting or deterring students (Diekman, Steinberg, Brown, Belanger, & Clark, 2017). People assess whether a particular role offers opportunities to reach their goals, and those roles that offer more opportunities are more attractive. Our research focuses on perceptions that STEM fields uniquely lack opportunities for communal goals: Both men and women share beliefs that STEM fields tend to lack opportunities for prosociality, collaboration, or connection (Diekman, Brown, Johnston, & Clark, 2010). Because of primary human needs for belongingness and relatedness, both men and women value roles that offer communal opportunities. However, because communality is central to the traditional female gender role, women may especially weigh communal opportunities. Communally-oriented contexts can particularly matter in settings where women are traditionally marginalized. Multiple benefits can emerge from broadening goal affordances in STEM at different temporal points in STEM pathways. Specifically, I will examine the advantages of STEM contexts that offer opportunities for both communal goals and agentic goals (i.e., achievement or self-expression). Beliefs that STEM fields do not afford communal goals can play an especially large part in recruitment (i.e., before students enter STEM majors). Among students who are in STEM majors, however, these perceptions shift. In college samples, students in life sciences, physical sciences, or engineering reported that their majors afforded communal goals; in turn, these communal affordance perceptions uniquely predicted their positivity toward their future career paths. Overall, science and engineering contexts that signal opportunities for both communal and agentic goals maximize flexibility and favorability because they can meet the needs of a wide range of students and the shifting needs of students over their personal trajectories. Faculty who signal an orientation toward developing student abilities, relative to displaying fixed abilities, can influence students' beliefs about broader fields. Across several studies, students who perceived that STEM faculty endorsed growth vs. fixed mindset beliefs were more likely to believe that STEM can afford communal and agentic goals. In turn, these perceived communal affordances strongly predicted student interest in pursuing STEM education and careers. From a structural perspective, both challenges and opportunities exist for broadening the perceived and actual affordances of STEM roles.

Paper 5: Gender differences in belonging in college physics

Zhang, S.; Graham, M.; Nguyen, H.; Martindale, K.; Bermudez, B.; Lampkins, S.; Husman, J.

Do I belong? This is an important question students ask themselves, the answer to which has important implications for STEM students (Kim & Sinatra, 2018). Although research on belongingness, particularly in STEM settings, is growing, research has focused on secondary education settings. The goal of this study is to explore university students' beliefs about their sense of belongingness in their major and course and their use of learning strategies. Researchers have argued that one reason for the established gender gap is that female identified students (FI) often do not feel like they belonging in science majors or classrooms (Sankar, Gilmartin, & Sobel, 2015). It is possible that FI students may feel a lack of belongingness simply due to their under-representation. In this study we surveyed students in a non-major

physics course, which has an even distribution of male and female identified students. It is possible, despite the content of the course, FI feel more belongingness than MI. To explore the effects of belongingness on classroom learning we look at the relation between belongingness, self-regulatory strategy use, self-efficacy, and course performance. What is the relation between course belongingness, self-efficacy, Self-regulation in a non-major physics course? Are their gender differences in course belongingness? We recruited 269 undergraduate students' (165 female identified, 175 European Americans) in a non-major physics course. We utilized established measures of self-efficacy, course belongingness, students question asking (High and Low), self-regulation, and other regulation. Based on t-tests male identified (MI) students had more belongingness than female identified (FI). For FI, only other regulation was significantly related to belongingness once self-efficacy was entered into the equation R^2=.26, $F(2, 101) = 17.3$, $p < .001$. We recruited students from another female-dominated non-major physic class. We were curious to discover whether belongingness and self-efficacy predicted performance. We separated our sample by gender identification and conducted regressions on each sample separately. MI students reported greater belongingness than FI. Belongingness was related to all self-regulation and strategy variables for both MI and FI. Belongingness was related to performance for MI and not FI. Across the two studies, self-efficacy and belongingness explained a significant portion of the variance in approaches to learning. We found consistent gender differences between male and female identified students. We fear that even when FI are over represented in a course the STEM course content may hinder female identified students' sense of belongingness. Recommendations for classroom interventions will be discussed.

Author biographies:

Nathan Berger, PhD is Postdoctoral Research Fellow in STEM Education at the Centre for Educational Research, Western Sydney University, Australia. His degrees in information technology (BIT), secondary teaching (MTeach, MEd), and the social psychology of education (PhD) are from the University of Newcastle, Australia. His research interests focus on the career and education aspirations of children and young people, with particular emphasis on understanding the motivational drivers which influence the development of aspirations for a wide range of careers during schooling. His research has been published in journals such as Frontiers in Psychology & Social Psychology of Education. | n.berger@westernsydney.edu.au

Amanda Diekman is a Professor and Associate Chair in the Department of Psychological and Brain Sciences. She received her B.A. from Kenyon College and her Ph.D. in social psychology from Northwestern University. She investigates how gender stereotypes stem from and reinforce the social structure. Her current research examines perceptions that STEM fields do not afford communal opportunities to connect with or help others, and the consequences of these beliefs for student attitudes and motivation. She is a Fellow of the Association for Psychological Science, the Society for Personality and Social Psychology, and the Society of Experimental Social Psychology. | abdiekma@iu.edu

Matthew C. Graham is a research assistant with the Oregon Education Science Laboratory at the University of Oregon where he specializes in statistical methodology. His research focuses on motivation of and physiological markers of arousal in post-secondary students. | mgraham@uoregon.edu

Jiesi Guo, PhD, is a senior lecturer at the Institute for Positive Psychology and Education. His areas of interest include educational and developmental psychology with a particular focus on how multiple systems on the cultural, social, and motivational development of youth shape individual and gender difference in achievement choice. | jiesi.guo@acu.edu.au

Judith Harackiewicz is the Paul Pintrich Professor of Psychology at the University of Wisconsin-Madison. Her most recent research concerns interventions to promote motivation, with a particular focus on promoting motivation for underrepresented students. She is currently testing motivational interventions in college biology and chemistry courses, working to promote interest and performance in the foundational course that serves as a gateway to biomedical careers, as well as retention in the STEM pipeline. | jmharack@wisc.edu

Kathryn Holmes, PhD is Professor of Education (Science, Mathematics, & Technology) at the Centre for Educational Research, Western Sydney University, Australia. She is the Research Director for the School of Education and the Director of the Centre for Educational Research. Her research interests are in STEM education, educational technology, and student equity and wellbeing. | k.holmes@westernsydney.edu.au

Xiang Hu, PhD, is an assistant professor in the Institute of Curriculum and Pedagogy at Beijing Normal University. His research interests focus on understanding the social, cultural, and pedagogical factors that interact with student learning outcomes, including motivation, academic performance, and STEM aspiration. | huxianghfp@gmail.com

Erin Mackenzie, PhD is Lecturer in STEM Education at the Centre for Educational Research, Western Sydney University, Australia. She completed a PhD in educational psychology at Macquarie University, and currently lectures in secondary science pedagogy, STEM education, and educational psychology. Erin's research interests include adolescent online interactions, coping, and the role of psychological and social factors in adolescent girls' participation in STEM. | e.mackenzie@westernsydney.edu.au

Herbert W. Marsh, PhD is an ''ISI highly cited researcher'' (http://isihighlycited .com/) with 7001 publications, 100,0001 citations and an H-index of 159. He coined the phrase substantive-methodological synergy that underpins his substantive (self-concept, motivation, gender, bullying; educational, developmental, and sport psychology) and methodological (factor analysis, multilevel modelling) research interests. | Herb.Marsh@acu.edu.au

Kyla Martindale is an undergraduate Educational Foundations major at the University of Oregon. She has served as an undergraduate research assistant for 2 years. She is interested in the development of students' self-regulation through instructional intervention.
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Hana Nguyen has worked as an undergraduate research assistant for 2 years. Her work has focused on student belongingness. She plans to study elementary education in graduate school.
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Reinhard Pekrun, PhD, is a professor of personality and educational psychology at the University of Munich, Germany, and Professorial Fellow at the Australian Catholic University, Sydney, Australia. His research areas are achievement motivation and emotion, personality development, and educational assessment and evaluation. He is a highly cited scientist who pioneered research on emotions in education and originated the Control-Value Theory of Achievement Emotions. | pekrun@lmu.de

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Shan Zhang recently completed an Ed.M. degree in the Human Development and Psychology program at the Harvard Graduate of Education. Prior to attending the HGSE, she received her B.S. in Educational Foundations from the University of Oregon. She is interested in STEM learning in early childhood and how environmental factors, such as parents, teachers, and caregivers, impact children's learning outcomes. She is also interested in how parental input influences children's language development. | shanzhang00@gmail.com

S2: Helping or Hindering Girls' STEM Motivational Beliefs: Students' STEM Achievement, Gender Stereotypes, and Teacher Support across Five Large U.S. Datasets

Chair: Starr, Christine
Discussant: Eccles, Jacquelynne S.
Pre-recorded introduction: https://youtu.be/9oVLM2q-lDc

Employing expectancy-value theory, this symposium examines four different gender and STEM research topics across 3-5 large scale longitudinal datasets collected among U.S. children and adolescents. By investigating across datasets, we attempt to replicate and extend our findings across a variety of populations that vary in ethnicity, age, etc. The first talk uses all five datasets to examine associations and gender differences in math motivation and outcomes. The second talk examines the prevalence of gender stereotypes about math ability among parents and students, finding little change in stereotypes across the past three decades. The third talk explores how teacher support is related to student motivation in math, especially among girls and Hispanic students. Finally, the last talk examines gender differences in aspiring towards health/biology related STEM occupations vs. physics/engineering occupations. Our discussant will bring her extensive knowledge as a leader in gender and STEM research and contributor to the datasets explored.

Keywords: motivational beliefs; gender; parents; teacher support; math.

Paper 1: High school students' math motivational beliefs: An examination of the associations and gender differences across five large U.S. datasets
Rubach, C.; Gao, Y.; Starr, C.R.; Safavian, N.; Dicke, A.L.; Eccles, J.S.; Simpkins, S.
Pre-recorded presentation: https://youtu.be/SCJHkfO14nE

Researchers have underscored that socio-demographic factors influence students' STEM motivational beliefs. When looking at patterns by gender, females, on average, have lower motivational beliefs in math compared to males (e.g., Huang, 2013). However, only trivial performance differences were indicated between males and females in math (Else-Quest et al., 2010). This is related to societal factors, such as gender stereotypes or gender bias in STEM fields (Leaper & Brown, 2008). Also discussed were differences explained by the intersection of gender and race/ethnicity. Results demonstrated that White male students had higher performance scores in math than Black and Latino male students (Riegle-Crumb, 2006). Only a few studies, to our knowledge, have systematically investigated differences in motivational beliefs in STEM fields, particularly math, by taking into account gender, race/ethnicity, and their intersection (Else-Quest et al., 2013). Such research is critical to uncovering the privileges and oppression that occur from multiple social identities within individuals. Given the centrality of math to all STEM domains, the current study aims to examine (a) mean level differences in adolescents' math motivational beliefs between gender and race/ethnicities (b) the extent to which changes in motivational beliefs vary as a function of gender and race/ethnicities and (c) the extent to how the gender*ethnicity intersection explains adolescents' math motivational beliefs. In educational research, we are experiencing a great deal of discussion about historical changes of equity across gender and ethnicity in STEM fields. Therefore, we utilize five large U.S datasets that span three decades from the 1990's to the 2010's. Replication studies, particularly those with multiple datasets in one paper, are critical but rare in this field. Thus, we focus on conceptual replications across five large-scale studies. First, the Childhood and Beyond Study (CAB) includes 723 adolescents (92% European American). Second, Michigan Study of Adolescent and Adult Life Transitions (MSALT) includes 1425 students (87% European American, 7% African American). Third, the California Achievement Motivation Project (CAMP) includes 15,893 students (70% Hispanic). Fourth, the Maryland Adolescent Development In Context Study (MADICS), includes 1482 students (30% European American, 59% African American). Fifth, High School Longitudinal Study (HSLS) includes a nationally representative sample of 21,444 students (51% European American, 10% African American, 16% Hispanic, 8% Asian American). Each dataset includes comparable measures of adolescents' math ability self-concept, interest, and importance from 9th to 12th grade. All scales have excellent face, convergent, and discriminant validity and strong psychometric properties.

Paper 2: Parent and youth gender stereotypes about math: Findings from four U.S. datasets from 1984 to 2011
Starr, C.R.; Gao, Y.; Dicke, A.L.; Rubach, C.; Lee, G.; Safavian, N.; Eccles, J.S.; Simpkins, S.
Pre-recorded presentation: https://youtu.be/iBotRmJd-ks

Holding the stereotype that boys are better at math may result in negative math outcomes for girls. However, few studies have longitudinally examined the prevalence of math stereotypes among youth and parents, the relationship between youth and parent stereotypes, and their

associations with youths' math self-concepts. We investigate these questions with four large (1,000+ participants) longitudinal datasets collected in the U.S., spanning 3-11th grade. In all four datasets, the following question was asked to youth and their parent: "Who is better at math, girls or boys?" (-2 = girls definitely better; 0 = boys and girls equal, 2 = boys definitely better). Additionally, youths' math self-concepts were measured. We examine the following research questions: 1) Have parent math-gender stereotypes changed over the past few decades? 2) Do parents' gender stereotypes predict youths' stereotypes? 3) Do youth gender stereotypes about math relate to math expectancy-value beliefs? We found that parents' gender stereotypes have stayed fairly consistent for the past few decades. While a majority of parents believed that all genders perform equally at math, the parent mean across datasets tended towards the belief that boys are better, with 30% of parents across datasets endorsing the belief that boys are somewhat or definitely better at math than girls. This belief did not decrease over time (mean in 1984 = .14; 1984 = .14; 1993 = .09; 2011 = .21). Among youth, most believed all genders are equally good at math, with younger children being more likely to think their own gender is better. However, by 11th grade, girls (and boys) were more likely to believe boys are better at math, with 25% of girls and 29% of boys saying that boys were somewhat or definitely better at math. Additionally, we found that parents' gender stereotypes significantly predicted youth stereotypes [girls B(SE) = 09(.01)***, Boys B(SE) = .10(.01)***]. Finally, youths' gender stereotypes were significantly related to their math expectancy beliefs; associating math with their own gender was generally significantly related to higher math expectancy beliefs. In sum, believing males are better at math is a small but persistent stereotype in the U.S., that relates to parents' beliefs and youth self-concepts. To our knowledge, this study is the first to examine parents' and child's math gender stereotypes longitudinally, and to explore math gender stereotype prevalence over the course of several decades. Future directions and implications, including possible developmental trajectories, will be discussed.

Paper 3: Perceived teacher support and its associations with math motivational beliefs: Exploring gender differences using three large U.S. datasets
Dicke, A.L.; Rubach, C.; Lee, G.; Safavian, N.; Gao, Y.; Starr, C.R.; Eccles, J.S.; Simpkins, S.
Pre-recorded presentation: https://youtu.be/AUnvDF1VPok

Despite relative achievement parity in mathematics, girls persistently report lower math motivation compared to boys. According to research, the stereotyped nature of mathematics as a masculine-typed domain is one source for this disparity. Research also indicates that teacher support is an important source of students' success and a buffer against the gender specific motivational gap. However, it is still unclear whether findings are persistent in the development across adolescence, across the last decades, and for students from different ethnic backgrounds. Using three large longitudinal datasets collected in the U.S. between 1983 and 2011 (MSALT, CAMP, and HSLS; see Paper 1), we investigated the association of perceived teacher emotional support and students' interest and self-concept in mathematics for European American and Hispanic participants from grades 7 to 9. In all datasets, teacher emotional support was assessed through students' perception of their math teachers' fairness, care, and openness towards their students. To assess math motivational beliefs, we used students' self-concept and interest. We asked: 1) Is perceived teacher emotional support positively associated

with students' math motivation and its development? 2) Do these associations differ across gender within European American and Hispanic students?

Using cross-sectional data, consistent moderate associations between teacher support and math interest (r = .35-.52) and math self-concept (r = .18-.32) emerged separately across Hispanic and European American students and across grades 7 to 9. However, these associations did not differentiate by gender in all three datasets. Change in math motivations across one (MSALT and CAMP) and two years (HSLS) were also examined. We found that teacher support was not systematically significantly related to the development of interest and self-concept, with the following exceptions: Across one year, teacher support was positively related to the development of self-concept for European American girls and across both genders for Hispanics in grade 7. In grade 9, teacher support was positively related to the development of interest for Hispanic girls, but not boys. Across two years, no significant effects, but the same tendency was found for Hispanics. Interestingly, teacher support was negatively related to the development of interest in grade 9 for both genders in the European American students.These findings suggest that teachers' emotional support might be particularly important for early adolescent girls and Hispanic students in the gender-stereotyped domain of mathematics. In addition, patterns of associations did not change fundamentally over the last decades. Future directions and implications will be discussed.

Paper 4: Hispanic, African American, and White youths' STEM-related career aspirations: Exploring gender differences using three Large U.S. Datasets
Safavian, N.; Dicke, A.L.; Gao, Y.; Starr, C.R.; Eccles, J.S.
Pre-recorded presentation: https://youtu.be/5uZZUkCqkKc

Gender and racial/ethnic inequity persist within the STEM workforce. Women and minorities are disproportionally underrepresented in some STEM fields (e.g., biological sciences) relative to others (e.g., physics). While explanations for STEM attritions vary, adolescents' occupational aspirations are well documented as a critical entry point into the STEM workforce. We examine three distinctly different datasets (MSALT, MADICS, and CAMP; see Paper 1), to understand patterns of adolescents' career aspirations across three different populations and time periods, by asking: 1) What careers do boys and girls aspire to and do they significantly differentiate? 2) Do adolescents' career aspirations differentiate developmentally and historically? Three large U.S.-based longitudinal datasets spanning over 23 years were used to examine adolescents' career aspirations during early (ages 14-15) and late adolescence (ages 17-18). Data from the following studies were used: MSALT (Years 1988-90, 60% female; 92% Caucasian, n=1,132), MADICS (Years 1993-96, 50% female, 60% African American, 30% Caucasian, n=802) and from CAMP (Year 2004, 49% female, 70% Hispanic, 10% Vietnamese, n=1,603). In all three datasets, students were asked an open-ended question about the type of job they would like to have when they grow up. Occupational aspirations (e.g., "Veterinarian") were coded using the 2010 Standard Occupational Classification system and thematically aggregated into 14 categories ranging from Management, Business, and Financial Occupations to Protective and Military Service Occupations. STEM designation was determined using the Occupational Information Network database. Approximately 40-45% of adolescents aspired to STEM careers across all three datasets and within early (ages 14-15) and late adolescence (ages 17-18). For STEM aspirers,

gender differences in aspirations strongly aligned with gender role stereotypes with girls aspiring to careers within Healthcare (approximate 70-80% of aspirations) and boys to careers in Computer, Engineering, and Science (approximate 61-75% of aspirations). STEM aspirations in early and late adolescence mirrored one another in pattern and proportions. Chi-square analyses examining within STEM variations yielded gendered aspirations for both early and late adolescence: girls significantly more often aspired to biology- and chemistry-driven professions (65-80%) and boys to physics- and engineering-driven professions (70-88%). Boys and girls aspired to math-driven professions in similar proportions. Interestingly, the patterns were consistent across different racial/ethnic populations, stages of adolescence, and time periods. Findings thus replicate prior findings of gendered occupational interests with girls showing interest in human services occupations and boys aspiring to more traditional STEM domains. Further findings and implications will be discussed.

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Jacquelynne S. Eccles is the Distinguished Professor of Education at the University of California, Irvine. Over the past 40 years, Professor Eccles has conducted research on a wide variety of topics including gender-role socialization, teacher expectancies, classroom influences on student motivation, and social development in the family and school context. One of the leading developmental scientists of her generation, she has made seminal contributions to the study of achievement-related decisions and development. Most notably, her expectancy-value theory of motivation and her concept of stage-environment have served as perhaps the most dominant models of school achievement, contributing to extensive research and reform. | jseccles@uci.edu

Yannan Gao is a doctoral candidate in the School of Education at the University of California, Irvine. She is interested in understanding the development of career choices over time. Another strand of her research focuses on two groups in STEM fields: women in physics, engineering and technology fields, and first-generation college students. Currently, Yannan is working on a large-scale classroom intervention to cultivate students' valuing of science on a demographically diverse college campus. | yannang@uci.edu

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exploring adolescents' STEM motivation and its relation to parents and teachers. She is also involved in a National Science Foundation-funded study investigating Hispanic youths' academic motivation and their post-secondary STEM-aspirations and career outcomes. | glonal@uci.edu

Dr. Charlott Rubach is a postdoctoral scholar at the University of California, Irvine. In her research, she aims to understand the relevance of inter- and intrapersonal factors determining student motivation and emotion during adolescence. A special interest is to understand how teachers' beliefs and behavior can foster student motivation and emotion in mathematics. Currently Charlott is working with Drs. Jacquelynne Eccles and Sandra Simpkins to study adolescents' STEM motivation and emotion, gender specific development and the relevance of families and teachers. | crubach@uci.edu

Dr. Nayssan Safavian is a Project Scientist within the School of Education at the University of California, Irvine. Her research applies an achievement motivation lens to study factors that optimize opportunities in math and science for young people within underrepresented communities. She is a co-investigator on an Institute of Education Sciences-funded study examining undergraduates perceptions of science relevance with a focus on students who are underrepresented in science—first-generation, underrepresented minorities, and female students. She is also a co-investigator on a National Science Foundation-funded study exploring the associations of Hispanic youths' math motivations and post-secondary STEM-aspirations and career attainment. | nsafavia@uci.edu

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Dr. Christy Starr is a postdoctoral scholar at the University of California, Irvine. Christy's research publications explore barriers that girls, women, and students of color face in STEM (such as stereotypes and discrimination) as well as factors that can improve gender and ethnic representation in STEM (such as active learning practices in classrooms). Christy received her doctorate in Developmental Psychology at University of California, Santa Cruz (Advisor: Prof. Campbell Leaper). Currently Christy is working with Drs. Sandra Simpkins and Jacquelynne Eccles for a National Science Foundation-funded project about adolescent STEM motivation, intersectionality, and families. | cstarr1@uci.edu

S3: Interest as key variable for STEM career choices in formative final school years and tertiary education

Chair: Paechter, Manuela
Discussant: Watson, Penelope
Pre-recorded discussant: https://youtu.be/CVrIjMBNZ58

The symposium investigates how interest as key variable in an array of variables (e.g., attitudes, abilities, personality) influences career choices for/against STEM and within STEM fields. It starts with a survey in upper secondary education on the impact of various interest variables and math ability for young women's decision for/against a STEM career. Within STEM fields the proportion of women also differs tremendously. Therefore, two contributions investigate the role of interest, self-concept, and motivation for a) female STEM pre-service teachers versus women studying STEM as major subject and b) women in STEM subjects that have either a low or a moderate proportion of females. The fourth contribution presents a long-term study, from the formative last school years to university education, which identifies key variables that explain interest-major congruence. The symposium provides not only a comprehensive view on formative years for career orientation but also gives recommendations for counselling.

Keywords: Vocational interests; Holland model; congruence; motivation; career choice.

Paper 1: STEM aspirations among young women in secondary education: The relevance of vocational interests

Malkoc, S.
Pre-recorded presentation: https://youtu.be/mfZ96QhW_gY

The underrepresentation of women in STEM fields is still a widely discussed and relevant topic. Research has mostly discussed this topic with a look at the differences of men's and women's vocational aspirations and variables that may explain them. Indeed, variables such as interest, personality, cognitive abilities, self-concept etc. can explain a large degree of the variation in men's and women's vocational aspirations. In contrast, less research has investigated differences within the group of women and aspirations for gender-typical (mainly non-STEM) vocations and for (gender-atypical) STEM vocations.

In the current study two groups of young women were analyzed in order to understand their vocational aspirations: women with vocational aspirations in STEM and women with other (non-STEM) vocational aspirations. Cognitive abilities, school grades, personality traits, and vocational interests were recorded. Altogether, 3962 female students in their final year in secondary school (mostly age 17 to 19), 3250 with non-STEM aspirations and 712 with STEM aspirations, took part. Binary logistic regression analysis with nested models was conducted to identify determinants of STEM respectively non-STEM aspirations (dependent variable for all models). Independent variables were included stepwise (taking previous findings into consideration): model 1: cognitive abilities; model 2: model 1 + school grades; model 3: model 2 + personality traits; model 4: model 3 + vocational interests.

STEM respectively non-STEM aspirations could be meaningfully explained only in model 4, when vocational interests were included. Furthermore, women who reported interests in things

and ideas (for this classification of vocational interests compare Prediger, 1982, Su & Rounds, 2015) as well as women with better grades in mathematics were more likely to show STEM aspirations. The results of the present study have implications for career counselling of young women as well as for learning and instruction in school. They emphasize the importance of gender-atypical vocational interests (things and ideas) in the development of STEM aspirations among women. Furthermore, they confirm the assumption of mathematics as a critical filter variable for career aspirations and career choice in STEM.

Paper 2: To what degree do STEM pre-service teachers' interests fit their teaching aspiration?

Ertl, B.; Hartmann, F. G.; Mouton, D.

Pre-recorded presentation: https://youtu.be/zL__nIkslgQ

According to Holland's theory (1997), a person's vocational interest profile can be characterized by six dimensions, namely realistic, investigative, artistic, social, enterprising, and conventional interests. According to their psychological similarity, these interest dimensions can be mapped to a regular hexagon. Equivalently, occupations can be described by such kind of interest profile. A good fit between an individual's interest profile and the profile of the aspired working environment, which is called congruence, is seen as a valid predictor for job satisfaction and performance (see Nye et al., 2012). Within academic STEM fields, one group is of special interest for society: Female STEM teachers who in their role as teachers may inspire especially girls (but also boys) for STEM. This contribution investigates to what degree the interests and the interest congruence of female pre-service teachers aspiring STEM teaching professions differ from female students aspiring working in the respective specialty areas (outside of teaching). Altogether, 1392 female university students of the NEPS SC5 cohort (first-year students) with 374 women with STEM specialty aspirations and 1018 women with STEM teaching aspirations were analyzed. Results show no significant differences with respect to interest congruence, neither between the STEM subjects nor between the specialty and teaching professions. However, there were differences between the six interest dimensions: For the investigative dimension, students in chemistry and biology showed significant higher values than students of mathematics. Pre-service teachers of mathematics and biology showed higher values regarding the artistic dimension than their specialty co-students, and pre-service teachers generally showed higher social and enterprising interests for all subjects. There were no significant differences with respect to realistic and conventional interests. The results indicate that female students in STEM indeed choose to teach or to specialize based on their different interest profiles. This is especially prevalent for the social and enterprising dimension. The results also indicate differences between the different STEM subjects, especially a lower level of investigative interests in mathematics. This may call for a more differentiated re-classification of STEM teaching professions.

Paper 3: Interest, self-concept, and family support as key-variables for women's motivation in STEM fields with different proportions of women

Luttenberger, S.; Paechter, M.

Pre-recorded presentation: https://youtu.be/KzNgwIFinWk

While some STEM subjects (e.g., engineering, technology) still appear unattractive for women, other subjects (e.g., geography, biology) have better chances at attracting women. Research has mostly neglected these differences, treating STEM as an overall category. Against this background, this study takes a differentiated look to separately investigate STEM subjects that have a low or moderate proportion of females. Considering enrollment as well as staying on a STEM career path, intrinsic and extrinsic motivation play a crucial role (Van Soom & Donche, 2014). Motivation is built up over the course of socialization and is influenced by significant other persons such as parents or teachers. Motivation is also related to the academic self-concept as well as to interest in a domain. The present study, therefore, investigates to what degree academic self-concept, support in the family, and two facets of STEM interest in school (STEM fields as favorite school subjects and activities in school that were to encourage interest in STEM) contribute to women's motivation in a STEM study.

Two groups were investigated. 284 women enrolled in STEM subjects with a low proportion of females (STEM-LPF) and 185 women in STEM subjects with a moderate proportion of females (STEM-MPF) filled in a questionnaire on motivation, academic self-concept, STEM interest, and support in the family. Latent regression analyses were carried out with intrinsic and extrinsic motivation as criterion, and self-concept, the two interest facets, and family support as predictor variables. Different variables contribute to motivation in the two samples. For STEM-LPF, regression analysis found positive relationships between the academic self-concept and both intrinsic and extrinsic motivation, but neither the two facets of interest nor support from the family contributed to motivation. In the STEM-MPF sample, only interest in STEM subjects contributed to motivation. Women who reported of STEM fields being their favorite school subjects expressed higher intrinsic and extrinsic motivation. An unexpected result was found concerning activities in school that were designed to promote interest in STEM. Memories of these activities were negatively related to both intrinsic and extrinsic motivation. It seems that especially in STEM fields with a moderate proportion of women, didactic attempts to promote STEM sometimes might be experienced as intrusive support and fail the intention of arousing interest.

Paper 4: Interest as key variable for STEM career choices in formative final school years and tertiary education

Bergmann, J.

Pre-recorded presentation: https://youtu.be/dNtY53bg0Ak

Little seems to have changed in career choices and the proportion of women pursuing a career in a STEM field is still low. To understand more about this disproportion, the present study looks closer into determinants of choices for STEM versus non-STEM fields, for men as well as for women, and seeks patterns of choice-related variables. According to Holland (1997), vocational interests are significant predictors of vocational choices and outcomes. Vocational choices are formed in a long-term process and it is of special importance to identify underlying

factors at different stages of this process. The present study aims to identify factors related to interest-congruent vocational choices at an early career stage, namely the choice of study majors at university. Furthermore, it investigates, whether these factors differ depending on gender and vocational aspiration (STEM versus non-STEM).

In a longitudinal study 584 high school students (54% female) took part in a survey at two points in time, shortly before their graduation and two to four years later, when they were enrolled in university. Linear regression was carried out to identify variables from the first measurement point (high school) that may explain a significant amount of variance in interest-major congruence at the second measurement point (university). The results mostly agree with Holland's theory, showing that interest consistency, vocational identity, and interest-aspiration congruence positively predict interest-major congruence. However, while interest-aspiration congruence has the strongest relation, differentiation of interests shows no relation to interest-major congruence. Controlling for motivational aspects (choice for a major subject), personality traits and cognitive abilities result in very little change. Repeating the same analysis separately for woman versus men with STEM versus non-STEM aspirations, results show differential patterns. One main finding is that for women with STEM aspirations the interest-major congruence can be predicted by interest-aspiration congruence, (little) openness, and figural abilities while for their male colleagues only interest-aspiration congruence is predictive. The results advocate school and career counselling programs, which focus on exploring vocational aspirations and establishing person-aspiration fit. They show that not all measurements are useful in that context, especially the differentiation of interests which was not related to interest-major congruence. Vocational counselling should explore a range of variables in depth and differentiate between men and women, as there was evidence for gender-specific determinants of (non-)STEM aspirations.

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Bernhard Ertl is professor for learning and teaching with media at Universität der Bundeswehr München. His research focuses on gender equality issues in the field STEM, particularly on concepts for gender mainstreaming in STEM teaching and gender specific facilitation methods. Examples for these are the EU-funded project PREDIL dedicated at PRomoting Equality in Digital Literacy or Mit-Mut, a project that aimed at developing a computer game for facilitating female pupils' interest and self-concept in the fields of information and communication technologies and entrepreneurship. He recently edited a research topic for Frontiers in Psychology about gendered paths into STEM. | bernhard.ertl@unibw.de

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Manuela Paechter is a full professor of Educational Psychology at the University of Graz, Austria. She studied Psychology at the Technical University of Darmstadt (Germany) and at the University of Hull (UK). Her research focuses on career choices (especially stereotyped decisions), on learning and growing up with digital media, and on motivation and emotions in learning and instruction (e.g., math anxiety, statistics anxiety). She investigates how motivational and emotional variables are related with learning achievements, choices, psychological and physiological well-being. She has edited a research topic for Frontiers in Psychology about gendered paths into STEM. | manuela.paechter@uni-graz.at

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S4: The power of women in STEM networks to create change

Chair: Mattson, Gail
Discussant: Kim, Jung Sun
Pre-recorded discussant: https://youtu.be/biUgJoKC7Zs

Many women in STEM networks around the world have come together to reduce barriers for women at the start of their STEM careers. This symposium led by the International Network of Women Engineers & Scientists (INWES.org) will explore the power for networks to influence policy and practice in STEM education, research, and training. The speakers at this symposium come from INWES member organizations in India, South Korea, the United Kingdom, and Mongolia. The four 15-minute talks will be followed by an open discussion of 30 minutes. Participants will be encouraged to share cases and examples of effective initiatives and activities led by women in STEM groups that have made a positive impact on removing gender barriers in STEM education and research. Potential output is guidance and thoughts for groups and networks wishing to carry out interventions and programs to create change for women.

Keywords: Networks; collaboration; interventions; good practice; international.

Paper 1: The power of networks and collaborations for gender and STEM

Peers, S. M. C.
Pre-recorded presentation: https://youtu.be/biUgJoKC7Zs

The African saying “When spiders unite, they can tie up a lion” provides a powerful analogy to explain why collaboration is so vital to overcome the many cultural and societal reasons why women do not participate fully in all areas of science and engineering. Why and how do networks work? Can Women in STEM groups be more than “lunch and networking” for women already successful in the sciences and engineering? Across the world, there are examples of good practice and interesting interventions that have made a difference to gender equity in science and engineering. The very best examples have embedded collaboration, created partnerships, and often been driven by groups of individuals with similar values and networks with shared aims. When individuals and organizations come together to share experiences, learn from each other, and agree on action, so much more can be accomplished.
Cases and examples from the past of radical change led by women’s networks, formal and informal, will be provided. The focus will be on the impact of women in STEM networks on policy and practice in different regions and on STEM education at schools. The use of digital tools to bring people together and to collaborate will be explored. The adaptation to virtual events and remote teamwork that many of us have had to make during the pandemic may lead to new and better ways of working across borders. The special role of global organizations such as INWES to support national and local networks to create change will also be covered.

Paper 2: The impact of women in STEM networks on education policy
Baatar, B.
Pre-recorded presentation: https://youtu.be/wjNW7wIoYaU

Despite women's rights advancement globally, gender equality progress has been relatively slow, particularly in science, technology, engineering, and mathematics (STEM). Gender stereotypes, gender bias, wage gaps remain. According to the UNESCO report, only 29 percent are women in STEM, 19 percent in South and West Asia, 32 percent in Europe and North America, and 48 percent in Central Asia. Globally, women are underrepresented in STEM. Mongolia has a legal and policy framework like the national gender system, Law on Promotion of Gender Equality, National Program on Gender Equality to promote gender equality. However, we still face many challenges with the implementation of the legislation and national programs. At the tertiary education level of Mongolia, women are interested most likely study programs in the field of education (20 percent of women, 7 percent of men), health, social science (11 percent of women, 3 percent of men), and the humanitarian disciplines (10 percent of women and 6 percent of men). Men predominantly study engineering and natural science disciplines (23 percent of men and 8 percent of women).

The majority of students in technical and vocational schools are male, and the number of female students has been declining in recent years. Gender imbalances in tertiary education are characterized by the number of female students in higher education institutions who are mainly studying education, health, and the humanities. Men are more likely to study engineering and natural sciences—this distortion caused by parental influence, private education providers. The main reasons for fewer women in STEM are gender stereotypes, women in STEM are underrepresented, and gender sensitivity in the working environment. Women in the STEM network can collaboratively influence education policy by enhancing the visibility of women scientists and engineers and encouraging girls and female students to take up STEM education.

Paper 3: Networking and collaboration to enhance women's participation in STEM education and employment
Singh, S.
Pre-recorded presentation: https://youtu.be/x2pBDrHYxBI

For a very long time, engineering and science industries were considered a male bastion but the need for women's participation has been realised in recent years and is being encouraged and promoted by all stakeholders across the globe. However, affirmative actions have not always been able to provide the expected results. Developed countries like Australia have experienced a plateau in the growth of numbers of women in STEM during the first decade of 21st century and even developing countries like India which experienced a boost during the 1990s and 2000s, is experiencing a plateau during the second decade. The situation has worsened with the experience of COVID19 where women are expected to go first in the case of job cuts. The forecast for employment elasticity of the Industrial Revolution 4.0 has already shown to be negative which means many job losses.

With this background, the discussion during this talk will be based on the experience of following three types of networks in encouraging education and employment of women in STEM. The associations will be as below:

1. International associations of many national units where these units have conditional lateral linkages between each other, such as Institution of Engineers (IoE) in India.
2. Associations that only work in the STEM field. The member countries have their own units and all of them have vertically linkages with the global unit, for example, International Network of Women Engineers and Scientists (INWES).
3. Associations in which are working on women's issues and issues related to STEM is only one among many issues they tackle, such as Graduate Women International (GWI).

Efforts of these associations will be investigated through the case study method. Suggestions and recommendations will also be made to make their contributions more productive.

Paper 4: Measuring perceptions of gender in science and engineering

Park, H. Y.; Kim, J. S.

Pre-recorded presentation: https://youtu.be/u8Fx13Um-yU

For over two decades, overcoming gender barriers and/or discrimination in STEM has been recognized as an important issue to promote sustainable human development. Bringing to light the problem with numbers as in the SHE Figures published by the European Union can be very effective. In Korea, both political and academic efforts have slowly but steadily contributed to legislative changes supporting women in STEM, which include funding projects for policy development. As a result, the Association of Korean Woman Scientists and Engineers (KWSE) has been able to initiate and run three international surveys among members of the Asia and Pacific Nations Network (APNN) of INWES on men and women's perceptions of the impact of gender in STEM education and work. The results of the surveys showed that the perception of gender discrimination of the younger generation in STEM was more progressive than their senior colleagues. The statistics also show there exist significant differences in perception/experience of gender barriers/discrimination in STEM between females and males. Young women in STEM perceived and experienced more gender barriers during their studies and research activities than their male colleagues. The statistical differences between males and females were more obvious and significant in the engineering fields. Crosstabulation analyses of perception of gender role stereotype or experience of gender barriers in STEM specifically in classroom or laboratory settings against sex and current status were also conducted among selected respondents from five countries. These results will be presented together with suggestions for future tasks to overcoming the gender discrepancies in STEM fields in Asia. The importance of learning and being exposed to gender issues in the classrooms and laboratories will be emphasized based on these results. Moreover, the need for a prolonged collective international effort in bringing to light the problem by vivid numbers will be highlighted in this presentation.

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Battsengel Baatar's background is chemistry with a Ph.D. in chemistry and chemical engineering from the Institute for Technical and Macromolecular Chemistry, RWTH-Aachen in Germany; her doctorate thesis was about the heterogeneous catalysis of multiphase hydrogenation reaction. She is currently a Rector and a Professor of Chemistry at the German-Mongolian Institute for Resources and Technology. As a woman rector of the engineering university, a member of the Board of directors and Vice President for Education and Research of INWES, and the Board member of WSTEM in Mongolia, she provides her experience for strategy and policy development of gender equality in STEM. | battsengel.baatar@inwes.net

Prof. Jung Sun Kim has held various leadership positions in academia, government committees, and non-governmental organizations. She is one of the few female leaders in higher educational institutions in her region. She is a medicinal chemist with over 50 papers in internationally peer-reviewed journals. Her current work focuses more on academic administration and policy research on women in STEM. She has been involved with INWES since 2003 and played a leading role in the formation of its first regional network APNN. She was conferred the Order of Science and Technology (Woongbi Medal) in 2019 by the Korean government. | jungsun.kim@inwes.net

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Sarah Peers' background is mathematics with a PhD in the application of artificial intelligence for maintenance of mechanical engineering structures. She is currently an Advisor and a Fellow of the Institute of Innovation & Knowledge Exchange in the United Kingdom, and Director at the STEM Foundation. Her consultancy provides expertise in skills strategy and policy for innovation, STEM (science, technology, engineering, mathematics) education, and diversity for industries. Sarah has championed gender equality in STEM since 1992, was Deputy President of INWES 2018-2020, and believes in global collaboration to improve the lives of women and men. | sarah.peers@inwes.net

PAPERS

"Does gender matter when teaching STEM?": Australian primary teachers speak
Abraham, J.; Skillen, M.; Gough, L.
Live recorded presentation: https://youtu.be/Kp-0Gxpdupl

Current literature illuminates that primary school teachers lack the skills and confidence required to teach STEM subjects effectively. This a recurring theme in the literature and a cause for concern. Recent research indicates that the primary school years are a critical period during which children's interests and dispositions towards STEM are formed. Building the STEM teaching capacity of Australian primary school teachers is, therefore, an issue gaining increasing prominence. Given that the Australian primary teaching workforce is predominantly female, it is also important to ask whether female teachers' needs in relation to STEM teaching are different from, or greater than, those of male primary school teachers. A substantial body of research evidence suggests that gender disparities exist in STEM motivation and interest. Therefore, any assessment of teachers' needs must be examined through a gender lens. This paper reports the findings of an Australia-wide study that compares the experiences and perspectives of female and male Australian primary STEM teachers (N ~ 100) on a range of topics, including: personal conceptualisation of STEM education; perceived importance of STEM; confidence in STEM teaching; and, enablers and barriers of personal STEM teaching efficacy. The paper also examines gender differences in teachers' personal needs in relation to effective STEM teaching. Using a mixed methods approach, little evidence of substantial gender disparities across the range of issues listed above in relation primary school teachers and STEM teaching were found. The paper discusses this somewhat counter-intuitive finding, and considers the implications in terms of approaches to primary teacher development in STEM.

Keywords: STEM teaching; Australian primary teachers; STEM teaching deficiency; gender differences.

Author biographies:
Dr. Jessy Abraham received her PhD in Education from the University of Western Sydney in 2013. She lectures in Primary Science and Technology. Before joining UWS she worked as a science teacher in NSW schools. Her research interests are in the area of student motivation, engagement and retention in sciences. Her research employs sophisticated quantitative analyses. Currently her research is focused on pre-service science teachers and practices that enhance their self-efficacy in teaching science in primary school settings.
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within the secondary classroom using digital media. The research utilised a longitudinal case study approach, whilst a mixed methodology was used for the data collection process. Maree's current research interests include cognitive development; mathematics education; mathematical problem-solving; teacher education; and technology in teaching and learning with an emphasis on mobile devices and Apps. | M.Skillen@westernsydney.edu.au

Lesley Gough completed a Master of Education (STEM) at Western Sydney University in 2019, completing a series of research projects defining the status of STEM education in Australian Primary Schools. Prior to this, she worked in diverse roles across the Science Consultancy sector prior to retraining as a Primary School Teacher in 2009. Having discovered a passion for teaching science, Lesley developed and taught a series of programs for teaching of science in Distance Education for K-12 students in Queensland. Relocating to Sydney in 2017, Lesley again has taken on a variety of roles in public and private schools, specialising in Science and Digital Technologies. Lesley is currently working as a STEAM instructional leader developing and delivering integrated STEAM programs in a variety of primary schools across Western Sydney. Since completing her Masters, Lesley has also undertaken work as a research assistant and tutor for the School of Education at Western Sydney University. | 19321455@student.westernsydney.edu.au

Lucy Mentoring Program: Redesign and impact evaluation
Bautista, L.; Cheng, E.
Live recorded presentation: https://youtu.be/IjZoE1JQkJ8

The Lucy Mentoring Program at the University of Technology Sydney (UTS) pairs undergraduate female students (2nd year and above) and Masters by coursework students with an industry mentor for a 5-month mentoring partnership. Since commencing with 10 student mentee-mentor pairs in 2005, the program has significantly increased in participation with 124 mentoring pairs in 2020. Mentoring is known to be effective in increasing female university students' confidence and ability to engage and retain in STEM studies, and shift perceptions of entering or continuing in STEM careers. In particular, industry mentors as role models play an important part in encouraging women to take up STEM and pursue careers in these professions. The importance yet lack of role models for women in STEM is well researched, where 'it's hard to be what you can't see' extends from school years into STEM participation in the professional workforce. At the tertiary level, a number of student-industry mentoring programs are already in operation across universities and industry. However, the impact evaluation varies. For the Lucy Mentoring Program, 2018 was the first year that pre and post-survey impact evaluation was conducted across mentees and mentors exploring the 2-way benefits that mentoring can provide. Based on this evaluation, the program was redesigned in 2019. In 2020, the program was delivered online due to COVID -19 restrictions. The learnings and possibilities introduced by this new format are being piloted in 2021 with a blended model of face-to-face and online mentoring and networking. This paper shares the redesigned Lucy Mentoring Program model, and the significantly increased impact seen from this model. For mentees, the impact is studied around the 4 main pillars of confidence, awareness, motivation and networks. The 2020 impact evaluation found that pre and post-program, mentees mentees who:

- feel fairly or completely confident in networking, interviewing, communicating professionally, self-marketing, job-seeking and making career decisions increased by up to 66%;
- feel fairly or completely aware of job opportunities, different roles available, skills required, and employer needs increased by up to 69%;
- agreed or strongly agreed that they had professional networks and female role models increased by up to 52%.

Bysharing the Lucy Mentoring Program model and learnings, impact evaluation approach and 2020 evaluation results, the applied significance of this work is in sharing best practice and facilitating discussion around effective mentoring, impact evaluation approaches, and collaborations to provide long-term cross-sector benefit.

Keywords: mentoring; evaluation; impact; redesign.

Author biographies:
Lucia Bautista is the Program Coordinator of Women in Engineering and IT at the University of Technology Sydney. She focuses on the Lucy Mentoring Program, scholarships, community development and industry engagement. She has a strong background in political analysis and collaborating with the not-for-profit and corporate sectors for the delivery of programs. Before moving to Australia, Lucia worked as an NGO policy advocate and participated in different research projects, specialising in oral history methodology, having conducted over 40 in-depth face-to-face interviews, resulting in 15 reports and a published book.
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Eva Cheng is the Director of Women in Engineering and Information Technology, and Senior Lecturer in the School of Professional Practice and Leadership. With a background in telecommunications engineering, With a background in telecommunications engineering, Eva actively collaborates on social justice and community engagement in STEM diversity and humanitarian engineering, including working with Tech Girls are Superheroes and Engineers Without Borders Australia. | eva.cheng@uts.edu.au

Positive attitudes towards mathematics and science are mutually beneficial for student achievement: A latent profile analysis of TIMSS 2015
Berger, N.; Mackenzie, E.; Holmes, K.
Live recorded presentation: https://youtu.be/ZYK8bLoL2AA

Australia has seen declining numbers of students choosing mathematics and science subjects in the senior secondary years, running counter to economic projections of accelerating need for STEM skills. Many students become less engaged with these subjects in the junior secondary years but attitudes like self-concept, utility value, and intrinsic value are important for subject selection decisions. In recent years, person-centred data analytic approaches have become increasingly important in the study of attitudes towards STEM education, as different subgroups may have particular needs, strengths, and outcomes. Such subgroups may go unobserved in variable-centred approaches. Therefore, in this study we investigate (i) what attitudinal profiles exist in Australian early adolescents towards mathematics and science, and

(ii) how these attitudinal profiles vary by gender, parental education, and academic achievement. Data for this study come from the Trends in International Mathematics and Science Study (TIMSS, 2015), a major international comparative study of student achievement and attitudes. We used latent profile analysis in R to examine the relationship between attitudes towards both subjects using data from 10,051 Australian Year 8 students sampled by TIMSS 2015. The model fit statistics pointed to six discrete groupings of students in the data. We named the groups (in italics): 1) Resistant to both subjects, 2) Receptive to both subjects, 3) Enthusiastic about both subjects, 4) Very Enthusiastic about both subjects, 5) Prefer mathematics, and 6) Prefer science. While most students were at least attitudinally receptive to both subjects, there were a number of students who either resisted both or expressed a strong preference for one over another. Positive attitudes towards both subjects were mutually beneficial – better attitudes towards both was associated with higher achievement in each – but boys tended to be more positive towards both subjects and so benefitted from this relationship more than girls. These findings contribute to our understanding of student attitudes and experiences in mathematics and science, and emphasise the practical role teachers play in supporting positive outcomes. The study also demonstrates how large-scale person-centred quantitative analyses can help researchers and educators to more thoroughly understand and support the needs of specific groups of students.

Keywords: mathematics; science; attitudes; latent profile analysis; gender.

Author biographies:

Nathan Berger, PhD is Postdoctoral Research Fellow in STEM Education at the Centre for Educational Research, Western Sydney University, Australia. His degrees in information technology (BIT), secondary teaching (MTeach, MEd), and the social psychology of education (PhD) are from the University of Newcastle, Australia. His research interests focus on the career and education aspirations of children and young people, with particular emphasis on understanding the motivational drivers which influence the development of aspirations for a wide range of careers during schooling. His research has been published in journals such as Frontiers in Psychology and Social Psychology of Education.
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Principals' gendered STEM background, attitudes, self-efficacy for STEM leadership and prioritisation of STEM investment in their schools

Beswick, K.; Dacosta, L.; Watt, H.M.G.; Fraser, S.; Geiger, V.

Live recorded presentation: https://youtu.be/wxQXbE1hxIE

The 'Principals As STEM Leaders' (PASL) initial participants consisted of 43 men and 42 women (M_{age} = 52.40 years, SD = 6.81), two of whom identified as Aboriginal or Torres Strait Islander. Schools were from the six states of Australia; 43 were metropolitan, 11 suburban, 11 rural, 18 regional, 4 remote. On average, participants had been Principals at their current school for 4.55 years (SD = 3.34) and Principals in total for 10.88 years (SD = 8.76). There was no gender difference according to school level at which Principals were located. As relatively few Principals reported higher education in STEM disciplines, STEM background was dichotomised according to whether they had completed one full year or more of tertiary studies in any of mathematics, science, engineering or technology (n = 23), versus not. There was a trend for men to have more STEM education than women. Despite gender differences in STEM educational background, there was no gender difference on any of Principals' interest, perceived importance or perceived difficulty of either mathematics or science (assessed using existing construct valid reliable measures, see Watt, 2004) - unlike gender differences favouring men identified among general populations. Both women and men Principals rated both mathematics and science as moderately difficult (around the midpoint on the 7-point Likert scales), rather interesting (more so for science), and highly important. Both women and men Principals reported similarly high self-efficacy to lead STEM reform in their schools. Possessing an interest in mathematics was an important correlate to STEM leadership self-efficacy. Interestingly, women Principals rated 'investing in STEM professional learning for teachers' as more important than men versus nine other school development needs. Women and men Principals had different levels of STEM educational background, which did not translate into different attitudes to mathematics or science. Women and men felt equally positively equipped to lead STEM reform in their schools, although women Principals more strongly prioritised investment in STEM professional learning for teachers. It is possible this may set a more favourable climate for success of the PASL Professional Learning program for women, relative to men Principals.

Acknowledgments: 'Principals as STEM Leaders (PASL): Building the Evidence Base for Improved STEM Learning' is an initiative of, and funded by, the Australian Government Department of Education, Skills and Employment.

Keywords: principals; STEM-specific school leadership; STEM capability; STEM participation; STEM learning.

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Kim Beswick is Head of the School of Education and Professor in Mathematics Education at the University of New South Wales. Her research interests centre on the beliefs, knowledge and professional development of mathematics teachers. She is particularly interested in how teachers' beliefs and knowledge relate to their expectations of and aspirations for their students. She has attracted more than $10M in competitive research funding including an Australian Research Council Future Fellowship and has published more than 110 peer reviewed publications. She has served on a range of national and international committees in relation to mathematics education and teacher education. | k.beswick@unsw.edu.au

Liam Dacosta is a PhD candidate in Psychology and as a research assistant, works closely with Prof. Helen Watt on a number of projects involving educational and occupation pathways among Australian students, teacher and student motivations, and school engagement in STEM, among others. | ldac4537@uni.sydney.edu.au

Helen M. G. Watt is initiator of the Network Gender & STEM, Professor of Educational Psychology at The University of Sydney, and Australian Research Council Future Fellow. She previously served at Monash, Michigan, Western Sydney, Sydney, and Macquarie Universities. Helen is a motivation researcher whose projects address: declining participation in advanced sciences and mathematics especially by girls (www.stepsstudy.org), and the engagement and wellbeing of beginning teachers (www.fitchoice.org), utilising long-term and large-scale survey data across comparative settings. She has published extensively on these topics, edited books and special issues, won research awards, extramural funding, and held leadership roles in AARE and AERA. | helen.watt@sydney.edu.au

Sharon Fraser lectures in science education in the Faculty of Education at the University of Tasmania and is a Co-Directors of the PASL project. Her research spans science and mathematics curriculum and pedagogy, teacher education and educator professional learning. Sharon is keen to assist in building the capacity of teachers to teach science and integrated STEM effectively through their enhanced Science Pedagogical Content Knowledge and to better understand the capabilities of science through a lens of Epistemic Insight. More recently, engaging rural and regional communities in education through a focus on STEM is a key area of research interest. | sharon.fraser@utas.edu.au

Vince Geiger is the Director of Research for the program STEM in Education: Design and Growth Across the Disciplines within ACU's Institute for Learning Sciences and Teacher Education. Research in The STEM in Education program focuses on the enabling and transformative role of mathematics within STEM disciplines and other areas of human endeavour. He is driven by an awareness that the capacity to know and use mathematics confidently is important for individuals' careers and their empowerment as informed citizens. | vincent.geiger@acu.edu.au

Meta-analyses of gender imbalance in visualizations about STEM and non-STEM tasks
Castro-Alonso, J.C.; Adesope, O.O.; Wong, M.; Ayres, P.; Paas, F.
Pre-recorded presentation: https://youtu.be/yXfXs1ULD34

Gender differences favorable to males are sometimes reported in the STEM fields, such as when learning STEM topics from instructional visualizations (including dynamic and static visuals). Visuospatial processing, which is fundamental in STEM areas, is generally involved in these detrimental results for females. In a recently published meta-analysis, we reported that the gender imbalance of the school and university samples influenced the effects of comparisons between dynamic and static visualizations. Overall, the meta-analysis of k = 82 comparisons (n = 5,474 participants), revealed a small-sized effect (g+ = 0.23) of dynamic visualizations being more effective than static visualizations. Assessing the influence of gender, the results showed that the dynamic visualizations were even more effective than the

static visualizations on samples with fewer females and more males (g+ = 0.36). These results were observed in the overall meta-analysis that aggregated STEM and manipulative-procedural tasks. The aim of the present study was to examine if the favorable effect of dynamic visualizations toward males could also be observed when separating the tasks in three meta-analyses, as: (a) S (science); (b) TEM (technology, engineering, and mathematics); and (c) manipulative-procedural. The analyses showed that the gender imbalance affected the effectiveness of dynamic over static visualizations to different degrees, depending on the task. As such, for S tasks (k = 45; n = 3,448), the samples with more than 38% males (median split) showed a larger positive effect of dynamic over static visualization (g+ = 0.32 [0.24, 0.41]), compared to the samples with fewer than 38% males (g+ = 0.12 [0.00, 0.23])). For TEM tasks (k = 15; n = 932), the samples above the median (29% males) also showed a larger positive effect of dynamic over static visualization (g+ = 0.26 [0.08, 0.43]), compared to the samples below the median (g+ = 0.04 [-0.18, 0.26])). The difference was even larger for manipulative-procedural tasks (k = 22; n = 1,094), in which the samples with more than the median of 39% males showed a larger positive outperformance of dynamic visualizations (g+ = 0.40 [0.21, 0.58]), compared to the samples with fewer than 39% males (g+ = 0.01 [-0.18, 0.16])). We conclude that the composition of males and females in the studies comparing dynamic versus static visualizations is influential, in particular those measuring manipulative-procedural tasks. Consequently, future comparisons of instructional visualizations should consider participants' gender.

Keywords: STEM education; gender differences and visuospatial processing; dynamic and static visualization; manipulative-procedural task; meta-analysis.

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Olusola O. Adesope is Boeing Distinguished Professor of STEM Education and Educational Psychology at Washington State University, USA. His research is at the intersection of educational psychology, learning sciences, instructional design and technology. His recent research focuses on the cognitive and pedagogical underpinnings of learning with computer-based multimedia resource, evidence-based practices through meta-analyses and empirical research, and investigation of instructional principles and assessments STEM domains. | olusola.adesope@wsu.edu

Mona Wong is a postdoctoral fellow in at Yew Chung College of Early Childhood Education in Hong Kong. She obtained her PhD in Educational Psychology at UNSW Sydney. Her PhD thesis examined the gender effect in learning with dynamic and static visualisations where spatial ability act as a covariate affecting the effectiveness in constructing mental modals from visualisations. She extended her knowledge on spatial ability into her current work and

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Gender and STEM: Linkages between workplace harassment and the impostor phenomenon in academia

Chakraverty, D.

Pre-recorded presentation: https://youtu.be/wwxgP3GWZHQ

The impostor phenomenon (IP) is characterized by feelings of self-doubt, luck, fooling others into overestimating one's ability, not attributing accomplishments to one's own ability, and the fear of being discovered as a fraud.1 Virtually no studies have examined the role of sexual harassment in exacerbating IP in science, technology, engineering and mathematics (STEM) except one survey that found that unwarranted harassment experiences correlated with a sense of not belonging in the field and intensified IP.2 This paper aims to study linkages between sexual harassment and IP, including the kinds of harassing behaviors that engender perceptions of IP within a sample of academics (PhD students, postdocs, faculty) in STEM. Following IRB approval in this US-based study, eligible academics completed a 10-minute online survey to indicate if they have experienced IP. A subset of the 920 survey-takers interviewed (n = 350) voluntarily. Participants were recruited by distributing informational flyers at US-based conferences, social media, and email listservs. Each semi-structured phone interview (~60 minutes) explored experiences related to hostile academic environment. Interviews were audio-recorded and transcribed. Constant comparative methods were used, collecting and analysing data iteratively. Sixty female academics across multiple career stages drew connections between workplace sexual harassment and IP. Responses were critically analyzed/categorized into five main themes. Theme one explored the linkages between sexual harassment and IP and the cost of experiencing both (feeling invisible and voiceless, developing trust issues and questioning competency, internalizing disparaging comments). Theme two analyzed field-specific instances of sexual harassment (field-work oriented disciplines, male- and female-majority disciplines). Theme three considered instances that were more generic and not necessarily restricted to a particular STEM field (looks and age). Theme four examined the typical demography of the perpetrators, who were from all genders and positions,

predominantly older males in position of power (PhD-advisers, class instructors), peers or someone closer to one's age, and younger students. Theme five discussed why sexual harassment were unreported or under-reported in the sample (culture and upbringing, fear, challenges to reporting). Experiencing workplace harassment has tangible physical/mental health implications. Findings emphasize how sexual harassment and IP might be connected, a largely understudied area in STEM. We need individual/institutional awareness about what constitutes harassment and what supports are available. IP was rooted in explicit, external cues that one doesn't belong in STEM. Concerted efforts to help people recognize, understand, and manage IP through professional development would be crucial.

Keywords: impostor syndrome; STEM; sexual harassment; higher education; institutional climate.

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Job satisfaction for ECRs in STEMM – is it different for men and women?
Christian, K.; Johnstone, C.; Larkins, J.; Wright, W.; Doran, M.
Pre-recorded presentation: https://youtu.be/G5zejv9CDj4

Early-career researchers (ECRs) in STEMM have long found difficulties caused by lack of funding and job insecurity, gender inequity, work-life imbalance, and insufficient professional development. Using a realist/postpositivist paradigm, an evaluative approach, and a framework of job satisfaction, this mixed methods project has explored and compared the views of ECRs to evaluate the factors which shape the ECR experience and contribute to job satisfaction or dissatisfaction and intention to leave, and to define the features which are necessary to keep an ECR in research. The overall picture in Australia is of people who love science, but are pursuing their profession in unsatisfactory work environments, overwhelmed by job insecurity and its consequences. Our results do not generally reflect more problems for women compared with men for those actually in the academic workforce as job satisfaction for men and women was similar across most measures. In some instances, women were more satisfied. At the same time, our survey results showed that the difficulties of combining a career in STEMM research with raising a family, while felt by both men and women, are likely to have more of an impact on women's intention to leave academia. Our interviews of women who had taken the decision to leave academic research indicated they did so to gain security and work-life balance. The women discussed the outcomes of their decisions and found that in "alternate careers" in

STEMM they could progress in their careers without compromising their other priorities. Is this why we have relatively low numbers of women at higher levels of academic STEMM? The numbers show that the problem is keeping women in the STEMM workforce, not attracting them to it. Our research shows that there are real and complex problems in STEMM careers for both men and women. Rather than focussing on a fight to improve things for women in STEMM, men and women must pull together to fight for an improved workplace culture and more job security for all ECRs, and for recognition that it is extra tough for both parents of young families who make a choice to follow this chronically insecure career. Looking after our ECRs will help achieve the Government's aims of making Australia one of the best places in which to undertake a scientific career.

Keywords: early-career researcher (ECR); workplace culture; job satisfaction; intention to leave; STEMM.

Author biographies:

Katherine Christian has worked in medical research for over 30 years, mostly for organisations conducting and supporting cancer research. Scientifically trained, she has chosen to manage research projects and assist scientists with the management of their research. Her work has involved Kate with many early-career researchers in a range of disciplines, and she enjoys teaching them how to manage themselves, their research and their careers. Kate has furthered her involvement in this field with her recently completed PhD. "Challenges faced by early-career researchers in the sciences in Australia" has sought to identify opportunities to address some of those challenges. | katherine.r.christian@students.federation.edu.au

Carolyn Johnstone has over 25 years of experience as an education and training specialist with the British Army. Her personal teaching experience has been in military classrooms, workplaces and now the tertiary sector. Carolyn also worked in defence and strategic policy. Her post-graduate studies on adult education as a stabilizing response to conflict drew on interests in both international relations and education. She is interested in adult education as a policy lever to address challenges of conflict, sustainable development and human security, focusing on adult education and work-based learning; refugees and vulnerable groups; the professional identities of teachers, as change agents in society. | c.johnstone@federation.edu.au

Jo-ann Larkins' primary professional focus over the last twenty years is on achieving quality teaching and learning outcomes for tertiary students. She specialises in engaging and mentoring first year students with their initial studies of statistics and basic mathematics, seeking to make it interesting, useful and less intimidating as a subject area. As an applied statistician, Jo-ann is a problem solver; helping to analyse and solve the wide variety of fascinating scenarios needing assistance in analysis by her colleagues. Jo-ann specialises in mentoring others in statistical analysis of larger multivariate data sets as well as adequately preparing HDR students to undertake independent quantitative research. | jo-ann.larkins@federation.edu.au

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Important themes in Wendy's research include: Wildlife conservation; disturbance ecology, conservation in highly modified environments and ecological anthropology.
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Mike Doran is located at the Translational Research Institute in Brisbane; he is from the Queensland University of Technology. His laboratory's research interests span efforts to repair cartilage, improve umbilical cord blood stem cell transplantation outcomes, and to develop new methods to mimic prostate cancer disease in cell cultures and in animal models. Further, Mike is interested in research into research. | mike@mikedoranlab.com

Survey of Australian STEMM early career researchers raises concerns about research culture

Christian, K.; Johnstone, C.; Larkins, J.; Wright, W.; Doran, M.
Pre-recorded presentation: https://youtu.be/91kO2qyB9qY

We sought to understand the pressures on Early Career Researchers (ECR) in the Science, Technology, Engineering, Mathematics, & Medicine (STEMM) disciplines, collecting data from 658 ECRs working in Australia. Respondents indicated a "love of science", but most also indicated an intention to leave their position. Decisions were primarily motivated by job insecurity (52%), while grievances included poor supervision (60%), bullying or harassment (34%), inequitable hiring practices (39%) and poor support for families (9.6%). A concerning rate of "questionable research practices" by colleagues (34.1% to 41.1%) was reported to have impacted ECR career advancement. Our study links recent reports that characterise the health of the research industry, providing direct insight from ECRs on job insecurity, workplace culture challenges, and the logical rise of questionable research practices. Internationally, nationally and institutionally the research community needs to improve job security (care for our people) and the quality of research data (our product). This paper shows that job insecurity is putting stress on Australian STEMM ECRs, clearly compromising career development, and likely putting downward pressure on research quality.

Keywords: early-career researcher (ECR), STEMM (science, technology, engineering, mathematics, medicine), Australia; STEMM; research integrity; education; workplace culture.

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Katherine Christian has worked in medical research for over 30 years, mostly for organisations conducting and supporting cancer research. Scientifically trained, she has chosen to use her background and a flair for organisation to manage research projects and assist scientists with the management of their research. Her objectives have included providing environments conducive to effective, efficient research and facilitating communication about that research to stakeholders. Kate's work has involved her with many early-career researchers in a range of disciplines, who she enjoys teaching how to manage themselves, their research and their careers. Having built up a body of expertise, Kate has furthered her involvement in this field with a PhD. *Challenges faced by early-career researchers in the sciences in Australia* sought to identify opportunities to address some of those challenges. In addition to the recommendations within her thesis, her published book *Keys to running successful research projects: All the things they never teach you* provides one tool.
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Carolyn Johnstone has over 25 years of experience as an education and training specialist with the British Army. She originally qualified to teach maths in schools but her personal teaching experience has been in military classrooms, workplaces and now the tertiary sector. Carolyn also worked in defence and strategic policy, supporting Ministers and senior commanders in the UK's Ministry of Defence and as part of the multinational planning staff during overseas deployments. Her post-graduate studies on adult education as a stabilizing response to conflict drew on interests in both international relations and education. Carolyn has been in Australia in academia for six years. As a researcher in Australia, she is interested in adult education as a policy lever to address challenges of conflict, sustainable development and human security, focusing on adult education and work-based learning; refugees and vulnerable groups; the professional identities of teachers, as change agents in society. | c.johnstone@federation.edu.au

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Increasing engagement with mathematics by seeing the mathematics in very young preverbal children's action

Cooke, A.

Pre-recorded presentation: https://youtu.be/zBGELe_B7LA

To engage with STEM, there must be engagement with mathematics. Engagement with mathematics starts in early childhood, with Yelland (2016) arguing that very young children need to have this to be able to fully engage with STEM. The majority of early childhood educators in Australia are female (Cohrssen & Page, 2016). Research indicates that female early childhood educators may actively dislike mathematics (Bates, Latham, & Kim, 2013). Psychological research has demonstrated very young preverbal children (those aged up to one year of age) are able to engage in mathematical thinking, for example, quantity, object categories, and time (de Hevia, Cassia, Veggiotti, & Netskou, 2020; Libertus, Duong, & Silver, 2020; Needham, Dueker, & Lockhead, 2005). Likewise, research with very young children in early learning environments has identified very young children's use of mathematical ideas such as space, patterns, length, and prediction (Franzén, 2015; Meaney, 2016). It is not the case that these very young children do not engage with mathematics – more that early childhood educators may not wish to recognise this or to create opportunities for mathematical engagement. It is the opportunities for very young children to intra-act (Barad, 2007) with their environment that will demonstrate and develop their mathematical engagement. This mathematical engagement is not overtly focused on 'mathematics', more that mathematics is evident through their engagement with their world that the children engage with mathematics (Björklund, 2018). Educators of preservice early childhood educators should create opportunities for their preservice early childhood educators to engage with mathematics in a way that enables them to recognise mathematics in what very young children do. In doing this, Gresham and Burleigh (2019) propose that preservice early childhood educators may be able to change their engagement with maths, specifically mathematics anxiety, poor mathematics self-efficacy, or negative mathematics teaching self-efficacy. The work of Barad (2007) underpins the framework of this presentation, particularly her consideration of reality as a constantly moving and dynamic process that is created by intra-action in a constant state of becoming. Six vignettes from 360-degree video of preverbal children in early learning environments are used to demonstrate types of opportunities that may help preservice early childhood educators change their engagement with mathematics based on evidence of very young preverbal children demonstrating mathematics via their intra-action with their environments. The preservice early childhood educators' changed engagement with maths may then generate a stronger foundation for the children in terms of mathematics and STEM.

Keywords: engagement with mathematics; preverbal children; early mathematics; early childhood education; early childhood educators.

Author biographies:

Dr Audrey Cooke is Senior Lecturer in Mathematics Education in the School of Education at Curtin University. She is passionate about mathematics and mathematics education and is interested in how people interact and engage with mathematics, particularly very young children and pre-service teachers. Her research includes how the actions of very young preverbal children might demonstrate mathematical thinking, disposition towards and

engagement with mathematics, development of the skills of noticing mathematics, and use of ICT in education. Audrey contributes to mathematics education through her work with pre-service teachers, her research, and through papers and presentations, both nationally and internationally. | Audrey.Cooke@curtin.edu.au

Design and implementation of an online course for interdisciplinary STEM teacher learning

De Meester, J.; Deprez, H.; Van Loon, K.

Pre-recorded presentation: https://youtu.be/AJZNWVfipso

For teachers to be able to demonstrate how STEM courses and their interdisciplinary links are relevant to current environmental problems, they should not only receive a discipline-specific, but also an interdisciplinary pedagogical schooling (Lang & Olson, 2000), following five instructional key principles (Thibaut et al., 2018a). This presentation discusses the design of an online course for interdisciplinary STEM (iSTEM) teacher education based on two qualitative studies: (1) a literature review in order to establish which ingredients of teacher education programs stimulate the classroom implementation of the key principles of iSTEM education; and (2) semi-structured interviews of teachers on how they felt their four-year participation in the design and/or implementation of iSTEM learning materials (De Meester et al., 2020) had affected their knowledge, attitudes, and classroom practices in (i)STEM. To promote classroom practices that are in accordance with the desired key principles, teacher education programs should encompass (a) participation in collaborative curriculum design, (b) a focus on disciplinary knowledge, (c) an active experience of the desired pedagogy (here: the key principles), (d) coherence between teacher and educator goals, and (e) close follow-up (De Meester, 2019; e.g., Dare et al., 2018; Thibaut et al., 2018b; Zee & Koomen, 2016; Ingvarson et al., 2005; Garet et al., 2001). The same ingredients appear to be effective in blended learning environments (Surrette & Johnson, 2015; Palloff & Pratt, 1999; Alonso et al., 2005). Having teachers participate in technology-supported iSTEM teacher design teams (iSTEM TDTs) thus seems a rich and meaningful way to promote teacher learning. Participation in iSTEM TDTs has proven to foster a sense of ownership and ideas more congruent with the key principles, a teaching style closer to coaching, and a more pronounced habit of learning from colleagues (De Meester, 2019), while blended learning has proven to foster self-regulation and intrinsic motivation for learning (Tseng & Kuo, 2010; Raes, 2015). Therefore, the developed course encompasses the cooperative design of interdisciplinary learning materials with the support of an online platform, in which pre-service teachers from different STEM disciplines and from remote campuses learn to establish an interplay between the separate STEM courses in secondary education. We elaborate on how we accommodated the students with frequent and different types of online information and feedback in times of a pandemic. We indicate the learning opportunities and constraints of the online course, and we share our students' and student educators' experiences with the course.

Keywords: online learning; interdisciplinary STEM; teacher education; teacher design teams.

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Hanne Deprez (Leuven, 1990) graduated with great distinction from KU Leuven as a Master in Electrical Engineering, option Embedded systems and multimedia in 2013. In 2018, Hanne received a Ph.D. in the research labs of Prof. Jan Wouters and Prof. Marc Moonen, respectively associated to the Departments of Neuroscience and Electrical Engineering, focusing on objective measures in subjects with auditory implants. She is now associated with the Faculty of Engineering Technology of KU Leuven in Ghent and involved in STEM and engineering education, study guidance and learning analytics. | Hanne.Deprez@kuleuven.be

Kristien Van Loon obtained her M.S. degree in Electrical Engineering in 2004 and an additional degree in the Advanced Studies of Biomedical and Clinical Engineering Techniques in 2005 at KU Leuven. From 2005 to 2010, she worked as a researcher at the faculty of Bioscience Engineering at KU Leuven. In 2011 she obtained her teacher's degree. Since September 2010, she is teaching mathematics, physics and computer science in a secondary school, which she combines with a job as teaching assistant in the teacher education program of KU Leuven, first in computer science and technology, and recently in interdisciplinary STEM education. | Kristien.VanLoon@kuleuven.be

Pathways and intersections: STEM futures and identity based motivation
DeRosia, N.; Bousselot, T.; Kim, M.; Anderson, R.; Madison, E.; Husman, J.
Pre-recorded presentations: https://youtu.be/qTEZYtc69_4

This study explores how minoritized students in late adolescence form and sustain a science identity and the potential positive role of near-peer mentoring experiences on that identity exploration and formation process. It further answers the conference theme of considering possible STEM pathways for bringing students, particularly women and girls, into STEM careers in the future. We asked students to not only reflect on experiences, but consider what their futures in science may look like. Our data was collected at a summer STEM camp hosted at an R1 school in the Pacific Northwest United States. We recruited 6 near peer mentors with minoritized identities who were either in undergraduate, or recently graduated STEM fields. We paired these mentors with 6 high school aged mentees also from minoritized backgrounds. We follow an identity-based motivation framework, apply an intersectional lens, and use a near peer mentoring format to pursue this investigation with twelve students in high school and undergraduate science programs. Our project is based on Oyserman's (2015) conception of Identity Based Motivation and her classroom interventions. We draw upon the work of Kimberle Crenshaw, a Critical Race Theorist and law professional, who coined intersectionality as an analytic to consider the structural relationships that make the experience

of black, women unique from other experiences of either gender or race (1994) and Hill-Collins and Bilge who refer to intersectionality as "a way of understanding the complexity of the world, in people, and in human experience" (2016, p.25-30). Intersectionality is a powerful analytic tool which can help us to better understand the complex identities of the students in our project. We can begin to ask questions about the ways in which minoritized and gendered students develop science identities at different stages in the science pathway (Hernandez et al., 2017; Packard & Nguyen, 2003; Yowell, 2002), and how a near-peer mentor with similar identities can help proteges to navigate the barriers (e.g., Destin, Castillo, & Meissner, 2018; Tenenbaum, Anderson, Jett, & Yourick, 2014). We found the near peer relationship did not focus on science content knowledge, primarily, but rather on candid descriptions of experiences of minoritization. Our preliminary findings in both survey data, and video transcriptions demonstrate the importance of opportunities to exchange social-cultural aspects of engagement in science and the contextualized construction of science identities. In their exchanges barriers to science pathways, positive drivers for science identity, and opportunity costs were all discussed. We hope to demonstrate the ways in which near peer mentoring between minoritized students can encourage strong science identity at different stages of the science pathway and discuss the various supports and barriers faced by the minoritized young people we worked with.

Keywords: intersectionality; identity based motivation; storytelling; near-peer; identity.

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Nicholette DeRosia is an educator, researcher, and graduate student at the University of Oregon. After working in refugee resettlement, adult education and K-12 education in Arizona, DeRosia currently is pursuing her PhD in Critical and Sociocultural Studies in Education. She continues her research from her Masters in International Peace Studies by researching the intersections of race, gender, and nationality in relationship to systems of oppression. She is particularly interested in the intervention opportunities offered by the field of Educational Psychology and ways to engage diverse learners in learning opportunities.
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Dr. Tracy Bousselot works as a Research Associate at Inflexion, a nonprofit consulting group that helps educators better prepare students for life. She enjoyed seven years as a middle and high school math and science teacher, instilling in her a passion for improving instruction and access in STEM/STEAM fields, particularly for students from historically underrepresented populations. She has worked on program evaluation and research projects at Inflexion that include elementary science professional development, school level case studies of best practice in college/career readiness, and creative engagement for teachers and students. She received her PhD in Educational Leadership at the University of Oregon, with her dissertation focused on the early origins of achievement gaps in science for elementary-aged students.
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"Feeling like a Scientist": Girls' and boys' rationale for selection of tools in the science classroom
Dickson, M.; McMinn, M.; Cairns, D.
Pre-recorded presentation: https://youtu.be/RnqYq5o93qc

As Trujillo and Tanner (2014) put it, "to encourage students' persistence in, and commitment to, science careers, it is critical to take an inventory of our students' science identities" (p.13). The purpose of this study was to explore the ways in which students' science identity impacts upon their choices of methods to perform science measurements, and so to identify whether using technological devices to 'perform' science leads children to 'feel' more like scientists. The research questions which the study aimed to answer included: How the students perceived 'doing' science in the classroom, and how does this influence or impact their own science identity, how a student's decision to choose to 'do' science manually or by using technology relate to their self-expressed science identity, what gender variations are observed in their equipment selection? This study took place in primary science classrooms in the United Arab Emirates (UAE), with children in upper primary grades. The researchers worked with the classroom teacher to plan lessons which aligned with their existent curriculum and unit plans, and which had scope for measuring and recording data by using one of three probe options; temperature, force or Ph. During the lesson, the researchers recorded the number of students

who selected the technological option for measuring this parameter, and the numbers who selected the manual option. It was found, perhaps surprisingly, that more children (both girls and boys) opted for the manual option than for the technological. Immediately following the lesson, children were interviewed in focus groups (n=60, with an approximately even gender split) to explore the thinking behind their choice of data collection tool, and broader questions such as whether they felt like 'real scientists' when they worked in the classrooms, whether they enjoyed the work, etc. We found that, overall, both genders disagreed that their classroom science was reflective of work a 'real scientist' would do, chiefly due to perceptions of the work not being dangerous enough, and because the teacher 'already knew the answers', suggesting to them a lack of genuine exploration or quest for answers. Overwhelmingly, girls and boys who chose to measure their parameter manually and not using the technological option (probe and tablet) did so because they felt it was 'cheating', and that a 'true scientist' would take their own measurements, not rely on a computer. The interview data revealed that boys were more likely than girls to refer to science needing to be dangerous, but both boys and girls were equally likely to express an interest in studying science later on, or taking up a science career. Since the research design involved the study of gender variation effects, it allows for projections to be drawn for discussion of the possible impact of perceptions on STEM career plans. Also, by focusing on primary age children, it may still be early enough to intervene and alter diversity of perspectives on the work of scientists enough to impact STEM career perceptions. In much of today's science, which may not take place in a lab setting, the stereotypical scientist wearing goggles, a white labcoat and performing unknown, 'dangerous' work, may symbolize some kind of desired science work, which the students do not perceive themselves to be doing.

Keywords: science; perceptions; children; technology; scientist.

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Dr. Martina Dickson has held a variety of teaching and advisory positions in Greece, Oman, Hong Kong and the UAE, and is currently Associate Professor in Curriculum and Instruction at ECAE. Her research interests include gender in education and science pedagogy. She holds a PhD in Physics from the University of London and MA in Gender, Education and International Development from the IoE (UCL) in London. | martina_dickson@hotmail.com

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Career prospects for women in STEM

Dockery, A.M.; Bawa, S.

Pre-recorded presentation: https://youtu.be/64StO6ctHl8

It has been generally regarded as good policy to 'foster women in STEM'. However, there has been only limited evidence on the labour market outcomes and experiences of female graduates in STEM (Science, Technology, Engineering and Mathematics) - evidence that is needed to critically assess the efficacy of such policies. This paper presents perspectives on current labour market outcomes and future demand for women with STEM qualifications, drawing on results from two recent research projects. First, updating results from Dockery and Bawa (2018) based on longitudinal data from the Household, Income and Labour Dynamics in Australia survey (HILDA), we highlight the relatively poor labour market outcomes of women with STEM qualifications in terms of participation rates, unemployment rates, job satisfaction and wages. We argue that policies to promote female participation in STEM courses need to be accompanied by affirmative action measures to address career barriers they face in the labour market. Second, we report on an innovative approach to measuring the evolution of demand for STEM skills. Moving beyond the standard dichotomy in which jobs are categorised as either STEM or non-STEM jobs, we use Census data to generate a continuous measure of 'STEM intensity' of jobs by occupation. Based on past and projected changes in the occupational composition of employment in Australia, we illustrate how the demand for STEM skills has changed over time and generate forecasts for future demand for STEM skills. Adding a gender dimension to those projections, we show how the changing nature of work and demand for STEM skills is likely to impact upon employment prospects for Australian women.

Keywords: STEM; women; wages; employment; demand.

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A science museum-based study of teachers' professional development and beliefs

Durksen, T.L.; Gajda, C.

Live recorded presentation: https://youtu.be/p6kDqWGftWE

Museum-initiated professional development refers to programming designed and provided by museums to support the professional learning of teachers (Grenier, 2010). Relevant and contextual professional development (PD) opportunities aimed at the underrepresentation of females pursuing STEM education can help students as well as inspire and sustain teachers. Efforts to improve such opportunities are critical if we wish to retain quality STEM teachers in areas experiencing shortages. Therefore, we sought to advance understanding of the PD needs and beliefs of teachers, particularly in relation to female students' engagement in STEM education. An integrated theoretical framework for teachers' PD, motivation, and engagement (Durksen, Klassen, & Daniels, 2017) was considered within Luft and Hewson's (2014) four component model (linking policy, context-based PD programs, teachers, and students). This study was guided by the question, How can we help develop teachers' ability to optimise female students' academic achievement and career aspirations in STEM? The main data source was a science museum-initiated PD survey. Data were collected from 101 teachers (online) using questions from self-efficacy scales (e.g., Self Efficacy Teaching and Knowledge Instrument for Science Teachers-Revised, Pruski et al., 2013) and PD measures (e.g., Durksen et al., 2017). With a mean age of 40.3, the majority of participants were female (76.8%) specialising in science teaching (67.9%) within government/public (59%) and co-educational (71%) secondary schools (83%). Preliminary findings revealed participants with high confidence in their abilities to influence student learning in STEM (self-efficacy; M=7.13, SD=1.23). The lowest self-efficacy rating related to their ability to motivate students who show low interest in STEM subjects or careers. Participants considered female students' achievement and aspirations in STEM to be influenced more by teacher factors (e.g., quality, expectations, gender) than student factors (e.g., ability, interest, effort). More participants believed there were gendered differences in STEM teaching (61%) than in STEM learning. Of the proposed range of PD needs, the highest need identified was student assessment practices in STEM. Participants also indicated a need for PD that promotes inspiration in STEM teaching and learning. This study provides a foundation for further analysis and longitudinal studies of teacher beliefs around gender and STEM (e.g., follow-up/tailored application of museum-initiated PD in school contexts). By enhancing the contextualised opportunities for PD, museums can help inspire teachers and optimise the impact their programming has on teaching practices and student outcomes.

Keywords: museum learning; teacher beliefs; science teaching; professional development.

Author biographies:

Dr Tracy Durksen is a Lecturer of educational psychology in the School of Education at UNSW Sydney (Australia). She conducts research in areas of teacher education, professional learning, recruitment and selection. She is specifically interested in how teachers' personal characteristics can be measured and developed across career phases and teaching contexts. Tracy's research partnerships include a locally funded project with the NSW Department of Education on teacher success and an international collaboration with the Teacher Selection Project (York, UK). She is also interested in community-based research and evaluation, which

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Cheryl Gajda is a PhD candidate in the School of Education at Western Sydney University (Australia). Her doctoral research is on enhancing primary school students' engagement in science. Cheryl's research interests include the impacts of classroom and Informal Science Institutions on teaching and learning, while promoting partnership studies and communities of practice between stakeholders. She aims to support primary teachers in developing their content knowledge and confidence to effectively teach science and encourage students to remain in STEM throughout their schooling. Cheryl was an ecologist prior to becoming a primary teacher and currently teaches at Western Sydney University.
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Stability of vocational interests and aspirations during university study
Ertl, B.; Hartmann, F. G.; Wunderlich, A.
Pre-recorded presentation: https://youtu.be/Gv5zNkbuKPI

Students' vocational interests can be characterized by Holland's theory of occupational choice. Holland distinguishes six interest dimensions: realistic, investigative, artistic, social, enterprising, and conventional. Although these attributes are relatively stable during adolescence, their stability increases dramatically during university study. Because vocational interests are often a factor in career counselling and the choice of what to study, it is essential to investigate the extent to which they develop during the first years of college. This study examines the NEPS first-year student cohort to investigate the stability of students' interests and aspirations. The paper analyzes 2,442 male and 3,435 female students who studied within one of six major study clusters and provided data about their vocational interests at wave 1 (study entry) and wave 9 (about 4.5 years later close to the end their studies). The study's results show strong and highly significant correlations for all six interest dimensions, as well as a high stability of students' aspirations. The correlations were strongest for artistic interests and weakest for conventional interests; they were significantly distinguishable between most dimensions. Further analyses showed notable differences with respect to gender and field of study. Female students showed significantly higher stability of investigative and artistic interests while male students had a higher stability in realistic interests. Furthermore, investigative interests were especially stable in STEM subjects with a medium proportion of female students. A follow-up latent class analysis revealed six latent profiles of students including one large class (72%) with almost stable interests and one medium sized class (17%) with a general gain in interests. While these two classes didn't show subject differences, the third largest class (6%) that indicated a general loss of interests was overpopulated by STEM students with a medium proportion of female students. Two minor classes (each 2%) showed specifics regarding STEM subjects with an under-representation of female students: this group of students was overrepresented in the class that gained social and enterprising interests and underrepresented in the class that lost social, enterprising, and conventional interests. These results indicate that although most students show almost stable interests during university time, there is notable interest development in the STEM area. Here, especially the social and enterprising interests that are atypical for the STEM area are gaining. This calls for

reconsidering stereotypes about STEM which may also provide a fertile background for equal chances in STEM.

Keywords: vocational interests; Holland model; university freshmen; interest stability; vocational aspiration.

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Bernhard Ertl is professor for learning and teaching with media at Universität der Bundeswehr München. His research focuses on gender equality issues in the field STEM, particularly on concepts for gender mainstreaming in STEM teaching and gender specific facilitation methods. Examples for these are the EU-funded project PREDIL dedicated at PRomoting Equality in Digital Literacy or Mit-Mut, a project that aimed at developing a computer game for facilitating female pupils' interest and self-concept in the fields of information and communication technologies and entrepreneurship. He recently edited a research topic for Frontiers in Psychology about gendered paths into STEM. | bernhard.ertl@unibw.de

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Gender composition of the publication output and funding awards by disciplines
Fárová, N.; Hladík, R.
Pre-recorded presentation: https://youtu.be/Z6y27DwpFRI

A study (Hechtman et al., 2018) focusing on gender in NIH grant awarding procedures found that gender inequalities in funding attrition could be explained by survival models that account for differences in initial characteristics of researchers, but unexplained underrepresentation of women persisted in the number of initial and renewal applications. In the Netherlands, Lee and Ellemers (2015) found evidence of a gender gap in the success rates of male and female grant applicants in life and social sciences. Interestingly, in the math-intensive disciplines where women had been generally underrepresented, the bias did not seep into the funding process. Yet, another research study on Dutch grant awards claimed that award councils are effective in correcting for gender inequalities, and located their source outside of the funding procedure itself: women tend to apply for smaller amounts and submit fewer applications overall (van den Besselaar & Leydesdorff 2009). The so-called gender funding or bibliometric gap has not been examined in the Czech Republic but as far as we know from previous research, women's

scientific work is more dependent on grants in comparison with the institutional funding (Vohlídalová, 2018). And as numbers of women in science in the Czech context are slightly decreasing (Tenglerová, 2017), the gender funding gap may be one of the reasons why. In our presentation, we build upon these insights by examining the association between gender compositions of disciplines and funding awards in the Czech Republic. For this purpose, we build a dataset from two comprehensive administrative sources: the Information Register of R&D Results (RIV) for publications and Central Register of R&D Projects (CEP) for funding awards and amounts. Both registers use identical disciplinary ontology (FORD), which allows us to compare them directly. To enrich the data with the gender variable, we rely on the names of authors and principal investigators as an imperfect indicator. The name-based disambiguation utilizes Czech language rules regarding gendered surnames, first-name database, and genderize.io service. The purpose of our study was to determine if the contribution of women to scientific literature is reflected in the access to and the amount of funding. We were particularly interested to find out if STEM and SSH disciplines differed in this regard and if the granularity of the disciplinary divisions altered aggregate ratios.

Keywords: gender gap; publication output; funding awards; STEM and SSH.

Author biographies:
Nina Fárová holds MA in Sociology and PhD in Anthropology from University of West Bohemia in Pilsen. She work as a postdoctoral researcher at the Centre for Gender and Science. As a team member, she has taken part in several research projects focused for example on working conditions and gender equality in Czech academia or on the fate of scientific knowledge in the (post)socialist chemical industry. At present, she focuses mainly on the topic of gender and technology. In 2018 she was a visiting student researcher at Leiden University's Centre for Science and Technology Studies. | nina.farova@soc.cas.cz

Radim Hladík is an advanced postdoctoral researcher who has spent a part of his postdoctoral career in science administration (scientific secretary, journal editor) and who is active in academic community (a founder of the Czech Association for Digital Humanities). He holds MA in Media Studies and PhD. in Sociology from Charles University. Since 2017, he has been a postdoctoral fellow at the National Institute of Informatics in Japan, where he has received intensive training in computational methods and statistical modeling for applications in the social sciences and the humanities. | hladik@flu.cas.cz

"Studying, and then?" Recognize perspectives and plan career! A quantitative analysis of career plans and aspirations of computer scientists'

Förtsch, S.M.

Pre-recorded presentation: https://youtu.be/cFePHjgJksI

This article aims to investigate gender differences among German students in computer science programs. In the male-dominated field of computer science leadership positions are predominantly held by men. In our empirical analysis, we investigate which career path students tend to choose, whether they are planning a specialist or management career. One reason for different career aspirations could be the gender role attitude. We distinguish between a

traditional and an egalitarian understanding of gender role attitude. The traditional understanding of gender role attitude considers men as breadwinners, whereas women take care of house- and family. Therefore, the career of women is less important. The egalitarian understanding of gender role attitude supports career-oriented women and accepts the consequences for the family. Our findings show that women compared to men, are more egalitarian-minded and they also interested in their career development. At the same time, women as-sume that the main family work will be at their expense. In comparison to male students, they are therefore more interested in family-friendly work time models. We assume that students of computer science differ in their professional plans. Due to the fact of gender stereotypes and gender roles, we expect that men are more interested to pursue a leadership position than women are. However, we believe that women are al-ready aware of their role in the family and they are interested in family-friendly working-time models. The empirical analysis based on the model of life planning in professional and private life (Abele, 2006). By interrogating students of computer science, we wanted to gain insights into gender dif-ferences in career aspirations, gender role attitude and preferred working conditions. The sample included 194 students of computer science (w = 70; m = 124). The data of the students were generated from the project Alumnae Tracking (2013-2015). Hypotheses were tested using Wilcoxon rank sum test, logistic and multinomial logistic regression. Female students of computer science are significantly more egalitarian compared to male students. Compared to men women definitely know which career path they would like to choose. However, women are also aware of their role in the family. Therefore, part-time offers from future employers are significantly more important to women compared to men. Because of the results, a coaching program was implemented. The measure aims to provide career-planning support for female students of computer science.

Keywords: women in computer science; career aspirations; management or secialist career; gender role attitude; working-time models.

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Silvia Maria Förtsch studied educational sciences (B. Sc.) at the University of Hagen and empirical educational research (M. Sc.) at the University of Bamberg. She worked as assis-tant of the Women in Computer Science Equal Opportunities Officer and organized a men-toring program for female students of computer science. From 2012-2015, she was a research associate at the project “Alumnae Tracking”. She earned her doctorate on the subject of gender differences in academic education and profession of IT. Her research interests include research on educational and professional pathways, career aspirations, life course research, and gender studies. | silvia.foertsch@uni-bamberg.de

What does it mean to be seen?: Increasing visibility and addressing inequalities in STEM
Gagnon, J.; Reggiani, M.
Pre-recorded presentation: https://youtu.be/rEZA8T2R1Mo

This presentation explores findings from the first phase of the STEM Equals project, particularly the role of visibility of women and LGBT+ people in STEM as one mechanism for addressing systemic inequalities. STEM Equals (www.stemequals.ac.uk) is one of eleven

EPSRC-funded projects under the Inclusion Matters initiative. It is a four-year research and impact project focused on working cultures, including better understanding and addressing systemic inequalities faced by women and LGBT+ people in STEM. Data was collected between November 2019 and March 2020 and includes interviews, focus groups, and reflective writing with 82 participants who are women and/or LGBT+ academic staff or PhD students in STEM. The participants included 38 academic staff and 44 PhD students. The data was thematically analysed using NVivo. The study is theoretically framed by intersectionality theory (Crenshaw, 1989), taking a critical approach to understand working cultures in STEM as conceptualised within Metcalf, Russell, and Hill's article "Broadening the Science of Broadening Participation in STEM Through Critical Mixed Methodologies and Intersectionality Frameworks" (2018). Findings reveal that women and LGBT+ academic staff and PhD students often face inequalities in their career and studies in STEM. Amongst the themes within the data, lack of representation, visibility, and diversity emerged as a particular concern for participants (discussed in 90% of the LGBT+ focus groups and interviews and in 71% of those with women). These quotes exemplify visibility, or lack thereof, in the data:
-"We only had two female members of staff. … You're not even accepting of women by not employing any, why would you be accepting of anyone gay?" (LGBT+, staff)
-"You're the only woman in the midst of men. I'm used to that because I've been like that for a very long time." (Woman, PhD).
-"I've never spoken about my sexuality to my supervisor. ... I feel at an organisational level that there's a real toxic masculinity that exists there." (LGBT+, PhD)
The presentation will conclude with an overview of the two visual models that were developed through findings from phase one. The first is titled the Slippery Slope to Discrimination to signify the dynamics of exclusionary working cultures, from lack of visibility and microagrressions through to gender based violence and discrimination. The second model is titled the Path to Inclusion, highlighting the need for a multi-faceted and holistic approach to addressing inequalities in STEM across organisations to embed inclusive working cultures.

Keywords: women; LGBT+; inequalities; inclusion; visibility.

Author biographies:
Dr. Jessica Gagnon has worked in higher education in the US and UK for 20 years. Jessica is a sociologist of higher education whose research is primarily focused on inequalities in higher education. In addition to her research, she has taught at the undergraduate, postgraduate, and doctoral levels. She grew up in a working-class, single mother family and is first in her family to attend university. On Twitter: @Jess_Gagnon | jessica.gagnon@strath.ac.uk

Dr. Marco Reggiani has been researching urban development, place identity, mobilities, and public life – particularly in the context of Japan. He has taught and tutored at the postgraduate level and has two years of experience as an architect. In 2016 he co-founded the research and design collective Urban Research Table, and he is the author of an illustrated nonfiction book about Japanese culture and lifestyle translated in five languages. On Twitter: @MarcoReggiani_ | Marco.Reggiani@strath.ac.uk

Gender ideology and STEM career choices in higher education students

Gewinner, I.; Esser, M.

Pre-recorded presentation: https://youtu.be/-h3-d_-1znU

Previous studies elaborated well on individual factors of career choices, mainly focusing on personal interests or self-efficacy. Yet, culturally rooted and context-related dimension of gender (a)typical choices has been less incorporated into explanatory models so far. Socialization effects and individual gender ideology may shed light on gendered choices of study programmes. Drawing upon the model of cultural stereotypes (Gewinner 2017) that regards career related orientation of individuals as coined by latent cultural stereotypes and gender ideologies, this study addresses the influence of socio-cultural factors, such as socialisation and gender ideology, on career choices of higher education students. It investigates the choices empirically, based on original data collected 2018 through a quantitative online survey at one big research university in Germany. In the sample including 1516 respondents, 861 persons are female (56.8%) and 634 are male (41.8%). We run separate models for men and women to identify gender specific effects of gender ideologies, gender role models and culturally rooted stereotypes on career choices. Based on logistic regression models, this study reveals gender differences in STEM choices in men and women. We find that conservative gender ideology has a significant impact on male's career choices, which is consistent with research that states, men still tend to choose STEM study programmes. For women, non-compliance with traditional, male breadwinner gender ideologies contributes to choice of STEM subjects. Yet, it is less significant than the educational level of parents and an intact parental family. The findings provide evidence for latent mechanisms of career choices that have hardly been highlighted so far. They show that gender ideology and individual ideal conceptions of life scenarios do matter.

Keywords: STEM career choices; gender ideology; cultural explanation; higher education students.

Author biographies:

Irina Gewinner is a postdoctoral researcher at the University of Luxembourg. She graduated from St. Petersburg State University (Russia) and completed her PhD at the Leibniz Universität Hannover (Germany). Her research interests lie at the interface between cultural transformation, societal diversity and social inequalities. She explores how cultural values, gender ideologies and socio-structural factors create a variety of behavioral patterns and what effect this has on social change. | irina.gewinner@uni.lu

Mara Esser is a MA student with focus on science studies at the Institute of Sociology, Leibniz Universität Hannover. She obtained her BA in sociology from the same university. Her interests include gendered career choices, media consumption and quantitative methodologies. | mara.ess@web.de

Empirical evaluation of an educational STEM intervention for high-school students

Giese, L.; Tellhed, U.; Björklund, F.

Pre-recorded presentation: https://youtu.be/0ur6c3bxSPs

According to social cognitive career theory, gender differences in interest in STEM can be explained by differences in self-efficacy, outcome expectations and goals. In similar vein, Eccles' expectancy-value theory explains career choices based on expectancies for success and job value. Previous research has shown that girls' interest in STEM can be increased by raising their self-efficacy, belongingness expectations and perceived career goal fulfillment. Therefore, educational activities are created to give children and teenagers practical experiences in STEM areas with the aim of raising their interest in the field. Since girls tend to have lower exposure to such learning opportunities, these kind of initiatives might be a promising avenue to raise girls' self-efficacy and thereby interest in STEM fields. However, while educational interventions are often designed to achieve these aims, they are often not empirically investigated for their effectiveness. This study empirically tests the effectiveness of one such educational intervention aimed at high-school students in form of a two-day interdisciplinary course about water and sustainability issues offered by a Swedish water supply company. The study investigates if the intervention raises girls' interest in studying engineering through raising their self-efficacy, sense of belonging as well as through reducing the stereotype that engineering does not fulfil communal or environmental goals. This study used a longitudinal quasi-experimental method. 725 Swedish high-school students answered a survey at three time points (prior to the intervention, immediately after the intervention and 3 months after the intervention) measuring their interest in engineering, self-efficacy, sense of belonging, stereotype threat, and perceived career goal fulfilment. Furthermore, answers were compared to those of a control group. Results indicate that the intervention raised girls' self-efficacy for engineering programs and sense of belonging into the field as well as reduced their stereotype threat, but did not increase their interest for engineering. The intervention also increased participants' beliefs that engineering careers can fulfil communal goals as well as environmental goals, which were both goals that were more important to women. However, the effects on belonging, stereotype threat and perceived goal fulfilment did not hold up at follow-up measure. The results of this study imply that educational activities can raise girls' self-efficacy and sense of belonging, but that a higher increase in those is necessary to have an effect on interest. Furthermore, repeated exposure or a boost might be necessary for the effects to last.

Keywords: intervention; interest; self-efficacy; belonging; career goals.

Author biographies:

Laura Giese is a PhD student at the Department of Psychology at Lund University in Sweden. Her research looks into gender differences in career interests, specifically which factors explain gender differences in STEM interest and how to reduce the underrepresentation of women in these fields. Her dissertation project is a collaboration between Lund University and Sweden Water Research, a R&D company owned by the water supply and management companies in Southern Sweden. | laura.giese@psy.lu.se

Una Tellhed is an Associate Professor at the Department of Psychology at Lund University in Sweden. Her dissertation from 2008 regarded gender-related stereotype threat. She is currently the leader of a research group in Lund who specializes in testing social psychological explanations of the horizontal gender segregation in the labor market, which includes the gender-skewed STEM-sector. As a side project she is also involved in research which tests psychological and physiological health effects of yoga. | una.tellhed@psy.lu.se

Fredrik Björklund is a professor at the Department of Psychology, Lund University. His research has mainly concerned moral psychology, stereotyping and personality assessment. In recent years, his interest has expanded to the area of applied research, with a particular emphasis on recruitment discrimination, person- organizational fit, as well as students' educational and vocation interests in the STEM-sector. | fredrik.bjorklund@psy.lu.se

In-curriculum primary and high school STEM outreach
Giugni, A.; Angelini, M.
Live recorded presentation: https://youtu.be/xWDCgpBb790

Evidence shows girls deter from STEM careers and educational pathways from early secondary school years. To effect meaningful change our approach involves a joined-up program that reaches girls at a primary age and is reinforced throughout high school to continue the positive association between female students and STEM careers. UTS' STEM x Outreach Program is a multi-touch approach with an embedded strategy to measure for evaluation and impact. It employs a design thinking pedagogy, which involves engaging primary and high school students through separate programs that share a common evidence-based and student-centred approach. The program is deliberately gender inclusive, to enable girls to build confidence in STEM in a collaborative classroom. STEM x Outreach addresses the following challenges:

- Intersecting influencers: engaging parents and teachers in building confidence;
- In-curriculum: curriculum co-design with teachers;
- Multi-touchpoint: multiple sessions enable long-term perception change and self-efficacy, through a student-led project design;
- Role models: University students, staff and STEM professionals are positioned as mentors;
- STEM equipment accessibility: uses existing school resources or accessible technologies in school hubs.

STEM x Play is completed over a 6-8 week period with Year 5/6 primary students, alongside parents and teachers actively working together to shift girls' perception towards, interest and confidence in STEM. Following the pilot phase in 2019 STEM x Play ran in 13 schools in 2020, reaching 1600 students and 45 teachers. Through our program evaluation we found a significant increase in girls' interest in problem solving, which led to enhanced confidence in designing and exercising STEM skills. STEM x Impact focuses on the engineering and IT elements within STEM to demystify this as misunderstood space. The program delivers targeted content designed for stages 4 and 5, as well as information and support for stage 6 students (ages 12-18). In 2020 STEM x Impact ran across 10 schools, engaging 540 students and 33 teachers. Our impact evaluation approach uses pre- and post-program surveys (teachers, parents), pre- and post-interviews (students, teachers), mid-program focus groups (parents), and weekly observations (teachers, students). In addition, student perception changes

about STEM are evaluated through post-program written reflections and drawings of 'STEM professionals' pre and post-program. The applied significance is in the building of best practice in school STEM outreach, focused on scalability and collaboration. Discussion will also help inform these programs to work towards developing local school 'hubs' and teacher capacity for program self-sustainability.

Keywords: outreach; primary; high-school; curriculum.

Author biographies:
Amelia Giugni is the Student Engagement Officer of Women in Engineering and IT at the University of Technology Sydney. Her focus has been coordinating and designing the WiEIT high school outreach program and delivering the First Year Buddy Program. In addition to her work with Women in Engineering and IT, Amelia is currently completing her undergraduate degree, Bachelor of Engineering (Honours) & Bachelor of Medical Science.
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Dr. Marco Angelini is the Outreach Coordinator of Women in Engineering and IT at the University of Technology Sydney. He was the project manager for Maths Inside. With a background in academic skills development, educational equity and the transition to higher education, he has taught humanities and science subjects at the London School of Economics, Queen's University of Belfast and the University of Technology Sydney. His research and publications include work on student engagement, academic literacies, philosophical thought and history. | marco.angelini@uts.edu.au

Gender inclusive instructional design strategies: How to engage and retain all genders in computer science professional development for teachers
Goode, J.; Peterson, K.; Malyn-Smith, J.; Chapman, G.
Pre-recorded presentation: https://youtu.be/SscatUywxWE

A known challenge in the field of Computer Science (CS) is the lack of equity and inclusion for women, as evidenced by low rates of participation in higher education and in the high-tech industry. In recent years, concerted efforts worldwide have promoted more equitable approaches to computer science instruction in secondary schools. In the United States, Exploring Computer Science (ECS) courses have approached gender parity in student enrollment, with research showing that a key ingredient in recruiting and retaining girls has been the preparation of high school teachers in face-to-face, long-term professional development programs that take place before, during, and after teachers' first year teaching an introductory CS course. Yet, the regional limitations of face-to-face professional development often is inaccessible, especially during the school year, to teachers outside of large regional hubs. In this paper, we explore how an online professional development environment can create learning spaces that allow teachers to sharpen their gender-inclusive pedagogical skills while being immersed in their first year of teaching the ECS course. This paper describes the evidence-based design strategies that were iteratively developed for creating a gender-inclusive venue for teachers to examine their belief systems, develop inclusive pedagogical practices, and collectively transform the culture of CS classrooms to places that support learners of all

genders. To inform our findings, this paper draws on survey and observation data from more than 200 project participants over three years, and in three cohorts, in an online PD setting, to understand how to attract, retain, and support national cohorts of majority women teachers in an online environment. The results of this study suggest that using particular aesthetics, features, and language can signal inclusion and support a gender-inclusive learning environment for teachers. Specifically, we found that teachers highly valued a transformative, feminist culture of a "shared experience", whereby facilitators and groups of teachers engage in collaborative planning and debriefing discussions around teaching in gender inclusive ways. The architecture and content of this online learning environment, with gender inclusion principles at the center of the learning experience, offers a set of recommendations that can inform the design and instructional content of other online PD efforts aimed at broadening participation in computing and in other STEM fields.

Keywords: instructional design; gender inclusive; online professional development; CS education.

Author biographies:

Joanna Goode is the Sommerville Knight Professor of Education at the University of Oregon. Formerly a computer science high school teacher, Goode's research considers how to create inclusive learning environments that support girls and students of color in learning computer science at school. She studies how policies, practices, curriculum, and pedagogy can shape students' opportunities for inclusive and culturally responsive learning in school classrooms. Goode serves as a PI on multiple federally sponsored research projects focused on broadening participation in computing. Goode is the co-founder of Exploring Computer Science and the co-author of Stuck in the Shallow End: Education, Race, and Computing.
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Joyce Malyn-Smith is a nationally-recognized thought leader in the field of workforce development, specializing in effective strategies to promote STEM career readiness and success. She has extensive expertise in facilitating the efforts of business and industry leaders to identify major tasks, skills, knowledge, and abilities needed by workers in emerging fields and significantly changed occupations. Malyn-Smith is the Principal Investigator (PI) of several initiatives that focus on fostering key workforce competencies. She is leading a national computational thinking forum and an initiative to design online learning experiences to prepare high school teachers to implement the Exploring Computer Science curriculum.
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Kirsten Peterson is an instructional designer with extensive expertise in developing and supporting online professional learning communities and managing, scaling, and sustaining online learning programs. She is currently co-PI for the NSF CS10k project Online Professional Development for Exploring Computer Science (ECS) where she and her colleagues are designing, implementing and researching capacity-building online professional development learning experiences for ECS teachers. Nationwide, Peterson has led production teams in providing custom online development and consulting services for K-12, higher education, non-profit and other organizations with an educational mission. | kpeterson@edc.org

Gail Chapman's work focuses on equitable education for all students and the impact that teachers and teaching can have on ensuring this. With Exploring Computer Science (ECS), Chapman works with partner districts on strategic planning related to implementation of ECS, including professional development, leadership development, and sustainability. She is co-designer of the ECS curriculum and professional development model and leads ECS PD Facilitator development. She is also co-developer of the exploratory online professional development model for ECS teachers. Gail is the recipient of the 2017 SIGCSE award for Outstanding Contribution to Computer Science Education. | chapgail@gmail.com

Cross-cultural and gender differences in predicting career aspirations in different STEM-related fields: An Expectancy-Value perspective

Guo, J.; Hu, X.; Pekrun, R.; Marsh, H. W.

Live recorded presentation: https://youtu.be/0dUJ1BMJmRA

While expectancy-value theory (EVT) has been suggested to explain various students' aspirations and choices in STEM-related fields, few studies have compared cross-cultural differences in respective effects of students' science expectancies and subjective values. By analyzing data on 472,242 15-year-old students from 72 countries using generalized linear models, the present study aims to examine the relationship between different motivation factors (i.e., science self-efficacy, enjoyment and utility value) and STEM aspiration, controlling for academic achievement in science, reading, and mathematics, gender, grade, and family socio-economic status. The results showed that 1) on average, science utility value is a stronger predictor of 15-year-old students' career aspirations in STEM than self-efficacy, enjoyment, and performance, particularly when predicting aspirations in life science-related fields; 2) however, there is a substantial country-by-country variation in the effect of utility value – the effects are stronger in more developed countries; 3) for gender differences, girls aspire more to life science than to physical science, and vice versa for boys; 4) utility value plays a more important role for girls than for boys in aspiring to STEM-related fields, particularly in more gender-equal countries. This is among the first study to provide a comprehensive test of the generalizability of the EVT predictions, which brings practical implications for motivation interventions targeting EVT motivational processes to promote STEM aspirations in a wider context.

Keywords: expectancy-value; self-efficacy; gender; STEM career aspirations; cross-cultural.

Author biographies:

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Reinhard Pekrun, PhD, is a professor of personality and educational psychology at the University of Munich, Germany, and Professorial Fellow at the Australian Catholic University, Sydney, Australia. His research areas are achievement motivation and emotion, personality development, and educational assessment and evaluation. He is a highly cited scientist who pioneered research on emotions in education and originated the Control-Value Theory of Achievement Emotions. | pekrun@lmu.de

Herbert W. Marsh, PhD is an ‘‘ISI highly cited researcher’’ (http://isihighlycited .com/) with 7001 publications, 100,0001 citations and an H-index of 159. He coined the phrase substantive-methodological synergy that underpins his substantive (self-concept, motivation, gender, bullying; educational, developmental, and sport psychology) and methodological (factor analysis, multilevel modelling) research interests. | Herb.Marsh@acu.edu.au

An investigation of school students' STEM career interest

Hatisaru, V.

Pre-recorded presentation: https://youtu.be/_zGR8TRVBpc

This presentation reports a study investigated Turkish school students' attitudes towards STEM disciplines and careers and explored determinants of students' STEM career interest (Hatisaru, 2021). In total, 117 lower secondary school students (aged 11 to 14) completed the STEM Semantic Survey including an open-ended question about their career intention after high school and the reasons for these. Using the conceptualisation of the influences of behavioural, personal, and contextual variables in career choice decisions (Social Cognitive Career Theory (SCCT), Lent et al., 1994; 2000), the students' descriptions of career goal reasons were presented to elaborate on the variables that influence their STEM career interest. According to SCCT, behavioural variables (self-efficacy, outcome expectations, interests, and goals) shape individuals' educational and occupational choices, and personal (e.g., gender) and various important contextual variables such as culture and educational climate impact on these behavioural variables. Attitudes towards individual STEM disciplines were from moderate to high and towards STEM careers were high. The gender difference was negligible. One of the key determinants of students' career intentions was interests, involving interest in a particular career (e.g., architect) and career-relevant activities (e.g., planning, drawing, and designing) or subjects (e.g., mathematics). Larger, societal influences (altruism and patriotism) were among the motives of students' career goals. The study findings imply that educational investments which take into consideration the SSCT variables have the potential to influence school students' attitudes towards and career choices in STEM. In particular, the influence of personal interests and societal factors on students' educational choices need to be considered in the development and implementation of STEM initiatives that aiming to impact students' orientations towards STEM.

Keywords: attitudes towards STEM; gender; school students; Social Cognitive Career Theory (SCCT); STEM career interests.

Author biography:
Vesife Hatisaru is a postdoctoral research fellow in mathematics and science education at the University of Tasmania. Her research addresses experiential and open-ended methods in teaching and learning of mathematics, teacher pedagogical content knowledge and its connection with student learning, and images of mathematics held by school students involving their views about mathematicians, perceived need for and stated attitudes about mathematics, and descriptions of mathematics classroom. Vesife recently is interested in components of effective STEM teaching and professional knowledge basis of STEM teachers.
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A teacher of STEM knows: "A Lot!" School principal perceptions of STEM capability for teachers

Hatisaru, V.

Pre-recorded presentation: https://youtu.be/PGDpi-GrrcY

STEM education is generally defined as teaching and learning practices that coordinate learning objectives of STEM subjects through open-ended, realistic, and interdisciplinary problem situations. It is increasingly believed having positive impact on learning outcomes of students. Although research on the STEM education has grown, several practical challenges in terms of its successful implementation remain. These include ensuring STEM success for all students—especially those from underrepresented groups including girls and women—the necessity of close collaboration among teachers of the component disciplines, teachers' commitment to and expertise in STEM, and support from school leadership. To help teachers consider and implement STEM, principals' perceptions of STEM are important, as they determine the extent to which they establish a school culture and structures in which teachers are supported to adapt effective STEM teaching practices. Little is known from research about how STEM and the teacher capability in STEM is perceived by principals. Previous research through the Principals as STEM Leaders—Building the Evidence Base for Improved STEM Learning [PASL] project has explored the perspectives of the PASL research team (Hatisaru, Beswick & Fraser, 2019) and a group of principals (Hatisaru, Fraser & Beswick, 2020) of STEM learning environments. In this presentation the principals' views of STEM, and STEM capability for the teachers of STEM, drawn from their responses to two prompts are reported: 'STEM is ...'; and 'A teacher of STEM knows ...'. An inductive content analysis was conducted to find the themes and patterns in the details of the responses. The results suggest that some principals regarded STEM as simply, "the integration of science, technology, engineering and mathematics" and believed that teachers of STEM know discipline-specific and integrated STEM knowledge and practices. A few responses revealed a view of teachers of STEM as no longer expert suggesting belief in the need of teacher professional development. Gender did not appear to be an aspect of the participant principals' perceptions. The study contributes to the discussions on how best support the development of principals' capacity to support teachers of STEM to develop their own STEM teaching capability.

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Keywords: perceptions of STEM; school principals; teacher expertise; teacher STEM knowledge.

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Perceptions of belonging, effort, and feedback: Gender differences in undergraduates considering graduate studies in STEM
Hodges, S. D.
Pre-recorded presentation: https://youtu.be/qK1UAR00m_8

Bias can work in concert with women's own feelings about whether they feel like they "belong" in STEM, contributing to female under-representation in STEM fields. Female students may choose to leave as they advance through STEM training because of negative feelings about whether they fit in (social belonging); about whether they have the right abilities (ability belonging); or about perceptions that they have to work harder than their peers – even when their objective records in STEM are equal to their peers'. The current study examined these variables as predictors of women's and men's reported future STEM persistence at an ecologically important decision juncture in pursuing a STEM career – after a discussion about preparation for [post-]graduate school. Participants were 177 undergraduate STEM majors (49.7% female) who expressed serious interest in applying to doctoral programs in one of six STEM fields. Undergraduates conversed in-person about graduate school preparation for 10 minutes with either a female or male doctoral STEM student in the field the undergraduate was interested in pursuing. Care was taken to balance the gender of undergraduate and doctoral students across dyads, as well as within STEM fields. After the conversation, undergraduate wrote down their beliefs about what the doctoral student thought during the conversation and how the doctoral student evaluated them. Coders compared undergraduate beliefs to the doctoral student's actual thoughts and evaluations. Undergraduates reported how much social belonging (Good, Rattan, & Dweck, 2012) and ability belonging (Lewis & Hodges, 2015) they felt in their STEM field. Undergraduate also assessed how much effort they felt they were exerting in their STEM field, as compared to their peers. Finally, the undergraduates reported their future likelihood of persisting in STEM. Female and male undergraduates were equally accurate in perceiving feedback from the doctoral students. Furthermore, contrary to predictions, women were no more negatively biased than men in perceiving how the doctoral students evaluated them (gender of doctoral student had little effect). However, as predicted, women reported significantly lower ability belonging than men (although they reported similar social belonging). Women also perceived themselves as exerting comparatively more effort in STEM than their peers. These results suggest that even undergraduate women who report robust anticipation of future persistence and who highly identify with STEM fields may nevertheless show the seeds of self-doubt associated with a higher exit rate from advanced STEM training (e.g., Smith, Lewis, Hawthorne, & Hodges, 2013).

Keywords: belonging; comparison; feedback; higher education.

Author biography:
Psychology Professor *Sara D. Hodges* has studied social cognition at the University of Oregon since 1995. Her work on "empathic accuracy" (the ability to infer other people's thoughts and feelings) has demonstrated how gender and motivation can interact to affect accuracy in guessing what other people are thinking. This research, along with her research on social comparison – in particular, work about how female undergraduate and graduate students in STEM perceive themselves as having to exert comparatively more effort than their peers – has led to her to study how students in higher education perceive feedback they get in STEM fields. | sdhodges@uoregon.edu

"Why I don't belong here…": Sources of male and female students' belonging uncertainty in the computer sciences
Höhne, E.; Zander, L.
Pre-recorded presentations: https://youtu.be/rDH8wodD-Jo

Belonging uncertainty, defined as the concern about one's social relationships in an academic setting, has been found to predict lower academic domain identification, achievement, and persistence. In higher education, female students are particularly likely to experience belonging uncertainty in STEM domains because they constitute a numerical minority in these stereotypically male-connoted domains in many Western industrial nations. With a percentage of 18.35%, computer science is one of the subjects with the lowest rate of female students in Germany, and, in contrast to other STEM fields, recently even underwent a significant decrease in the number of female first-year students. Despite the increasing number of studies that focus on the effects of belonging uncertainty, to date, only little research investigated its psychological sources. To address this research gap, we examined three potential sources of belonging uncertainty in a sample of 449 undergraduate computer science students in Germany (23.2% female) focusing on (a) perceived affective and academic exclusion by fellow students, (b) domain-specific academic self-efficacy beliefs, and (c) perceived individual performance potential compared to that of fellow students. In multiple linear regression analyses, we found that both the perceived affective and academic exclusion and self-efficacy beliefs significantly predicted female but not male students' belonging uncertainty. The perception of one's individual performance potential compared to that of fellow students, however, was a relevant predictor of both male and female students' belonging uncertainty. Our findings imply an expanded view of the theoretical concept of belonging uncertainty that goes beyond mere concerns of social connectedness and may serve to inform interventions aimed at fostering students' sense of belonging and increasing the share of female students in computer science and other STEM domains.

Keywords: belonging uncertainty; ability-related stereotypes; higher education; gender; STEM.

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Lysann Zander is full professor of Empirical Educational Research at Leibniz University Hannover, Germany. She studied psychology at Humboldt University in Berlin, the University of California, Santa Barbara and Cal State Northridge. In her research, she seeks to uncover the mechanisms underlying the sometimes astounding congruence of students' self-perceptions and the social networks they establish within their learning environments, particularly when it comes to academic domains for which there are strong gender or ethnic stereotypes. She has been further involved in several projects developing interventions with the aim of fostering equal status peer interactions among students from different social groups.
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Promoting female middle leaders: Primary schools as sites for education leadership in STEM education.
Hunter, J.L.
Live recorded presentation: https://youtu.be/KTynhe2v5no

Primary school education in Australia is historically a feminised space and successive national gender equity policy frameworks have not significantly altered how female teachers in K–6 schools are positioned. Middle leaders frequently take on critical responsibilities beyond their teaching and learning roles in classrooms as a preferred route to organisation leadership. Middle leading in pedagogical leadership often acts as a 'safe, rehearsal space' for female teachers to attain principal or more senior leadership responsibilities in their quest to improve co-teaching practices and student learning outcomes. This paper examines research in STEM education in one education jurisdiction through a mixed methods study involving small teams of female middle leaders in six primary schools. Over 18-months middle leaders learned how to build trust, become critical friends, create effective teams, and collect targeted evidence to improve student learning outcomes. Using an inquiry approach and the High Possibility Classrooms framework these middle leaders created more than 70 S T E M artefacts that reflected the effective integration of four disciplines in combination with important concepts in the Arts and Humanities. Designs for student learning across all year levels were described in the findings as transformational and transdisciplinary because of the shifts in instructional practice from being highly teacher centred and subject specific to a more student-centred and integrated focus; students in these classrooms also noted the change and they welcomed it. Furthermore, if female primary school middle leaders work with junior colleagues in stage-appropriate teams they can form powerful alliances through a flexible professional network that more readily provides attention to innovative cross-disciplinary pedagogical practices. Socio-cultural theory offers a useful lens to understand the more embedded notions of practitioner research that these middle leaders drew on in the hope that they might act as authoritative supports for effective school policy and practice in STEM education. When accompanied by generous school-based priorities, such urgencies provide time for middle leaders to engage in deep conversations about learning, guided reflection and more

collaborative less-siloed curriculum planning. As K-6 schools move to teaching and learning sizeable groups of students in large open spaces for STEM education it is critical to share how small teams of middle leaders embraced the challenges, adapted their practices, led organisation change and teacher professional learning where it mattered. This study and the approaches used will be discussed in the context of a new blueprint for STEM education in Australian schools.

Keywords: integrated STEM; middle leadership; pedagogy; practitioner research; K-6 education.

Author biographies:
Associate Professor Jane Hunter is a researcher and teacher whose professional career has focused on teacher education and schools. Her pedagogical framework of High Possibility Classrooms scaffolds teacher agency in pedagogy, technology enhanced learning and curriculum; in 2019 it was awarded HIGH impact by the Australian Research Council in the first ever Engagement and Impact Assessment. She has numerous national and international awards for outstanding contributions to student learning in Australian universities. Her new book "High Possibility STEM Classrooms: Integrated STEM Learning in Research and Practice" (2021) is the culmination of four years of research in Australian K-6 schools. She tweets @janehunter01 | jane.hunter@uts.edu.au

Why do girls avoid STEM fields? Mathematics achievement, motivation and gendered educational and occupational choices

Jaegers, D.; Lafontaine, D.

Pre-recorded presentation: https://youtu.be/-sQ9h4BrSLI

The expectancy-value model states that gendered educational and occupational choices are influenced by differences in motivation and mathematics achievement. If it is well established that girls are less motivated in mathematics than boys (OCDE, 2012); researchers have shown that achievement alone cannot explain gender differences (Mullis et al., 2016). For example, Parker et al. (2014) found that math self-concept is a more critical filter to STEM fields than math achievement. Previous studies (e.g., Watt, 2006) have also shown that math course level is a strong predictor of mathematics-related career intentions. Experts often estimate the role of mathematics in studies or careers on the basis of objective classifications such as the O*NET classification. Beyond the objective role of maths, what is also decisive in the study choice is the perception a student has of the major/minor role maths play in these studies. To our knowledge, no study has so far investigated the students' perception of the role of maths in the studies they chose. The present study aims at investigating whether mathematics achievement, motivation and attended number of maths periods per week moderate the influence of gender on perceptions and aspirations to STEM studies and careers. 25 schools in French speaking Community of Belgium, 2 classes per school, 777 students, 53% female, grade 12. Measures: 4-point Likert scales for motivational variables (self-efficacy: α=.81; self-concept: α=.89; interest: α=.87; utility: α=.91). Prior achievement in mathematics was measured by a math test of 13 items administered at grade 11 (α=.77). The number of maths periods per week were recoded into a dichotomous variable (0=less than 5h/week; 1=more than 5h/week). The

educational and occupational aspirations were measured by asking the kind of higher education they expect to enroll in after secondary education and the kind of job they expect to have when they will be 30. Reported higher studies/occupations were coded: 1=study/work in a math field, 0=study/work in another field). Finally, students were asked to tell how they perceive the importance of maths in their future studies. Their answer were dichotomized (1=perceptions that maths play a major role; 0=absence/minor role of maths). Several models used Multivariate Logistic Regression Analysis with SAS 9.4 in order to predict studies aspirations, careers expectations and perceptions of the importance of maths in future studies. The gender effect on aspirations to STEM studies and careers remained when students' characteristics were kept under control. Even if gender was a strong predictor, some motivational variables and the number of maths periods were also strongly linked to STEM studies and careers. Regarding the perceptions of the importance of mathematics in the higher education programs, the gender effect disappeared when prior achievement, motivation and the number of maths period in their program were kept under control. We do not only try to understand educational aspirations and careers in studies in which math objectively play a major role. It also aims at understanding which variables influence students' perceptions of the role of maths in their future studies. This new approach brings new perspectives in terms of how to overcome girls' reluctance to choose STEM fields.

Keywords: Studies and careers expectations; mathematics; gender; perceptions; motivation.

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Representation, reciprocity, and computer science education: Perspectives of women teachers of color in the United States"

Johnson, S.; Ivey, A.; Snyder, J.; Skorodinsky, M.; Goode, J.

Pre-recorded presentation: https://youtu.be/iGHrG5Gi1d4

The participation gap in computer science (CS) persists despite a great number and variety of efforts to address it. This gap is most profound at the intersections of race and gender. In a democratic country, it is especially imperative that girls and women of color have access to the study of, and employment in, any field that brings them satisfaction. It is equally important that they have access to positions with agency to define and shape the field of computing, which currently exercises immense influence over most aspects of our lives. While multiple research-based interventions have been forwarded which focus on recruiting girls of color to computing, most of these are single sex, out of school programs, which aim to influence girls' confidence and belongingness in computing. Currently, there is a scarcity of published research which examines the experience of CS high school teachers, who are women of color, centering perspectives on their role in the educational experience of their students and their teaching practices and strategies to engage students in CS. How do women of color understand and approach their role as CS teachers based on their unique standpoint? How do their intersectional identities impact their teaching praxis? The aim of this study is to center the voices of CS teachers whose lived experiences as women of color give them a unique perspective regarding the interplay of teachers, students, parents, race, gender, CS, school location, demographics, and school culture. We employ the theoretical frameworks of standpoint theory and Native Feminist reciprocity theory to analyze and elevate the values and praxis of these teachers in order to gain a better understanding of operationalizing engaging and supportive CS education that embraces marginalized students. Using ethnographic methods and data collected from professional development observations and interviews, we examine how the intersectional identities and embodied experiences of these educators can inform efforts at broadening participation in computing for students. The findings of this study point to the importance of not playing it safe, representation, place, reciprocity, and critical hope [4] as key tenets in these teachers' standpoints towards broadening participation in computing. While some of these tenets can inform other educator's pedagogical efforts at broadening participation in computing, the embodied, gendered, and racialized nature of these findings highlight the need to prepare a diverse teacher cadre as part of building authentic opportunities to learn for all students.

Keywords: intersectionality; reciprocity; broadening participation in computing; female teachers of color.

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Max Skorodinsky worked as a software engineer for over a decade. He currently teaches Computer Science (CS) at an alternative public high school as an openly transgender person. He is involved in multiple grassroots efforts to support non-binary and transgender people. Additionally, Max is a fourth year PhD student in UO's Critical and Sociocultural Studies of Education. His research is focused on democratizing the field of CS and broadening student participation in CS education. To this end, he has taught CS in a variety of venues focused on empowering underserved youth. | makseem@uoregon.edu

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Gender inclusive education in the mathematics classroom
Kavatsyuk, O.; Ioannou, M.; Avraamidou, L.
Pre-recorded presentation: https://youtu.be/y3qyMBfKuBQ

In every region of the world, women researchers remain underrepresented in Science, Technology, Engineering, and Mathematics (STEM) fields (Unesco, 2018). Interestingly, large-scale empirical studies point to the fact that this is not an issue of lack of interest or capability (Spelke, 2005). Prior research identified some of the reasons for this disparity: lack of confidence, lack of female role models, as well cultural and gender-STEM stereotypes. These issues have been examined through the construct of 'STEM identity' which refers to how individuals see themselves as science persons and how they are recognized by others (Avraamidou, 2019; Hazari et al., 2010). In attempting to address the problem of women's under-representation in STEM and framed within an identity-based framework, this project focuses at university-level representation where the greatest disparity lies. The project aims at shedding light into the role of the university classroom in cultivating and supporting the development a strong science/mathematics identity, by designing and incorporating a series of gender-inclusive instructional sequences in the context of an introductory Calculus course. Our project consists of two parts: (i) generating evidence-based recommendations via a student-led research on how the course can change to be more inclusive; (ii) evaluation of the impact of the course on students' STEM identity development.

The course was purposefully redesigned to offer a set of gender inclusive instructional practices as follows: adopted a problem-based approach centered around real-world problems; introduced female mentor/role-models; engaged students in hands-on activities that exemplify

the application of science to everyday life, and incorporated explicit discussions about gender-STEM stereotypes as well as the role of women in science. Research data have been collected through a combination of both quantitative and qualitative methods: surveys administered to students of the course, in-depth interviews with students who took the course, and interviews with the teacher of the course and Calculus-I teachers from other faculties. We are currently in the process of analyzing the data, however, initial results show that specific aspects of the course as well as the role of the teacher were instrumental to the development of the students' STEM identities. The project has scientific and practical implications as it will contribute evidence towards understanding the kinds of activities that might support university students' STEM identity development and will also provide a set of concrete, evidence-based practices as part of an innovative, gender-inclusive course.

Keywords: gender; STEM; identity; university education.

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Oksana Kavatsyuk is a lecturer at University College Groningen (UCG), teaching various Physics and Mathematics courses. She finds it extremely important to give chances and support to all talents (also at University level). She believes that her task is to provide a high quality up to date education, including creating a safe and stimulating classroom environment and engaging different learners. Currently, she and her team are exploring how all students regardless of gender could be encouraged to explore their talents in mathematics to their full potential. Based on the obtained results, structural changes in Mathematics courses at UCG were implemented. | o.kavatsyuk@rug.nl

Maria Ioannou is a social psychologist and is currently working at the University College Groningen (UCG). Her research lies in the field of prejudice and discrimination and also on ways of reducing prejudice/ discrimination. Within UCG she is involved with courses, workshops and committees that serve the theme of diversity and inclusion. Within this project her role is to supervise the student-led research based on which the recommendations for creating a more inclusive mathematics classroom are generated. | m.ioannou@rug.nl

Lucy Avraamidou is Associate Professor of Science Education at the University of Groningen where she leads a team of 8 PhD students. Her research is associated with theoretical and empirical explorations of what it means to widen and diversify STEM participation in school and out-of-school settings through the lens of intersectionality. At the heart of the account of her work is an exploration of minoritized individuals' identity trajectories and negotiations with the use of social network theory as well as narrative inquiry methods. | L.Avraamidou@rug.nl

Designing authentic assessments to promote girls' self-efficacy and interest in STEM subjects
Koh, K.; Chapman, O.; & Liu, S.M.
Pre-recorded presentation: https://youtu.be/oiDCAEXkiyo

Our study draws on Koh's (2011) criteria for authentic intellectual quality (AIQ), Biggs and Collis's (1982) structure of the observed learning outcome (SOLO) taxonomy, and an

integrated patchwork text approach (Koh & Burke, 2018). The AIQ criteria guided our design and development of Grades 5-6 authentic STEM assessments while the SOLO taxonomy enabled us to identify specific learning outcomes across the different levels of cognitive complexity (i.e., learning progression) in the STEM authentic assessments. The objectives of our study were to (1) develop and validate authentic assessments in STEM for elementary students; and (2) examine the effects of authentic assessments on grades 5 and 6 girls' self-efficacy and interest in STEM subjects. An authentic STEM assessment consists of patches of tasks and a culminating project, both of which require students to apply the knowledge and skills they acquire from all STEM subjects to solve the real-world problem embedded in the project. We posit that girls' undertaking of authentic assessments could increase their self-efficacy and interest in STEM. Participants were 37 grades 5 and 6 students from a Canadian Catholic school. Data sources included pre- and post-intervention questionnaires that measured change in students' self-efficacy and interest in STEM subjects, students' written reflections, and teachers' interviews regarding students' experiences in STEM authentic assessments, classroom observations of students' learning and engagement in STEM, as well as teachers' implementation of the STEM authentic assessments. We adopted Design-Based Research (DBR) methodology (Design-Based Research Collective, 2003), which enabled us to situate our design and testing of a significant intervention/solution (STEM authentic assessments) in two grades 5 and 6 classrooms. We also developed a self-report questionnaire to measure STEM self-efficacy. Girls' self-efficacy and interest in STEM subjects and careers did not increase significantly after the intervention. However, their growth mindsets improved. Additionally, girls' selection of their roles in the STEM project were diverse, but none of them chose the role of an engineer. Some girls faced challenges in their collaboration with boys. The design of the authentic STEM assessments is important because there is lack of instructionally sensitive assessments of STEM learning. Our findings indicate potential for using authentic assessment tasks to develop girls' growth mindset in STEM.

Keywords: authentic assessment; STEM; girls; self-efficacy; interest in STEM.

Author biographies:

Kim Koh, PhD, is a full professor in educational assessment and measurement at the Werklund School of Education, University of Calgary, Canada. As a Principal Investigator, she has successfully conducted both large-scale assessment and classroom assessment research projects in Singapore and Canada. Her current research includes building preservice elementary teachers' capacity in mathematics authentic assessment (funded by the Social Sciences and Humanities Research Council of Canada), identifying signature pedagogies for developing preservice teachers' assessment literacy (funded by the University of Calgary Teaching and Learning Grant), and developing STEM authentic assessments for girls (funded by Alberta Education). | khkoh@ucalgary.ca

Olive Chapman, PhD, is a professor in mathematics education at the Werlund School of Education, University of Calgary, Canada. She has an academic background in the STEM disciplines and teaches a STEM course to student teachers. Her research focus includes mathematical problem solving and modelling, inquiry-based pedagogy in mathematics education, students' thinking in learning mathematics, and formative assessment in teaching

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Is co-education in science the reason for female underrepresentation in physics?
Ladewig, A.
Pre-recorded presentation: https://youtu.be/x9dAXDabN5s

Sense of belonging is defined as the feeling of membership in a group, acceptance and valuation by its members (Good, Rattan, & Dweck, 2012). In school it is an important part of students' lives (e.g., Anderman, 2003) but is limited for girls in science domains. Stereotypes about girls' talent especially in physics cause stereotype threat (e.g., Steele & Aronson, 1995), which reduces intentions to pursue a science career and also girls' belonging (Good et al., 2012). This effect was found to be especially strong in predominantly male domains and when stereotypes were endorsed (Schmader, Johns, & Barquissau, 2004). We evaluated a school's project which separated students of the 8th grade in science into single-sex classes to investigate whether belonging in physics increases for girls in an all-female environment. 62 students attended regular mandatory co-educational physics classes; participation in the additional single-sex science course was based on students' choice of a single-sex science, technology, engineering, and mathematics course (n = 23, age: M = 14.00, SD = 0.60; 53.85 % female) as opposed to participation in a coeducational language course (n = 39, age: M = 13.87, SD = 0.41; 65.22 % female). Single-sex education did not reduce stereotypical beliefs but positively impacted how female students perceived teaching quality. For female students, regardless of being taught coeducational or in a single-sex class, teaching quality positively impacted sense of belonging. No stereotype threat effect showed for females. Male students either showed higher belonging when endorsing stereotypes (all-male science class) or felt less belonging due to perceiving more stereotype in the environment (only co-educational physics). Concluding, this study showed that teaching students in single-sex groups in science appears not to be the solution to improve the learning situation for both male and female students. Single-sex education led to higher instructional quality for students in all-female compared to students in all-male science lessons. Even if this small intervention cannot extinguish the problem, it presents an opening for more awareness and development of an intervention that can heighten belonging in science. Especially the results regarding perceived teaching quality present a chance to teachers to change their teaching style in science lessons and thereby heighten teaching quality and sense of belonging.

Keywords: sense of belonging; teaching quality; single-sex education; science.

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Gendered motivational heterogeneity across domains: What role does it play for educational choices in early adulthood?
Lazarides, R.; Dicke, A.-L.; Rubach, C.; Oppermann, E.; Eccles, J.S.
Pre-recorded presentation: https://youtu.be/A9sbHacecV4

Referring to expectancy-value theory Eccles et al. (1983), we examined girls' and boys' profiles of motivational beliefs in four domains - mathematics, English language, biology and physics. Studies have already shown that inter-individually different motivational profiles are related to students' gendered educational aspirations (Chow, Eccles & Salmela-Aro, 2012). This study extends prior research by applying a longitudinal perspective regarding both girls' and boys' changes in profile membership and the role of profile membership for future educational choices. Data were drawn from the Michigan Study of Adolescent and Adult Life Transitions Study (Eccles et al., 1989). In this paper, we included students who participated in Grade 10 and Grade 12 data collection (n = 911; 56.1% female). Analyses on inter-individual differences in college major choice included a subsample of n = 567 (58.4% female) students, analyses on inter-individual differences in occupational skill sets use n = 356 (62.6% female) with full response rates. We conducted latent profile analyses and latent transition analyses using student-reported subjective task value and ability self-concept in mathematics as profile indicators which were worded equally at each measurement and in each of the four domains. Data on college majors were assessed 2, 6 and 10 years after high school and were coded into ONET job families. Data on occupational skill sets were collected 22 years after high school. We identified five motivational profiles at Grade 10: 'High motivation' (30.1%; girls: 48.5%), 'Mathematics' (8.7%; girls: 62%), 'Mathematics and Englisch' (34.1%; girls: 55.2%), 'English profile' (12.6%; girls: 62.3%), 'English and Science' (14.5%; girls: 65.2%). In Grade 12, a four-profile solution fitted the data best: 'High English, moderate math and science' (31.3%; girls: 54.7%), 'Mathematics' (28.6 %; girls: 61.5%); 'High mathematics and science' (24.3%; girls: 43.1%), 'English' (15.8%; girls: 66.7%). Boys were more likely than girls to change to the 'Mathematics and science' than to the 'English' profile from Grade 10 to Grade 12. Math- and physical science-related majors and occupational skill sets in Mathematics, Physics, or Engineering were more often selected by students who were in the 'Mathematics and science' profile in Grade 12. Gendered motivational trajectories and their relation to future choice behaviors are clearly shown in this study. The findings emphasize the value of examining motivational heterogeneity among girls and boys to better understand educational choice behaviors.

Keywords: gender; motivation; STEM; latent transition analysis.

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Fostering girls' STEM interest through STEM integration at a developing STEM middle school

Leammukda, F.; Boyd, B.; Roehrig, G.

Pre-recorded presentation: https://youtu.be/HT-8k3B8ywE

The fields of science, technology, engineering, and mathematics (STEM) have been and continue to be dominated by men (Corbett & Hill, 2015). Women are underrepresented in post-high school STEM majors and careers. The population of STEM majors and careers do not reflect current demographics of the U.S. population (Corbett & Hill, 2015), with the decline in

attitudes among girls occurring during the middle school years (Reigle-Crumb, Moore, & Ramos-Wada, 2010). The aim of this study was to identify ways that a community-embedded STEM integration experience foster aspects of STEM interest in middle school girls at a developing STEM school in the Midwestern United States. Data sources included audio recordings of the target students' presentations of their STEM projects, focus groups with target students reflecting on their STEM experiences, and interviews with STEM coordinator. This single embedded case study was contextualized within the integrated STEM experiences with multiple units of analysis (Yin, 2014). The units of analysis were the seven female target students who completed an additional project based on one of the two inclusive STEM units that were developed in this study by core seventh grade teachers. The case was the developing STEM interest of these girls and was bounded by the participation in the two integrated STEM units and follow-up projects. SciGirls Seven -- Proven Strategies for Engaging Girls in STEM and the STEM integration framework of Moore et al. (2014) were both used to frame this study. Results of this study illuminated five ways that a community-embedded STEM experience fostered aspects of STEM interest in middle school girls at a developing STEM school. These included: (a) giving students the opportunity to make personal connections and connections to helping others within their community, (b) building self-confidence in students, (c) giving students the chance to work in a supportive and collaborative community, (d) allowing students to take ownership of their own learning, and (e) encouraging students' to persevere and learn from their own mistakes. Findings can be used to develop and guide further integrated STEM curricula that focuses on improving STEM interest, with the ultimate goal of increasing representation of women in these areas. The authors of this study challenge educators to find ways to appropriately support girls in their success in STEM by improving their STEM interest.

Keywords: female students; STEM interest; single case study; integrated STEM curricula.

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Measurement and stability of affective and cognitive interest components among Australian adolescent girls and boys

Lee, K. J.

Live recorded presentation: https://youtu.be/EymN2SjS4Jo

Individual interest in a domain has important positive associations with academic achievement, engagement and participation as emphasised in prominent motivational theories (e.g. expectancy-value and self-determination theories) as well as within the interest literature. Interest is therefore particularly pertinent for educational researchers in STEM fields, where secondary school participation and achievement in comparative international testing are current issues. The recent literature conceptualises interest as multidimensional, involving both cognitive and affective components. However, the measurement of interest has typically assessed affective interest. In this study a new interest scale, constituted by cognitive and affective items, was designed to measure students' interest in mathematics. Three research questions were addressed:

1. Could cognitive and affective mathematics interest components be reliably distinguished?
2. Would these components be similarly constituted across age groups?
3. What is their relative stability from one school year to the next, and how may gender differences be implicated?

Participants were students in grades 7-10 from three independent schools in metropolitan Sydney across two timepoints (separated by 12 months in consecutive school years N_{T1} = 1,213, N_{T2} = 928). Confirmatory factor analyses established four cognitive items and five affective items for the final Cognitive-Affective Mathematics Interest Scale (CAMIS), which demonstrated acceptable model fit (T_1: RMSEA = .074, SRMR = .026, TLI = .967, CFI = .976). High criterion-related validity with a general interest item was also successfully demonstrated. Cronbach's alphas were .838 for cognitive interest, and .918 for affective interest. Selecting the youngest and eldest groups, scalar measurement invariance held across grades 7 and 10 students. Scalar measurement invariance also held across the two time-points, facilitating the calculation of composite scores for cognitive interest and affective interest using factor score regression coefficients for each student. Given equivalent measurement properties across youngest/eldest groups and time-points, composite construct score comparisons could meaningfully address questions of gender difference and developmental change through repeated-measures ANOVAs. Differences in cognitive and affective interest among boys and girls were non-significant, with grade level effects requiring further investigation. The CAMIS highlights the need for educators to focus on both cognitive and affective factors when seeking to develop mathematics interest in students. The construct validity of the CAMIS facilitates the measurement of mathematics interest and future interest-based studies.

Keywords: mathematics; interest; measurement; quantitative; CFA.

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Reducing gender differences in motivational-affective student factors through interventions: A meta-analysis

Lesperance, K.; Holzberger, D.

Pre-recorded presentation: https://youtu.be/uQ3y3bEzgBw

Gender differences in educational outcomes has long been a topic of discussion among educational researchers, politicians and practitioners. Research shows that while patterns of gender gaps in performance outcomes have lessened over recent years, gender gaps still exist in motivational-affective student factors in subjects such as math, science or reading, where one gender is stereotypically disadvantaged. A common trend is that STEM subjects are seen as stereotypically "boy" subjects, whereas subjects such as reading or language arts are stereotypically "girl" subjects. As motivational-affective factors are themselves strongly linked to academic success, these differences between male and female students can consequently lead to differences in achievement. These gaps can also lead to differences later in life in track choice and career preference, which themselves can lead to discrepancies in the work force, for example, the well-known problem of female underrepresentation in STEM careers. Investigating strategies that could narrow this gap between students is a crucial step in lessening gender differences in educational contexts. Many studies have empirically tested school-based interventions that could promote and strengthen different motivational-affective factors in students, both for all students in general, as well as targeting the disadvantaged gender in a given context. However, these studies differ in regards to the interventional strategies and motivational-affective factors they address, and it is unclear which interventions are most promising in regards to gender-specific effects. This study aims to conduct a meta-analysis on intervention studies that target student motivational-affective factors, in order to assess whether these interventions have differential effects for the stereotypically disadvantaged gender (e.g., females in STEM and males in reading/writing) and stereotypically non-disadvantaged gender in a given academic domain. We plan to additionally evaluate potential moderator variables such as grade level, intervention duration, and intervention target, which might influence these effects. Results from a systematic database search resulted in 8,260 studies. We contacted authors of relevant studies as well as research networks and organizations in order to find unpublished studies or data. The theoretical and methodological characteristics of each study will be coded and effect sizes prepared for analyses. Meta-analytic methods will then be used to evaluate the gender-specific effects of these interventions studies, and any effects of moderator variables. This study will offer insight into which interventions are most promising for narrowing the gender gap in student motivational-affective factors, as well as directions for further research and evidence-based recommendations for practitioners.

Keywords: meta-analysis; motivation; emotion; interventions.

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Connecting mathematics with science contexts in junior secondary school: Impact on expectancy-values, teaching and learning of mathematics

Little, J.

Live recorded presentation: https://youtu.be/cUtWjdic9QU

This study investigated the impact of a secondary school intervention that made connections between mathematics/science through student projects on students' motivations and learning and teaching. Objectives were to i) identify emerging themes (qualitative) from students/teachers about teaching/learning mathematics through science contexts, and ii) explore the impact (quantitative) on key motivational constructs within Expectancy-Value Theory (EVT). This intervention was designed in response to declining numbers of secondary students choosing advanced mathematics courses. Eccles et al.'s (1983) EVT has shown that expectancies and values (intrinsic and utility) predict achievement-related choices including gendered career aspirations (Eccles, 2009; Watt, 2016). Making content connections between mathematics and science has been encouraged to enhance student engagement/values in mathematics (Honey, Pearson & Schweingruber, 2014). Mathematics and science at the participating Australian secondary school were taught by the same teacher in grade 7. For 3-4 weeks each term, connections were made between mathematics/science through student projects. Individual interviews were conducted with students (N=8; 4 girls) and teachers (N=7) after each project per term (Times 2-4). Students were selected on baseline achievement and intrinsic value in mathematics. Student/teacher questionnaires on EVT items were collected at baseline (Time 1) and after each project (Times 2-4). Final data will be collected December 2019. Initial repeated-measure MANOVAs highlighted main effects of time (increasing success-expectancies/intrinsic/utility values after each project) and gender (boys higher); non-significant interaction effects. Thematic analysis of student interviews identified: i) preference to learn mathematics (not science) through projects, ii) student perception that projects involved previously learnt mathematics/new science content, iii) improved communication/collaboration skills, iv) increase in girls' aspirations for STEM careers. All boys interviewed preferred learning mathematics traditionally/girls through projects. High-achieving mathematics students changed preference from traditional to PBL in

mathematics/PBL to traditional in science, throughout the intervention. Teacher themes: i) concern for mathematics rigor and learning in projects, ii) teachers' lack of mathematics content knowledge, iii) challenges in making authentic connections, and iv) need for scaffolding/explicit instruction. Making mathematical connections with science contexts can advance students' motivations in mathematics. Girls' lower perception of mathematics utility value is concerning given the strong influence on further participation in mathematics (Watt et al., 2012). Gendered perceptions about how best to learn mathematics and science influenced students' preference to learn in a traditional/cross-disciplinary environment. Emerging challenges and benefits in making contextual connections between mathematics and science add to emerging integrated STEM education research.

Keywords: motivations; mathematics; teaching; learning.

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The Adolescent STEM Anxiety Scale: Construction, validation, and gender differences
Mackenzie, E.; Berger, N.; Holmes, K.
Live recorded presentation: https://youtu.be/LNrzQDdy3W8

Student participation has been shifting from subjects such as calculus-based mathematics towards non-calculus-based mathematics, with similar shifts in the sciences and technologies. Declining participation in subjects is of concern given the projected importance of STEM knowledge and skills for the future workforce. Furthermore, gender differences continue to persist in some STEM subjects and careers, and research attention has focused on examining factors that are implicated in these gender differences. While a range of factors are implicated in students' choices to study STEM subjects, students' affective responses to these subjects is an important factor. There is evidence to suggest that student enjoyment or fear of a subject will influence their subject choices and for some students, fear of a subject can develop into subject-specific anxiety. There has been substantial research attention on anxiety towards mathematics, involving both cognitive and affective reactions to learning and performance in mathematics. Comparatively fewer studies have examined anxiety in other STEM subjects, notably science and technology. In an era of increasing curriculum integration across these subjects, we argue that a more nuanced understanding of students' underlying concerns about their abilities in one or more STEM subjects is required. In this study we designed a measure of domain-specific anxiety elicited by science (biology, chemistry, and physics), technology, and mathematics for use with secondary school students. An initial version of the Adolescent STEM Anxiety Scale was developed and piloted with NSW secondary school students in Years 7-10, and changes were made to minimise measurement error. In this paper, we report on the validation of the second version of the Adolescent STEM Anxiety Scale with a new cohort of

students from NSW secondary schools. Exploratory factor analyses were used to investigate factor structures, revealing five factors: mathematics anxiety (including learning and testing in mathematics), technology anxiety (including learning, testing, and manipulation of components in technology), science (biology, chemistry, and physics) testing anxiety, physics anxiety (including learning and completing practical work in physics), and biology/chemistry practical work anxiety. This structure was also investigated using confirmatory factor analysis with a different cohort of students. Gender differences in the various STEM anxiety factors were identified, and implications for practice and theory will be discussed. An understanding of STEM anxiety has the capacity to guide intervention efforts in improving participation in senior STEM subjects and improving student wellbeing more generally.

Keywords: STEM anxiety; scale development; adolescent; mathematics anxiety.

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Gendered perceptions of classroom emotional climate and attitudes in integrated STEM classes in government and non-government schools

McLure, F.I.; Fraser, B.J.; Koul, R.B.

Pre-recorded presentation: https://youtu.be/kq02rD3LHfY

The decline in enrolments, particularly of females, in STEM subjects in high school and university has been a matter for concern. In an attempt to improve students' understanding of STEM careers and the relevance of STEM in the 21st century, integrated STEM programs have been introduced into many schools. Because little is known about the classroom emotional environment (CEC) and gender differences in CEC in these integrated STEM classes, the present study drew on theoretical frameworks from the fields of learning environment, classroom emotional climate and gender differences to fill these gaps. Male and female perceptions of CEC and attitudes in integrated STEM classes were compared using an eight-scale CEC/attitudes questionnaire. Participants came from nine government-funded schools (20 classes, n=239) and six non-government schools (12 classes, n=155), all with mixed-gender classes whose students were completing integrated STEM projects. Questionnaire responses

were analysed based on gender and school type (government vs. non-government) using Rasch analysis, MANCOVA and effect sizes. Although there were significant gender differences in perceptions of clarity, motivation, consolidation and attitudes to STEM in government schools, gender differences were non-significant for all scales in non-government schools. Relative to girls in government schools, boys in government schools were more positive about their classroom emotional climate and attitudes to STEM. However, both girls and boys in government schools were significantly more positive about all aspects of classroom emotional climate and attitudes than girls and boys in non-government schools, even after controlling for socioeconomic status. However, examination of gender differences according to the nature of the integrated STEM activity (elective vs. non-elective) revealed a more- nuanced interpretation. In elective STEM classes, girls in government schools were more positive about CEC and attitudes than boys, but no gender differences existed in elective STEM classes in non-government schools. In non-elective classes where STEM projects form part of another subject (e.g. science or mathematics), females mostly were more negative than boys in both non-government and government schools, except for the scales of collaboration (in non-government schools) and control (in government schools), with females being more positive than males. Results of this study provide much-needed understanding of student experiences in integrated STEM classrooms. Investigation of student perceptions of types of projects could further improve understanding of ways to redress loss of females from the STEM pipeline.

Keywords: learning environments; emotional climate; attitudes to STEM; integrated STEM projects.

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Experiences of STEM outreach: What shapes girls' identities?

Prieto, E.; Sincock, K.; Blackmore, K.; Berretta, R.; Wanless, E.; Johnson, S.; Giacomini, A.; Todd, J.

Pre-recorded presentation: https://youtu.be/iGHrG5Gi1d4

This study explores the responses of High School girls to a STEM intervention program aimed at increasing interest and participation in STEM careers. Previous research has taught us that the development of a science identity is an important part of students achieving long-term engagement with STEM. Identity has been linked to both expectation of success and to the way individuals attribute value to particular tasks. With this mind and by combining the use of mentors, with hands-on, community-based problem-solving challenges, we aimed to contribute to girls' STEM identity and, as a consequence, improve their engagement with STEM. We conducted post-intervention group interviews with the objective of gaining insight into the intervention program participants' perceptions of STEM, and to determine whether our program had any effect on those perceptions. The program has run over three years – in 2017 with 27 participants, in 2018 with 69, and in 2019 reaching 9 schools and over 150 participants. After the intervention, we visited the participating schools, conducting 30 semi-structured interviews with groups of 3-6 girls that ran for approximately half an hour. Girls were asked questions regarding their opinions of STEM subjects in school, what they believe STEM is and how it can be applied, their career aspirations, the opportunities they believe women have in STEM, and what they thought of our program. Interviewers allowed the group conversations to digress if the topic was relevant and of interest to the girls. The interviews were recorded, transcribed and then analysed thematically. Our analysis highlighted a number of important themes. Before the program, many girls had experienced a 'buzz' moment of understanding in a maths or science class, but they reported a lack of clarity about what a STEM career might look like and their perception of science and technology being largely 'male' fields, discouraged them from pursuing STEM subjects. However, girls that engaged well with our program reported that they were excited by the opportunity to tackle a problem in their own community, work with mentors who they admired, learned practical techniques such as app building, and visit industry sites where they could see STEM 'in action'. Many of them enjoyed the sense of independent yet guided learning that our program provided. Incorporating these elements into STEM learning and providing opportunities for girls to see women working in real-life STEM roles emerge as key factors in encouraging girls to take up STEM careers.

Keywords: STEM outreach; high school Intervention; STEM career mentorship.

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Hanging by a thread: Precarious futures for early career women academics in STEM
Richardson, P.; Heffernan, A.; Westcott, S.; Watt, H.M.G.
Live recorded presentation: https://youtu.be/itRskO-YIos

Globally, we have seen the rise of “team science” replacing the lone scientist, an exponential growth in both publications and the number of PhDs awarded, without a rise in the number of available academic positions. There are now scientists who spend their whole academic career supporting others as lead authors without having led a publication themselves, impacting their ability to seek a tenured position. These individuals often feel obliged to work long hours, assuming this to be the only way to increase their productivity and competitiveness when applying for ongoing positions and/or research funding. Australian early career academics (ECAs; five years since their PhD) qualify and work in an increasingly competitive environment. Available positions are often limited term, with uncertain career prospects. For many women ECAs in STEM fields the future is precarious. They are often employed on ‘soft money’ from research grants in limited term postdoctoral appointments. This study focuses on seven women ECAs working in STEM (six employed on ‘research only’ contracts; one as a regular ‘teaching and research’ academic). They formed part of our larger study (N = 40) of ECAs working in a range of disciplines in Australian public universities, recruited via social media and a subsequent snowballing technique. Rich qualitative interviews explored women STEM ECAs’ career motivations, experiences, perceptions and expectancies. Transcribed

audio-recorded telephone interviews were analysed using thematic and comparative procedures. These ECAs were highly committed to academic work. They were passionate about researching their field (environment, behavioural ecology, public health, bioethics and psychology). An overarching theme was the desire to make a difference and to help others. While they embraced the flexibility and autonomy to decide work hours and time allocation, they found role expectations often unclear, and had difficulty creating boundaries between work and personal life. Participants reported academic work was "not a job you can leave at the office", and commonly involved workload pressure, overwork, stress, emotional exhaustion and unhealthy competition. Those who chose not to overwork expressed concern about their competitiveness in seeking employment and anxiety about the future. While most expressed satisfaction in terms of disciplinary research engagement, there was evidence of low employer/workplace commitment from those employed on grant-dependent funding. Their levels of anxiety concerning a predictable career path highlights the potential wastage of investment for these early career women scientists in universities, who are reliant on contributing to the careers of others as their own prospects dwindle.

Keywords: early career academics; career motivation; women; STEM; precarious employment.

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Gendering STEM digital. Potentials and challenges for promoting technoscientific literacy within STEM disciplines

Schmitz, S.

Pre-recorded presentation: https://youtu.be/HcPATj_5fL8

Within a joined project, my team at the Center for transdisciplinary Gender Studies of the Humboldt University Berlin has developed Open Educational Resources (OER) for STEM students and teachers, tailored to biology, chemistry, computer science, and physics. All OER share a common emphasis on gender in STEM, comprising learning units that are modularized and connected to each other, accessible under Creative Commons license via an online learning portal. The portal also includes cross-disciplinary learning units on gender in technoscientific literacy, on basic gender concepts, on issues of gender equity; and it offers a collection of statements from experts in STEM disciplines about gender research in their field. Gendering STEM digital builds on the concept of scientific literacy developed in the educational science and defines "the ability to engage with science-related issues, and with the ideas of science, as a reflective citizen" (OECD 2013). Technoscientific literacy, as a reflexive competence, should improve competencies to assess, reflect and debate science' knowledge production and technological developments, based on knowledge of their socio-cultural and intersectional embeddedness and their impacts on human lives. In cooperation with colleagues from biology, chemistry, computer science and physics, we proved the OER in blended learning and digital courses of their disciplines. STEM students embarked on subjects that are rarely part of STEM curricula with inverted classroom and self-learning didactics. The open access portal enabled students to work independently and according to their own timelines with our digitalized courses, enriched by animated white board videos, expert statements, podcasts, quizzes, and questions for self-reflection. In dialogue with chairs and teachers in the respective STEM fields, we collaboratively explored ways to deploy our OERs in their offline and online courses. We continuously evaluated the courses and further developed the OER according to the feedback of students and teachers. The portal primarily was developed in German language. With a presentation of some of it already translated and subtitled OER in English, I aim to engage in discussions over potentials and challenges of OER for promoting the inclusion of gender perspectives into STEM disciplines. We raised awareness and motivated STEM students to engage with gender aspects in their respected disciplines by picking them up from their own (stand)points, and with low-level entrance by starting from questions of gender within their respected disciplines. This necessary tailoring of our OER involved simplifications. We faced this challenge with videos on basic gender concepts and theories, that provided access for the students to move away from a mere deconstructive approach to gender binaries to complex bio-socio-cultural concepts of gendered norms, symbolism and societal power structures. And we enacted tools for individual and collective reflection on socially and culturally biased processes of knowledge production even within STEM fields. I aim to build on and extend conversations concerning OERs in Gender in STEM education and the question how Gender in STEM knowledge is transformed through digitization.

Keywords: Open Educational Resources; gender in STEM; technoscientific literacy; STEM students; STEM teachers.

Author biography:
Sigrid Schmitz, PhD in biology, for more than 30 years teaches Gender in STEM. She chaired the Competence Center for Gender in Natural and Computer Science [gin] (University of Freiburg), was Professor for Gender (University of Vienna), and chaired the project Gendering MINT digital (HU Berlin, 2017-2020). She researches on brain sciences, neurocultures and feminist epistemologies. She published On the use of innovation arguments for getting gender research into STEM (2018, Gender Studies and the New Academic Governance, ed. Heike Kahlert), and Collaborative Enactments in Teaching with Feminist Materialism (2015, Teaching with Feminist Materialisms, ed. Pat Treusch & Peta Hinton).
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'I'm good at science but I don't want to be a scientist': Australian primary school students' stereotypes of science and scientists

Scholes, L.; Stahl, G.; McDonald, S.
Live recorded presentation: https://youtu.be/xQNwqdlTxLM

Our research focuses on the complex relationship between stereotypes of science and scientists and, more specifically, what these stereotypes may mean for students' career aspirations at the end of primary school. How young people come to aspire is 'strongly inflected, shaped, and constrained by identities and inequalities of gender, social class, and 'race'/ethnicity'. For scholars focused on gender identity in schooling, it is often theorized as a performance, a 'process' toward understanding one's identity, individually and in relation to others' identities as a 'social practice' (Connell 2005). As students navigate, aspire and perform specific learner identities – in relation to subject areas such as science– their masculinities and femininities are an integral part of the how they navigate the process. We explore how Year 4 (9-10-year-olds) students perceive science, scientists, and a career in science. Data sources included 45 students (m=29; f=16) attending six primary schools in diverse contexts in South East Queensland, Australia. While the Draw-a-Scientist Test (DAST) has been widely used to understand student's perceptions of scientists we chose to use semi-structured interview methods to engage participants in exploratory discussions. To this end, the study investigates three interrelated research questions: How do students perceive science, scientists and a career in science? What do their rationales for their beliefs tell us? What role do stereotypes play in their perceptions? Interview responses were coded using a thematic template (Miles, Huberman and Saldana 2013). Categories were developed to describe students' justifications for pursuing a career in science, or not. Additionally, descriptors about what kind of work a scientist did and what a scientist might look like were established. Thirteen students aspired to a career in science, 6 students were unsure, and 25 students indicated no aspirations toward an occupation in the sciences. There were no significant differences regarding aspirations towards a science career based on location of schools. Categories and sub categories of student justifications for not pursuing a career in science included i) Stereotypical views of scientists (gender; paraphernalia), and, ii) Non-Aspirations (difficulties and pressure; science as physically dangerous). Outcomes provocate further research into tensions around the ways non-gendered

language was taken up by students who advocated that both males and female could be scientists, on the one hand, but then talked about the constraining factors around becoming a scientist associated with traditionally masculine traits such as danger, on the other hand.
Keywords: science identities; gender stereotypes; primary school; science career aspirations.

Author biographies:
A/Professor Scholes has a PhD in Education (University of Queensland), a Master's degree in Justice Studies from the Faculty of Law, and a Bachelor's Degree in Primary Education (Queensland University of Technology). She was awarded a Discovery Early Career Researcher Award (DECRA) from the Australian Research Council (2017-2020) where she is researching constructions of gender in schools and student experiences in the classroom. Her research has been published in a range of international journals, including Gender and Education, British Journal of Sociology of Education, and British Educational Research Journal. Current research interests relate to gender, student identities, and engagement. | laura.scholes@acu.edu.au

A/Professor Stahl has a PhD in Education (University of Cambridge), a Masters' degree in International Education (New York University) and a Bachelor's Degree in Secondary Education and English (Indiana University). He was a awarded a Discovery Early Career Researcher Award (DECRA) from the Australian Research Council (2017-2019) where he researched the relationship between extreme disadvantage, masculinities and widening participation. In 2019, he was ranked by The Australian newspaper as one of the top 40 researchers in Australia who were less than 10 years into their career. His research interests focus on the relationship between education and society, socio-cultural studies of education, student identities, equity/inequality, and social change. | garth.stahl@gmail.com

Ms. McDonald is a PhD candidate in the Education Futures at the University of South Australia. She has a Master's degree in Education Research (Flinders University), a Bachelor's Degree in Secondary Education (Flinders University) and a Bachelor's Degree in Humanities (University of Adelaide). Her doctoral research focuses on how the intersection between gender and class interacts with higher education, and how this interaction impacts upon the construction of feminine identities for young women transitioning into university. Her research interests are in gendered subjectivities, social mobility, social barriers, and inequalities in education. | sarah.mcdonald81@gmail.com

Examining the experiences of South Asian undergraduate women in STEM education
Shaukat, K.; Puvirajah, A.
Pre-recorded presentation: https://youtu.be/ZT7iibeKgOY

Despite the growing demand for a STEM (science, technology, engineering, mathematics) educated workforce, women, and more specifically minoritized women continue to be underrepresented in various STEM related fields. The underrepresentation is even more prevalent at more senior level and leadership oriented STEM positions. For cultural, historical, social, familial, and other reasons women, especially those of minoritized races continue to be geared away from STEM (Ong et al., 2011; Burger, 2012). While many studies have focused

on various aspects of representation of women in STEM, there is very limited research literature examining experiences of minoritized women of immigrant background in STEM. Additionally, current research about minoritized women in STEM does not account for the oftentimes unique cultural and societal factors that specifically focus on South Asian women. Using intersectional feminism and diasporic identities as lenses, our study examined, through narrative research, five female South Asian undergraduate students' personal experiences and perspectives on societal and cultural factors shaping their pursuit of a STEM degree. The study, which took place at a Canadian university, shed light on tensions and supports of such factors as family, culture, religion, and socialization for charting a course toward STEM studies and subsequently a career in STEM. Stories of the five students are presented through their answers from semi-structured interviews, and we made certain interpretations of the stories using our theoretical lenses. More specifically, we used intersectional feminism to deconstruct and discuss how gender along with race, class, ethnicity, and other single axis identities (Pande, 2018) influence our participants' lived experiences as a South Asian woman pursuing a STEM degree. Additionally, we shared our interpretations of how diasporic identities were constructed by our participants through their experiences. We also used both inductive and deductive approaches to draw thematic links between participant stories. The study is of scientific significance as it adds to the scant literature that exists within the area of South Asian immigrant women's intersectionalized experiences in STEM. Additionally, the study has applied significance in that student support and career/college counselling personnel and STEM and other educators at high schools, as well as post-secondary institutions, can be better informed to support STEM aspirations of (South Asian) immigrant women.

Keywords: south Asian women; undergraduate STEM education; intersectional feminism; diasporic identities.

Author biographies:

Kinza Shaukat is a third-year Master's student at the University of Western Ontario's Faculty of Education. She holds an Honours Bachelor of Arts degree in English and Philosophy from the University of Toronto. As a woman of South Asian descent herself, Kinza's current research interests focus on the intersectionalized experiences of South Asian female undergraduate students pursuing Science, Technology, Engineering and Mathematics. Her research explores how culture and society influence career-related decision-making for South Asian women. | kinza.shaukat@gmail.com

Anton Puvirajah, Ph.D., is an Assistant Professor of STEM Education at the University of Western Ontario in Canada. Anton's active and well-developed research and outreach programs in teacher education and STEM learning align with his interest in examining how teachers and science learners use Discourses to explore, negotiate, and develop their respective roles and identities within a community of practice. Within teacher education, his research focuses on using novice teachers' reflections of their practice to examine their professional identity development. With respect to STEM learning, Anton's research centers on studying the STEM experiences of minoritized and underserved youth in informal spaces.
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Generative leadership development in a peer mentoring program for undergraduate women in STEM

Sherwood, K.; Kelly, A.M.; Bugallo, M.

Pre-recorded presentation: https://youtu.be/VOmoanJ5X5U

The present study examines the experiences of undergraduate peer women STEM mentors and the development of their generative leadership, or the collegial ability to work within the constructs of a dynamic environment to encourage transformational change in individuals. This work builds upon previous theories in behavioral and intentional persistence by examining how mentoring creates a support network that facilitates a sense of belonging and encourages young women in STEM degree completion and career attainment. Support networks may increase behavioral persistence by facilitating self-efficacy, self-determination, and socialization, while intention persistence may be fostered through STEM identity and sustained commitment to their field of study. Leadership may be generative in its capacity to foster the next generation of young women to become future leaders through the reciprocal processes of advocacy and building competence. The participants in this study (N=13) were part of the Women in Science & Engineering Honors Program at a large research university in the Northeastern U.S. The young women, all STEM majors in their second or third year of college, served as peer mentors to first-year women, meeting with small groups each week in a structured program of academic support, network facilitation, and social integration. The mission of the WISE Honors Program was to promote academic excellence and career development, provide research opportunities, and to create a community that employed inclusive strategies and opportunities for outreach and collaboration. Mentors received two to three hours of training in the summer and ongoing support throughout the year. The exploratory qualitative research design employed an iterative coding process that utilized both provisional coding and aspects of grounded theory. Four major themes were identified in relation to behavioral and intentional persistence: 1) lack of encouragement in their fields, 2) fear of failure, 3) lack of parity and role models, and 4) developing a tolerance for ambiguity. In terms of intentional persistence, the transformational characteristics of good leadership were grouped into five themes: 1) the desire to give back to a community that had been supportive of the mentor's own goals, 2) the importance of communication, validation, and emotional intelligence, 3) STEM passion and its motivating effects on work, 4) the access mentors provide to resources, advice, and goal-setting, and 5) the openness of shared stories and confidence gained through experiential success and failure. Implications for the value of peer mentoring in fostering generative leadership will be discussed.

Keywords: intentional persistence; behavioral persistence; generative leadership; peer mentoring; undergraduate women.

Author biographies:

Kristin Sherwood is a Ph.D. Candidate in the Program in Science Education at Stony Brook University. She is a science teacher at Aquinas High School in Bronx, NY. Her research interests include leadership development of women in STEM.
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Angela M. Kelly is the Associate Director of the Institute for STEM Education and Associate Professor of Physics at SUNY, Stony Brook. Her joint roles include teaching and advising students in the Ph.D. Program in Science Education and teaching undergraduate physics. Prior to SUNY, Professor Kelly was a member of the faculty at Lehman College. She was awarded the Provost's Faculty Recognition Award for Excellence in Scholarship & Research from Lehman College in 2010, and the SUNY Chancellor's Award for Excellence in Teaching in 2016. | angela.kelly@stonybrook.edu

Mónica F. Bugallo is Professor of Electrical & Computer Engineering and Vice Provost for Faculty Affairs and Diversity, Equity, and Inclusion at Stony Brook University. She is also the Faculty Director of the Women in Science and Engineering (WISE) Honors and STEM Smart Programs. She is currently leading as PI on educational efforts for more than $2.5M funded by NSF and industry. She has received the SUNY Chancellor's Award in Excellence in Teaching in 2017 and the IEEE Athanasios Papoulis Award (2011), "for innovative educational outreach that has inspired high school students and college-level women to study engineering." | monica.bugallo@stonybrook.edu

Gender differences in work-family conflict and work-family enrichment for STEM researchers and engineers in Japan

Shinohara, S.; Fujimoto, T.

Pre-recorded presentation: https://youtu.be/bnY2GCzasJ0

This study aims to investigate gender differences in work-family conflict (WFC) and work-family enrichment (WFE) for STEM researchers and engineers in Japan. Individuals experience WFC when work and family roles interfere each other (Greenhaus & Beutell, 1985), while WFE results when experiences in work and family domains positively interact, and enhance the quality of one's overall life (Greenhaus & Powell, 2006). These two concepts are independent, meaning that it is possible for an individual to experience WFC and WFE simultaneously. Although WFC and WFE are considered bi-directional (i.e., "work to family" and "family to work"), we focus on family-to-work WFC and WFE to understand how roles in family domain influence experiences at work for STEM researchers and engineers. In Japan the proportion of women in academic research has been increasing gradually, but it remained 16.2% in 2018, and this was much lower than other industrialized nations. Notably, women's proportion is even smaller in STEM fields, such as 11.1% in engineering, and 14.6% in science (Statistics Bureau, Ministry of Internal Affairs and Communications, 2019). The notion of "leaky pipeline" (Blickenstaff, 2005) depicts women's tendency to leave STEM occupations as their career progresses, and the difficulty in balancing roles in work and family is considered a significant reason for this phenomenon. We used data that came from an online survey conducted in 2018 by the first author. Analytic sample for this research was 408 men and 169 women who attained their highest degrees in STEM fields, including occupations such as academic researcher, faculty at vocational schools, and R&D engineer in private sectors. We conducted a series of t-tests to examine whether there were significant differences between women and men in mean scores of four items measuring WFC and eight items measuring WFE. Results show that Japanese women in STEM fields experience significantly higher levels of WFC and WFE than their male counterparts. For example, women were more likely than men

to leave workplace without finishing work due to their family duties. Nevertheless, women indicated much higher likelihood of gaining knowledge and acquiring skills in family domains that are applicable to work. Our results indicate that women in STEM fields do experience both conflict and enrichment between roles in work and family domains. Future research needs to investigate whether and how experiences of WFC and WFE might impact women's likelihood of leaving STEM occupations.

Keywords: work-family conflict; work-family enrichment; STEM; researchers; engineers.

Author biographies:
Sayaka Shinohara received her Ph.D. in Sociology from Bowling Green State University, Ohio, U.S.A. Her research interests include women's career development and family formation. She is currently working on the positive interactions between experiences in non-work domains and work performance particularly among women in STEM fields in Japan. | sayakaks@gmail.com

Tetsushi Fujimoto is a professor of sociology at the Graduate School of Policy and Management, Doshisha University, Kyoto, Japan. His research interests include the intersection of gender, work, and family. He is currently investigating the non-linear patterns of career development for Japanese women holding advanced degrees in science and engineering. His article, co-authored by Sayaka Shinohara and Tsuyoshi Oohira, titled "Work-Family Conflict and Depression for Employed Husbands and Wives in Japan: Moderating Roles of Self and Spousal Role Involvement" received the 2015 Outstanding Author Contribution award in Contemporary Perspectives in Family Research from the Emerald Group Publishing. | tfujimot@mail.doshisha.ac.jp

Investigating gender differences in parent-child conversations about life and physical science topics

Shirefley, T.; Leaper, C.; Blood, T.; Cornell-Rath, K.; Gohari, D.; Upton, R.
Pre-recorded presentation: https://youtu.be/0HhEnaHoNwM

The gender gap in many science, technology, engineering, and math occupations has narrowed over the years—particularly in the life sciences. However, there remain large gender gaps in the physical sciences (NSF, 2018). Prior studies note that parental encouragement of science predicts children's later motivation (Simpkins et al., 2005). However, most of this prior work has focused on older children, despite evidence that differential encouragement of science by gender may begin in early childhood (Shirefley et al., 2020). Most prior studies have focused on mother-child interactions though prior work suggests fathers may be more likely than mothers to treat boys and girls differently in science contexts (Leaper, 2015). We coded the talk 96 Mother-child and father-child pairs from the same family used while reading two science books to their 4-7 year-old children (N_{girls} = 24, M_{age} = 5.4). For these analyses we focused on science learning talk. Science learning talk was coded when parents referenced the process of learning about science or holding knowledge about science. We conducted a Mixed Linear Model including parent gender (mothers vs. fathers), child gender (girls vs. boys), and book type (life science vs. physical science) as fixed variables and the proportion of parent

science learning talk as the dependent variable. We found a significant main effect of child gender $F(1, 46) = 10.4$, $p = .002$, which was superseded by two two-way interactions. The first two-way interaction was between child gender and parent gender, $F(1, 45) = 5.9$, $p = .019$. Posthoc tests revealed that mothers used on average a higher proportion of science learning talk with girls ($M = .073$) than with boys ($M = .041$), but there were no significant differences in fathers' science learning talk for boys and girls. The second two-way interaction was between child gender and book type, $F(1, 46) = 9.7$, $p = .003$. Posthoc tests revealed that parents used on average a higher proportion of science learning talk with girls ($M = .073$) than boys ($M = .042$) when reading the life science book, but no significant differences when reading the physical science book. Our findings provide evidence that parent-child conversations about science, may vary by the gender composition of the parent-child dyad and the type of science dyads are discussing. Counter to prior work (Crowley et al., 2001) we found that girls received more science talk focusing on the process of learning science and knowing scientific information than boys when discussing life science. Implications of our findings will be further discussed.

Keywords: parent-child interaction; science learning; book-reading; mothers and fathers; gender differences.

Author biographies:

Tess Shirefley is a Developmental Psychology graduate student working with Drs. Campbell Leaper and Maureen Callanan at the University of California, Santa Cruz. Her research interests focus around investigating gender differences in parental support of science learning and engagement for young preschool-age children. Tess is particularly interested in informal learning contexts, such as the home, where early messages of gender socialization and science learning may take place. | thaifley@ucsc.edu

Campbell Leaper is a Professor of Psychology at the University of California, Santa Cruz. For over 30 years, he has been investigating gender and sexism during childhood, adolescence, and adulthood. Many of his studies have examined how gender biases and discrimination are related to girls' and women's identities, motivation, and success in STEM. Other research interests include the study of peer relations as contexts for the development of gender (and other) identities; gender ideologies and close relationships; language and social interaction; and representations of gender in the media. He has also published several meta-analyses documenting moderators of average gender differences in behavior. Professor Leaper organizes and co-chairs the biennial Gender Development Research Conference (gender.ucsc.edu), which is held in San Francisco. | cam@ucsc.edu

Tessa Blood earned her Bachelor degrees in Intensive Psychology and Anthropology at the University of California, Santa Cruz. She is currently volunteering with several research projects in her free time while working full-time for a state-funded Housing Support Program in Humboldt County. She is interested in research on gender, race and intersectionality with a particular focus on how research in these areas can support effective and cyclical social programs and policy. University of California - Santa Cruz. | tblood@ucsc.edu

Kendra Cornell-Rath earned her Bachelor of Science degree in Psychology at California Polytechnic State University. Currently, she volunteers as a research assistant while working full time as a Practice Coordinator at Tufts Medical Center. Her research interests center on

parent-child relationships and their influences on body image and eating behaviors; focusing on the influence of parental attitudes and communication on eating behaviors and attitudes towards food and body image in children and young adults. University of California - Santa Cruz. | kcornellrath@gmail.com

Dena Gohari earned her Bachelor of Arts degree in intensive psychology from the University of California Santa Cruz. In addition to preparing graduate school applications, she is currently employed as an instructor at The Bay School, an institution that utilizes applied behavioral analysis to support behavioral and educational needs of nonverbal autistic youth. Dena's research interests range from neurodiversity, particularly autism spectrum disorder, to gender diversity, particularly the pathologization of nonlinear gender development. Dena aims to research the intersection between autism spectrum disorder and gender dysphoria. University of California - Santa Cruz. | dgohari@ucsc.edu

Rebecca Upton earned her Bachelor of Science degree in Psychology at California Polytechnic State University. She will be starting her first year as a Social Psychology graduate student working with Dr Joseph Vandello at the University of South Florida. Her research interests include gender stereotypes and prejudice and the effects of these issues on individuals and cognition. Specifically, she is interested in the role of masculinity and femininity in romantic and sexual relationships. University of California - Santa Cruz & University of South Florida. | rebecca.a.upton@gmail.com

Investigating gender variations in how European-American and Latinx parents talk about science with their preschool age children during a book-reading task

Shirefley, T.; Callanan, M.; Jipson, J.; Castaneda, C.

Pre-recorded presentation: https://youtu.be/i8lawZd3Wm4

Women's participation in the STEM workforce varies by discipline with significantly lower participation in some sciences (National Science Foundation, 2018). In prior research, European-American parents explained more to boys than girls during science tasks (Crowley et al., 2001; Tenenbaum & Leaper 2003). Growing research investigates Latinx parents' science talk with their children (Solis & Callanan, 2016; Tenenbaum & Callanan, 2008), however, few studies ask whether Latinx parents talk about science differently with preschool-aged boys and girls. Furthermore, little work considers how parent-child science conversations vary by context. To gain understanding of where STEM gender disparities may originate, we explored gender differences in the science talk European-American and Latinx parents used while reading a science-related book with their child, as well as gender differences in families' reports of everyday conversations about nature. We invited 38 European-American and 27 Latinx parents with 3-5-year-old (M = 55 months) children (32 girls) to read the children's book, The Sun is My Favorite Star. We conducted two separate 6 (Elaboration Type: Science, Fantasy, Personal Connections, Book talk, Describing, Labeling) x 2 (Gender of child: boy or girl) mixed ANCOVAs, with children's age in months and parents' years of schooling as covariates, and with repeated measures on elaboration type. Results for European-American families revealed an interaction between elaboration type and parents' years of schooling, $F(5, 170) = 3.144$, $p = .010$, $\eta^2 = .085$. Follow-up analyses revealed that parents with secondary-to-college schooling were more likely to talk about science to boys (M = .23) than to girls (M = .07), $p < .001$; whereas parents with post-graduate schooling did not differ in their elaborations

to boys and girls. For Latinx families there were no gender or schooling effects on the science talk used with children. 58 of these families subsequently kept a diary journal of the nature-related conversations they engaged in with their children over 2 weeks. When investigating the diary reports, we found no gender, schooling or age differences in the conversation topics reported by Latinx parents or European-American parents. Our findings suggest that early socialization of science may differ by background, including family ethnicity, child gender, and parents' schooling. Our book-reading task and diary report findings also support that early gender differences in science socialization may vary by context of families' engagement with science.

Keywords: book-reading; parent-child science conversations; cultural variability; parent schooling levels; gender differences.

Author biographies:

Tess Shirefley is a Developmental Psychology graduate student working with Drs Campbell Leaper and Maureen Callanan at the University of California, Santa Cruz. Her research interests focus around investigating gender differences in parental support of science learning and engagement for young preschool-age children. Tess is particularly interested in informal learning contexts, such as the home, where early messages of gender socialization and science learning may take place. | thaifley@ucsc.edu

Maureen Callanan is Professor of Psychology at the University of California, Santa Cruz. Her research focuses on young children's developing understanding of the natural world in the context of family conversations. Taking a sociocultural approach, she investigates language and cognitive development in young children, with particular attention to diversity across families and communities, as well as gender diversity. Callanan has a long-standing research partnership with Children's Discovery Museum of San Jose, where she has been PI or co-PI on several NSF-funded projects investigating children's and families' informal learning about science. | callanan@ucsc.edu

Jennfer Jipson: Children at the preschool age are naturally motivated to understand the world around them. In my research program, I explore young children's developing understandings within the domains of science, health, and technology. In addition to examining what children of different ages know about specific topics, I investigate how everyday interactions in informal settings (e.g., museums, zoos, virtual environments, preschools, parent-child conversations) contribute to children's learning. Finally, I am interested in exploring the extent to which these early experiences impact later engagement with, and proficiency in, scientific, technological and health-related activities. | jjipson@calpoly.edu

Claudia L. Castañeda is a Developmental Psychology Graduate student at the University of California, Santa Cruz. Claudia's research examines children's development and engagement in science during everyday activities with their families. A main goal of her work is to investigate how children, including those from Indigenous and Indigenous-heritage communities of México and the Americas, begin to make sense of environmental issues and practices. In her work, she uses an interdisciplinary approach to create a more inclusive

theoretical framework that allows for a better understanding about how and what children with different cultural values and experiences learn in family and community contexts.
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Investigating the influence of secondary student STEM experiences on subject choices and HE pathways
Skilling, K.
Pre-recorded presentations: https://youtu.be/sZZDED2y_yE

This presentation reports on a transdisciplinary STEM project in a UK secondary school where over 10 months, students (aged 15-18 years) designed and constructed several heavy weight robots which were tested in several 'real life' robot competitions. The projects, involved constructing electro-mechanical non-autonomous robots, requiring the students to contend with engineering processes learn new technical skills, to draw on their mathematical and scientific knowledge and engage in a collaborative project environment. The importance of integrated approaches to STEM learning and balancing STEM discipline knowledge is noted by English (2016) who advocates for the application of knowledge and skills through purposeful activities and experiences for improving student understandings. From a practical perspective, instructional practices for integrated STEM learning would benefit from alignment with theoretical framework that promote constructivist approaches to learning and the integration of subjects in ways that are meaningful and relevant (Hallström & Ankiewicz, 2019). A framework, advocated by Thibaut et al. (2018), underpinned by social constructivist theory integrates five guiding principles for framing an integrated STEM approach. The principles include: integration of STEM content; problem centred learning; inquiry based learning; design based learning; and cooperative learning. As these principles espouse the active construction of knowledge in social settings with a student-centred approach it was used as a framework for the STEM Robot study. With concerns about student participation in STEM learning and meeting future workplace demands for STEM related careers (NAO, 2018), the STEM Robot study aimed to investigate factors influencing the STEM beliefs and intentions of school students. With little known about the breadth of students' STEM beliefs and their experiences, in-depth interviews with 12 students explored students: 1) beliefs about STEM; 2) experiences of a collaborative STEM based project and; 3) how these experiences influenced future subject and HE study choices. In particular, the presentation focuses on four of the female students who designed and constructed the final robot and interview reports from the teacher (who oversaw the project facilitation) which reflected the active support of female team members and the particular attributes and skills they developed. Other findings, report overall student beliefs about: the emphasis on the STEM disciples and their shift throughout the phases of the robot building; reciprocal connections between STEM projects and academic STEM subject study; and commentary about cognitive processes and metacognitive thinking being deepened (e.g., cognitive processes aligned with systems thinking; visualising; learning from mistakes; and problem solving).

Keywords: student beliefs; engagement; project.

Author biography:
Dr. Karen Skilling is a Departmental Lecturer in mathematics education and Deputy Director of Doctoral Research at the Department of Education, University of Oxford. Her research interests include: student engagement and motivation in mathematics; teacher beliefs and practices for promoting student engagement; mathematics instruction across primary through to secondary years; integrated STEM learning, project based STEM activities; and vignette methods. Karen is also on the Editorial Board for Teaching Education Journal. | karen.skilling@education.ox.ac.uk

More than binary, more than normative, more than quantities: Diverse gender identities in computer science education research

Skorodinsky, M.A.

Pre-recorded presentation: https://youtu.be/k295hQ4CTmI

In the past several decades, a vast body of research has focused on addressing the gap in participation of women in computing. In computer science (CS) education interventions, this research is predominately focused on three trajectories of inquiry: how to fix girls so that they can fit into CS [1], how to make CS more girl-friendly, so that it can better accommodate girls [2], and how to expand the stereotypes about computer science/scientists in order to increase girls' sense of belongingness [3]. All three categories rely on comparisons between girls and boys, as in the case of determining what girls are interested in with respect to computer science that differs from boys [4], or how girls use technology as opposed to boys [5]. The theoretical underpinnings of such projects assume a static category of girls/boys from which to formulate research questions such as: how should computer science content be modified [6] so that more girls are engaged? This questioning relies on stable girl subjects who can speak for all girls, simultaneously establishing that there are stable boy subjects who are very different from girls, and who fit existing computer science. There is a dearth of research in CS education which acknowledges and investigates gender realities outside of the binary. This paper examines the ways in which current CS education research, which aims to address the participation gap for girls, essentializes girl/boy identities and leaves out the students who claim more than binary and more than normative identities. Employing recent findings from the field of psychology which refute the existence of strictly dichotomous female/male genders [7, 8, 9], recommendations for more nuanced gender categories [10], and accounts of trans/queer experiences in CS/tech [11, 12, 13, 14, 15], this literature review aims to examine the unintended consequences of research focused on girls/women in CS education, that is grounded in treating gender as a binary. The study illustrates how the categories of girls/boys, employed in such research, hail [16, 17] a narrowly defined gender identity, at the same time failing to acknowledge and support all others. The frequency with which measurements based on girls/boys categories occur in computer science education research raises the need for more textured analysis of students' lived gender [18, 19]. To this end, this study outlines significant questions that need to be addressed by the research community as we design and analyze interventions that aim to engage more students in CS.

Keywords: Computer Science education; interventions; transgender; non-binary; queer.

Author biography:
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Double identity threat vs. double identity boost: How gender and race stereotypes relate to STEM identity among a diverse sample of undergraduates
Starr, C.R.; Leaper, C.
Pre-recorded presentation: https://youtu.be/Hc5b3sq56Ic

Prior studies have found that women who associate math with men have lower identification with math, while men who associate math with men have higher identification (e.g., Nosek et al., 2011). In addition to gender, people may also associate STEM with racial categories, such as Asian and White. The combined effects of both associations may amplify disidentification with STEM for some groups (e.g., Latina women) while providing a buffer for other groups (e.g., Asian women). This study explored the relative contribution of both gender- and race-STEM implicit associations and explicit stereotypes on STEM identity. We also investigated whether exposure STEM people of your own ethnicity/gender in the media was related to stereotypes. Exposure to people of your own gender or ethnicity in the media might influence your implicit associations and stereotypes as well as your associations with yourself and STEM. Participants were a large and diverse group of undergraduates (N = 1,140, 67% women, 44% underrepresented minority [URM]). We used three different implicit associations tasks (IAT): self-STEM, gender-STEM, and an author created race-STEM IAT. A questionnaire asked about both gender and race explicit stereotypes, explicit STEM identity, and exposure to people in STEM of your race and gender in the media and interpersonally. As expected, we found that for women, implicitly associating STEM with men was negatively related to STEM identity (both implicit and explicit), but positively associated for men. Additionally, implicitly associating STEM with being for Asian/White people was negatively related to STEM identity among URM students, but positively related among non-URM students. As a result, Black/Latinx women experienced "double identity threat," while Asian/White men experienced a double identity boost. Meanwhile, Asian/White women and Black/Latinx men experienced threat but also (sometimes) a buffer. Results for explicit stereotypes were more inconsistent, and often no longer significant once implicit associations had been taken into account using regressions. Furthermore, experiences with people of your own gender and ethnicity in STEM was generally related to both implicit and explicit gender and race stereotypes. Finally, among women implicit self-STEM associations were negatively related to mostly seeing men in the media as a child and adult. This study provides preliminary evidence that implicit associations about STEM and ethnicity also contribute to student's STEM identity, in addition to gender associations. Additionally, gender and race implicit associations about STEM may be connected to representation in the media. Future directions and implications will be discussed.

Keywords: gender stereotypes; race stereotypes; implicit associations; STEM identity; media representation.

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Dr. Starr is a postdoctoral scholar at the University of California, Irvine. Christy's research publications explore barriers that girls, women, and students of color face in STEM (such as stereotypes and discrimination) as well as factors that can improve gender and ethnic representation in STEM (such as active learning practices in classrooms). Christy received her doctorate in Developmental Psychology at University of California, Santa Cruz (Advisor: Prof. Campbell Leaper). Currently Christy is working with Drs. Sandra Simpkins and Jacquelynne Eccles for a National Science Foundation-funded project about adolescent STEM motivation, intersectionality, and families. | cstarr1@uci.edu

Campbell Leaper is Distinguished Professor of Psychology at the University of California, Santa Cruz. For over 30 years, he has been investigating gender and sexism during childhood, adolescence, and adulthood. Many of his studies have examined how gender biases and discrimination are related to girls' and women's identities, motivation, and success in STEM. Other research interests include the study of peer relations as contexts for the development of gender (and other) identities; gender ideologies and close relationships; language and social interaction; and representations of gender in the media. He has also published several meta-analyses documenting moderators of average gender differences in behavior. Professor Leaper organizes and co-chairs the biennial Gender Development Research Conference (gender.ucsc.edu), which is held in San Francisco. | cam@ucsc.edu

Students discussing climate change
Steffensen, L.
Pre-recorded presentation: https://youtu.be/zanIgcsez5o

Climate change concerns gender in multiple ways; one involves unequal gender participation in decision-making, policy formulation, and implementation actions. United Nations (2019) identified a correlation between females in power on the one side, and lower carbon footprints and higher ratification of environmental treaties on the other side. In addition, attitudes differ across gender; women are more concerned and likely to act, while men focus on technological solutions. The study presented in this research addresses how students can engage in climate change discussions to facilitate critical citizenship. The context is CO2-emission and transportation. In Norway, approximately 50% of new cars are electric vehicles. This high share is caused by incentives, which have caused scientific and political debates on whether these are useful. This paper concerns students' discussions on electric vehicles and climate change with a particular focus on gender-perspectives in students' argumentation. The empirical study was carried out in a classroom in Norway, involving three mathematics and natural science teachers and their four classes of 15-16-year-old students. During one year, they organized 42 lessons such as an excursion, posters, an energy-exhibition, dialogue-games, and debates. Each lesson was video and audio-recorded. The data used here is from a lesson where the students discussed climate change in groups and classroom-debates. Three classes participated; 46 females and 34 males. The students worked in groups of 3–5, and a strategic

sampling of nine groups was done. The recordings were transcribed and thematically coded. One code concerned gender; here, the number of words and utterances were counted, and the content was analysed qualitatively. The gender-differences in the students' argumentations constituted mainly the number of utterances, but also the length of utterances. Moreover, in line with the findings from the UN (2019), the male's arguments tended to concern technological issues, while the female's arguments tended to involve actions on climate change. Both genders' utterances involved mathematical and scientific argumentation, everyday knowledge about society, and included values. The student's discussions with peers displayed a willingness to listen to each-others' argumentation, and they acknowledged different views. The findings suggest that gender-perspectives should be taken into consideration when students discuss climate change in school.

Keywords: student's argumentation; climate change; critical citizens; male and female utterances.

Author biography:
Lisa Steffensen is assistant professor at the Department of Language, Literature, Mathematics and Interpreting, at the Faculty of Education, Western Norway University of Applied Sciences. Her PhD involved a teaching and research partnership in lower-secondary school who included critical mathematics education and climate change in the mathematics classroom. Steffensen has a background as mathematics and natural science teacher in lower secondary school. Research interests concerns how mathematic education can contribute to developing students' critical competencies by working with socio-political topics in the mathematics classroom. | lste@hvl.no

Women's preparation for a mathematical STEM career: How do expectancies and values predict attainment of a mathematical STEM tertiary degree?

Toh, L.; Watt, H.M.G.

Live recorded presentation: https://youtu.be/Z4gF6mqGSck

Gendered participation in science, technology, engineering and mathematics (STEM) fields remains a pressing concern, for reasons of gender equity. Although women have made progress in entering certain fields of science such as the life sciences (LS), they remain severely underrepresented in the physical sciences, mathematics, engineering and technology (PMET). Mathematics has been identified as an underpinning discipline that filters entry into other fields, such as PMET. Mathematics motivations such as self-concept of ability (SCA) and subjective task values (STV) have been heavily studied within the secondary school setting. However, fewer studies have evaluated how these secondary school motivations are linked to the next phase of career development; undergraduate degree attainment. Drawing upon the Eccles et al. Situational Expectancy Value Theory, the current study made key contributions by first examining how secondary school mathematics motivations explain attainment of undergraduate qualifications in disaggregated STEM fields (PMET or LS) compared to non-STEM, using actual undergraduate degree attainment, over and above grade 9 mathematics achievement and perceived science talent. Secondly, the current study examined how these motivational processes may differ by gender. To examine undergraduate degree attainment as

a dependent variable, only data from retained participants of the Study of Transitions and Education Pathways study who reported attaining undergraduate degrees were analysed (N = 212, 53.3% women). Participants' ages at the time of follow-up ranged from 31-38 years (M = 32.77 years, SD = 1.06). The sample came from 376 participants retained in the STEPS Study at the follow-up online survey (2015-2019) approximately 20 years later than their latest secondary school timepoint (latest grades 9, 10, 11; 1995-1998). Of the Eccles and colleagues' expectancy-value theory constructs SCA and STV, only STV predicted attainment of a PMET, but not LS degree compared to non-STEM degrees. Key findings suggest that STV plays an important role in predicting future choices such as PMET degree attainment, for both boys and girls. To improve gender equity in PMET fields, greater effort should be taken to increase girls' mathematics STV in secondary school.

Keywords: gender; mathematics motivation; tertiary education.

Author biographies:
Lili Toh is a PhD candidate at The University of Sydney examining women who opt out of mathematical science, technology, engineering and mathematics (STEM) careers. With a background in psychology, she is interested in how psychological processes and social contexts influence career choices. Her PhD draws upon longitudinal data from the Study of Transitions and Education Pathways (STEPS) to look at high school career aspirations and entry into actual careers approximately 20 years later. | ltoh7188@uni.sydney.edu.au

Helen M. G. Watt, PhD, is initiator of the Network Gender & STEM, Professor of Educational Psychology at The University of Sydney, and Australian Research Council Future Fellow. She previously served at Monash, Michigan, Western Sydney, Sydney, and Macquarie Universities. Helen is a motivation researcher whose projects address: declining participation in advanced sciences and mathematics especially by girls (www.stepsstudy.org), and the engagement and wellbeing of beginning teachers (www.fitchoice.org), utilising long-term and large-scale survey data across comparative settings. She has published extensively on these topics, edited books and special issues, won research awards, extramural funding, and held leadership roles in AARE and AERA. | helen.watt@sydney.edu.au

Accessing mathematics through interest: Conceptualising mathematics tasks aligning with the four-phase model of interest development

Tuohilampi, L.

Live recorded presentation: https://youtu.be/-sOrkaKK300

Girls and women in particular suffer from low self-efficacy (OECD, 2014, p. 90) and anxiety (OECD, 2014, p. 100) regarding mathematics. The individual inconvenience ends up in severe consequences at the societal level, such as women avoiding STEM-related careers. That in turn causes a shortage of mathematically skilled graduates in the labour market (Martin, Anderson, Bobis, Way, & Vellar, 2012). The pattern touches even high-performing female students, as seen in a group of high achievers outside Australia (Metsämuuronen & Tuohilampi, 2017). In order to make mathematics more accessible to students (girls and also boys) who suffer from negative disposition towards mathematics, a movement called 'Maths for Humans' aims to

provide a solution. Maths for Humans produces easy-access activities that lower the threshold of participation by using the four-phase model of interest development by Hidi and Renninger (2006). There is some evidence that student engagement in mathematics can be reinforced through the concept of interest (Middleton, Jansen, & Goldin, 2016); i.e., through activities that would catch and hold student interest both momentarily and in the long run. The question then is: What kind of tasks actually allow (or may guarantee) interest development? The hypothesis is that some degree of everyday life connections are needed (e.g., Kalchman, 2011), but also a level of imagination and surprise (Arana, 2016) and a sense of importance (Watt, Shapka, Morris, Durik, Keating, & Eccles, 2012). The hypothesis is examined in a study ran through social media at the beginning of the year 2021, involving teachers around the English speaking world giving their opinions about what makes an interesting mathematics task. In the presentation, results gained so far will be presented, answering the research question: In teachers' opinion, what constitutes a mathematics task that catches and holds students' interest?

Keywords: interest development; engagement in mathematics; affect in mathematics; mathematics tasks.

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Dr. Laura Tuohilampi is a mathematics education researcher, an in-service teacher trainer and the founder of Math Hunger and Maths for Humans. Passionate about shifting mindsets to view maths as positive, engaging and achievable, her work explores practices that innovate and inspire traditional teaching methods to evolve with students' learning habits. She has been awarded the Leader of the Future Award for her work in making mathematics learning more inclusive. Her dissertation was awarded The Best Didactical Thesis of the Year Award in Finland in 2017. Her research focuses on affect, engagement and the social and contextual aspects of learning. | l.tuohilampi@unsw.edu.au

Disciplines and interdisciplinarity in a competence-based STEM curriculum
Tytler, R.; White, P.J.
Pre-recorded presentation: https://youtu.be/zypuAK2aUIE

Fast changing global futures raise questions about the role of schooling in preparing youth for productive lives and work futures. Governments are increasingly focusing on STEM R&D and Education as a condition for future wealth creation. As a result, there is pressure to move towards competence-based curricula, and within STEM, moves to emphasise authentic problem solving through cross-disciplinary project work. This presentation will critically examine the links between education in the disciplines, and interdisciplinarity, as advocated in global and national policy documents. We will argue that productive curricular pathways towards STEM domain competences must recognise the role of disciplinary thinking and working, but that they call for a rethinking of the way subjects are positioned. We offer a model of an interdisciplinary mathematics and science curriculum that preserves and enhances disciplinary integrity, and captures the imagination of students. We start with a review of 'STEM skills' that are advocated in competence based curricular prescriptions, drawing on the first author's work with OECD and UNESCO, and argue that STEM competences call for a revisioning of epistemic practices in the disciplinary subjects, and a revised pedagogy, more

fundamentally than interdisciplinarity. For this we draw on our previously published analyses of interdisciplinary practices. We then report, with examples, on a current ARC project that combines mathematics and science in theoretically informed ways. The IMS project (www.imslearning.org) is working across four primary schools, supporting teachers to implement an interdisciplinary, guided inquiry pedagogy across multiple topics. Case study classrooms are videoed to examine teaching and learning practice development. Case students are tracked longitudinally across 3 years. There is a focus on student representational invention, sharing and evaluating, refinement/revision, and coordination. Results show significant student engagement with learning, and science and mathematics achievement in advance of expectations. Examples will be given in the presentation. Students advance their mathematical competences in measurement, variation and data modeling, and mapping. Teachers are positive, but find the methodology challenging. For some teachers the project has changed their thinking about the nature of mathematical and scientific practices, and has resulted in ongoing practice. The research offers a model of STEM subject integration that a. leads to enhanced engagement and learning, b. situates subjects within interdisciplinary settings with integrity, and c. offers a pathway to re-imagining teaching and learning in mathematics and science.

Keywords: STEM skills; competence-based curriculum; mathematics education; science education; interdisciplinarity.

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Russell Tytler is Alfred Deakin Professor and Chair in Science Education at Deakin University, Melbourne. He has researched and written extensively on student learning and reasoning in science. His interest in the role of representation as a multimodal language for reasoning and learning in science extends to pedagogy and teacher and school change. He researches and writes on student engagement with science and mathematics, school-community partnerships, and STEM curriculum policy and practice. His current interest is in interdisciplinarity leading to critical and creative reasoning. He is widely published, and has been chief investigator on a range of Australian Research Council and other research projects. | tytler@deakin.edu.au

Peta White is a science and environmental education lecturer at Deakin University. Peta has worked in classrooms, as a curriculum consultant and manager, and as a teacher educator in several jurisdictions across Canada and Australia. Peta gained her PhD in Saskatchewan, Canada where she focussed on learning to live sustainably which became a platform from which to educate future teachers. Her passion for initial teacher educator, activist environmental education, and action-orientated methodologies drives her current teaching/research scholarship. Peta's current research interests follows three directions including science education, sustainability and environmental education, and collaborative/ activist research. | peta.white@deakin.edu.au

Belonging comparisons between STEM domains help understand high school girls' variability in STEM interest

Veldman, J.; Van Laar, C.; Thoman, D.; Van Soom, C.

Pre-recorded presentation: https://youtu.be/NVIBHIW3Euo

In trying to understand women's underrepresentation in STEM (Science, Technology, Engineering, Mathematics), most research to date focuses on one STEM domain or collapses across all of STEM. However, these domains differ vastly in terms of female representation: women are strongly underrepresented in technological and computer science university majors and to a lesser extent in mathematics and chemistry, while they are not as much underrepresented in biological science majors. Drawing upon Dimensional Comparison Theory, we argue that to understand this variability it is key to examine how girls in the process of making higher education choices compare different STEM domains to each other. Previous work suggests that educational decisions involve such intra-individual comparisons of achievement in different subjects. However, we know that anticipated belonging in a STEM domain plays a key role in interest in pursuing that domain. Therefore, we examined comparisons of anticipated belonging in different STEM domains. A sample of 343 high school girls in STEM-focused preparatory university tracks completed a survey on their anticipated belonging and interest in pursuing different STEM majors. Latent Profile Analyses resulted in 3 profiles, which showed different patterns of belonging comparisons across STEM domains. Examination of these belonging comparisons, both within a profile and across profiles, provided insight into what influences girls' interest in pursuing the different STEM careers. These findings indicate that belonging comparisons between STEM domains occur and can help understand variability in interest – pushing girls away from certain STEM domains and pulling them towards others.

Keywords: belonging; career interests; dimensional comparison; girls in STEM.

Author biographies:

Jenny Veldman is a PhD Candidate at the Center for Social and Cultural Psychology (University of Leuven, Belgium) and a Research Fellow at the Flanders Science Foundation. She is a social psychological researcher focusing on understanding the underrepresentation of particular social groups in work and education fields (e.g., women in engineering, ethnic minorities and low SES students at university). Her primary research examines how members of such minority groups actively cope with the challenges they face (e.g., to obtain a sense of belonging) rather than passively undergo these challenges, and how this maintains or challenges organizational inequalities. | jenny.veldman@kuleuven.be

Colette van Laar is Full Professor at the Center for Social & Cultural Psychology, University of Leuven. Her research examines social psychological factors and processes that transfer negative group stereotypes and prejudice into lower outcomes in education and work. She examines well-being, motivation and performance in women in a number of fields, including girls with regard to math, young Muslim women in education and the labor market, and women pursuing upward mobility and leadership positions in the police force, telecom, banking and other organizations in which they have traditionally been underrepresented. | colette.vanlaar@kuleuven.be

Dustin Thoman is a faculty member in the Department of Psychology at San Diego State University. His work focuses on the development of student interest, and the influence of stereotypes and social identities in shaping the development of students' educational and career interests. Through consulting and program development, he also works to improve educational programs, particularly those designed to broaden participation and promote diversity in science and math education, through theoretically and empirically-grounded approaches. | dthoman@sdsu.edu

Prof. Dr. Carolien Van Soom is head of the Tutorial Services and Educational Development & Innovation unit at the Faculty of Science. She is team leader of the LESEC Research Team on Study Career guidance of STEM students . Her research interest focuses on cognitive and non-cognitive predictors of academic achievement and drop-out, changes in motivation and academic self-concept during the first year of higher STEM education, and on gender and study choice. She developed and coordinates outreach events to raise interest of female adolescents in exact sciences. | carolien.vansoom@kuleuven.be

Using intersectionality-informed approaches to explore the experiences and perspectives of women graduate students and faculty in STEM

Villanueva, I.

Pre-recorded presentation: https://youtu.be/SV9Q379zaP8

Traditionally, most research studies that explore issues of inclusion in quantitative or mixed-methods ways tend to designate confounding covariates such as race, gender, age, etc. in an additive or aggregated way. This limits how intersectionality issues that may be at play on a given phenomena are interpreted. Intersectionality is not just limited to race and gender as it recognizes the presence of politics, culture, class, wealth, access, citizenship, and other societal and structural mechanisms that intertwine with an individual's identity. The purpose of this session is to present how intersectionality-informed approaches can change the way that scholars conceptualize, research, and analyze data when conducting STEM education research. This session will help audiences to identify issues of inclusion that could include intersectionality considerations, discuss intersectionality considerations in research designs, and provide examples from current research. The example studies provided will be discussed from the lens of multi-modal and intersectionality-informed approaches. Intersectionality-informed signifies the deliberate design, collection and analysis of participant data taking into consideration the tenets of intersectionality. Multi-modal methods, on the other hand, represents the multiple ways that data can be collected and analyzed to address the multiple and interactional realities of individuals.

Keywords: intersectionality; women; STEM.

Author biographies:

Dr. Villanueva has worked on several engineering education projects where she derives from her experiences in engineering to improve outcomes for minoritized groups in engineering using mixed-methods and multi-modal approaches. She currently is an Associate Professor of Engineering Education at the University of Florida. In 2019, she received the Presidential Early

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Understanding gendered transformative and self-defeating resistance resulting from situational hidden curriculum in engineering

Villanueva, I; Sellers, V.; Youmans, K.

Pre-recorded presentation: https://youtu.be/IQN0lRFPoF0

Hidden curriculum (HC) refers to the unwritten, unofficial, and often unintended assumptions, lessons, values, beliefs, attitudes, and perspectives that are not openly acknowledged in a given environment. Previous research has identified four factors that regulate an individual's response to HC: awareness, emotions, self-efficacy, and self-advocacy. Self-efficacy traditionally positions the individual as the originator of change. We acknowledge that self-efficacy is also socially constructed, which involves having access to the ideological, institutional, and social resources that provide the foundation needed for an individual to take an action. We operationalize self-efficacy as an individual's perceived ability to resist HC in engineering. As part of a larger study, we performed inductive analysis with the open-ended responses of women and non-binary persons (n=155) in engineering who become aware of HC and conceptualized and communicated strategies for their self-preservation and adaptation in the field. We applied descriptive and in-vivo coding on women and non-binary persons' responses to determine the strategies they used to resist HC in engineering. We grouped 65 self-efficacy strategies into 10 categories. By categorizing the participants' strategies, we distinguished how women and non-binary individuals approached the HC they encountered. Overall, participants displayed varying levels of self-efficacy by taking inward measures of resistance, (internal transformational resistance) like developing mental resistance and self-assurance, and displaying outward measures (external transformational resistance), such as proving others wrong or speaking directly to a peer about an issue. Some women and non-binary persons engaged in self-defeating resistance, like avoiding or not knowing how to mitigate HC. We want to highlight categories of outward strategies for this work, which include: 1) mediating, 2) seeking help or resources, 3) addressing issues directly, or 4) looking for/increasing representation for women in engineering. We determined that women from both majority and minoritized groups used internal transformational resistance strategies more than external transformational resistance strategies, likely because external strategies require women to have greater self-efficacy. Women and non-binary persons who employ external strategies provide positive social persuasions and vicarious experiences for themselves and other women, even though they may risk negative consequences. While women and non-binary persons need slightly less self-efficacy to use internal strategies, they place the onus on themselves to adapt to HC communicated to them by other individuals and systems. Thus, women and non-binary persons may be exposing themselves to frustration, anger, and burnout as they navigate the chilly and unwelcoming environment of their engineering education instigated by HC.

Keywords: hidden curriculum; resistance; women; gender.

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Dr. Victoria Sellers has dual B.S. degrees in Geology and Environmental Health from East Carolina University, and a M.S. in Hydrogeology and Ph.D. in Engineering and Science Education from Clemson University. Dr. Sellers' dissertation work focused on comparing affective responses to classroom, outdoor, and virtual reality geology field experiences. Dr. Sellers has been an editorial assistant for the Journal of Women and Minorities in Science and Engineering and has served as a communication intern for the Journal of Engineering Education. Dr. Sellers is a postdoctoral associate in engineering education at the University of Florida researching hidden curriculum in engineering. | vsellers@ufl.edu

Dr. Kate Youmans serves as the Director of the Multidisciplinary Design Program in the Whiting School of Engineering at Johns Hopkins University. She brings a broad perspective to her work, drawing from her experience in the medical device industry, leading diversity and outreach initiatives for MIT's Office of Engineering Outreach, and development of innovative K-12 STEM programs in Robotics, Design Thinking, and Computer Science. Prior to joining the faculty, Kate earned her Ph.D. in Engineering Education at Utah State University with a focus on improving student success in engineering. | kyoumans@jhu.edu

100 jobs of the future
White, P.J.; Tytler, R.
Pre-recorded presentation: https://youtu.be/bd0MfeqKIic

The world of work is changing dramatically and so too must our education strategies. In the future, through major societal trends such as Industry 4.0 (AI, big data, robotics and automation, scientific discoveries), climate change and resource availability, and population changes, students can expect a very different future in terms of life and work than current education approaches prepare them for. Loss of jobs to automation, and the power of digital processes that enter all aspects of our lives, have reduced the value of routine work and skills compared to creative and critical thinking, interpersonal skills, and digital literacies. Our research aim has been to interrogate the work futures through the predictive construction of '100 jobs of the future', that go beyond generalities of trends and skills, and offer a grounded, but complex and imaginative projection of future work. We developed a 'future job quiz' aimed at youth, to assist them in aligning their interests and skills with jobs that do not yet exist. After a comprehensive review of the futures literature we identified key domains, such as agriculture, health and games, that would feature significantly in future work trends, and used these to identify 11 experts familiar with cutting edge developments in their fields of expertise. We interviewed each expert, asking them to identify trends and areas of growth, specific jobs that may be created, and the skills that such jobs would demand. We then synthesised the interview

data to a) identify the major drivers of change in these disciplinary areas; b) scope and develop a sample of 100 future jobs that captured the breadth of future trends, skills and work patterns; and c) analysed each job in terms of the skills required. Some of the jobs are variations of those that already exist, but with more technology enablement. Unsurprisingly, we found that jobs across all these categories are influenced by the major drivers of change: technological advances, climate change, data democratisation, globalization, population pressures and changed demographic profiles. We identified three major skill clusters; cross-disciplinary skills/disciplinary depth/creative orientation; interpersonal skills; and flexibility/adaptability. The research attracted significant media interest, and has the capacity to influence thinking about STEM Education aims. In the presentation we link the findings and our experience with current international calls for competence-based curricula, and general capabilities.

Keywords: future of work; careers; skill development; STEM skills; competence-based curriculum.

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Peta White is a science and environmental education lecturer at Deakin University. Peta has worked in classrooms, as a curriculum consultant and manager, and as a teacher educator in several jurisdictions across Canada and Australia. Peta gained her PhD in Saskatchewan, Canada where she focussed on learning to live sustainably which became a platform from which to educate future teachers. Her passion for initial teacher educator, activist environmental education, and action-orientated methodologies drives her current teaching/research scholarship. Peta's current research interests follows three directions including science education, sustainability and environmental education, and collaborative/activist research. | peta.white@deakin.edu.au

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Feeling-thinking-making gendered and raced school spaces (The Materials Engineering classroom and basketball court)
Wolfe, M. J.
Pre-recorded presentation: https://youtu.be/Sa8rFhLNm2s

This paper considers the power of affective relations at school and argues that relations make gendered (and raced) spaces of school, resulting in inequity. Reductive historic figurations of the ideal scholar as a white cis-gender male heterosexual body reiterate and create negative relations of belonging for girls that need attention. Negative classroom relations act as a noiseless barrier for diverse participation in traditionally male-dominated STEM subjects and

activities. I present segments of two filmed intraviews with high-performing Year 10 female students who attend a selective Australian, science-focused, secondary school. These accounts are interrogated in order to speculate how female students may affectively come to belong or not belong within spaces at school. I focus on Jasmine's account of the male dominated Materials Engineering classroom to illustrate how female students may noiselessly emerge as not belonging with the becoming-male spaces of school. I speculate on how the schoolgirl figure, under the terms of her own affective subjectification and her desire to belong, may incite a performance of avoidance that is an erasure of potentiality in the STEM field. In this paper the focus is on female orientation, as affections of non-belonging within STEM subjects. The creative empirical research, conducted over three years, consisted of an online survey (130 students), filmed interviews (13 students) and two focus groups (11 students) and an exit survey (59 students). Data discussed emerged through a mixture of visual and linguistic qualitative methods. Karen Barad's (2007) concept of intra-action is put to work to illustrate how matter comes to matter two-fold. The differing mobilities at school of students are created through cartographic tracing (Braidotti 2019). These traces demonstrate that the school site is an assumed fair and just space where students are often blind-sided to systemic sexist and misogynistic forces, structures, and practices– and find it difficult to resolve their own deep belief in equity and autonomy with the material discomfort (fear and anxiety) felt. This paper draws links between everyday pedagogical encounters, as affective processes of belonging in the making. Experiences on the basketball court and engineering classroom are examined to make an argument of how these everyday experiences reduce capacity for female identified students in the male dominated STEM classroom. I speculate on how implementing positive feminist critique in classrooms with students may enable increased capacity for girls to participate in STEM spaces.

Keywords: affect; intra-action; STEM subject participation; schoolgirls; belonging.

Author biographies:

Dr. Melissa Wolfe works at Monash University as a Senior Lecturer in Visual Art, Media education and Creative Methodologies. She was awarded International Visual Sociology Association Prosser ECR award (2016) and the Australian Association for Research in Education ECR Award (2016). Her PhD entitled *Girls' Tales: Experiences of schooling* was awarded the Mollie Holman award for best education thesis (2016), Monash University, and a commendation award from the Australian Association of Educational Research (2017). Melissa's educational research in high schools utilizes a creative filmic research methodology that takes account of gender, socio-economic categorization and public pedagogical practice. She pragmatically thinks with Karen Barad's (2007) theory of agential realism as a conceptual framework. Her filmic research and publications are available on her academic website https://www.affectionsthatmatter.com.au | melissa.wolfe@monash.edu

Dr. Wolfe's 2021 Book Discount Flyer available here: www.routledge.com/9780367364069

The impact of parents' education level, attitude and self-efficacy on young boys' and young girls' STEM learning

Wong, M.; Chan, B.

Pre-recorded presentation: https://youtu.be/8pdCfaAuN3E

Gender difference in STEM field existed and persisted at both secondary and tertiary education level over centuries, with a large record showing a greater percentages of men than women studying and working in STEM area (e.g. Liben & Coyle, 2014). Gender stereotype which came from social values and/or expectations (i.e. males outperform females in STEM-related area whereas females outperform males in language and arts) is claimed to be one of the stable factors (e.g. Allison et al., 2017; Doyle & Voyer, 2016; Iskander et al., 2013; Kohlhaas et al., 2010; Marchand & Taasoobshirazi, 2013; Neuburger et al., 2015) of the gender gap. In more recent years, the gender gap in STEM is also seen among young children. Both Penner and Paret (2008), and Curran and Kellogg (2016) reported a substantial gender difference in mathematics performance with an insignificant boy advantage at kindergarten, and such advantage progress to a significant one at upper primary level. Penner and Paret (2008) even reported that the gender gap was wider among children from highly educated parents. Despite social value, parents are playing an influential role in students' career choice e.g. Eccles (2009), academic achievement (e.g. Lynch, 2002; Perera, 2014; Sun et al., 2012), and aspirations and interest (e.g. Mihelich et al., 2016; Sáinz & Müller, 2018). This influential effect is believed to be stronger for younger children. Yet, STEM in early childhood is still an understudied area and more evidence is needed in order to draw a valid claim. This current study will be an exploratory study with objectives to a) understand the level of STEM attitude and self-efficacy among kindergarten parents in Hong Kong, and b) investigate if parents have different STEM-expectations toward young boys and young girls. A set of parent questionnaire was developed based on literature to capture 1) SES background, 2) parents' attitude towards STEM in early childhood, 3) parents' self-efficacy, and 4) children's experience with STEM. The questionnaire will be administered to about 360 kindergarten parents who come from various schools in different SES areas. Correlational analysis and regressions are planned to be conducted in order to identify the relationship between the above factors. The questionnaire has just been administered by the time of submission, and preliminary results will be presented in the conference. One of the research significances is to contribute more evidence and understanding about STEM and gender in early childhood education into the literature.

Keywords: early childhood STEM; parents STEM attitude; parents STEM efficacy; gender difference.

Author biographies:

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Dr. Brad Chan is an assistant professor at Yew Chung College of Early Childhood Education in Hong Kong. He leads a large-scale project that promotes STEM education in Early Childhood Education. One of the key objectives of the project is to narrow the learning gaps among children with different socioeconomic and cultural backgrounds. Brad is interested in research related to STEM and language development in early childhood. He is specialised in intervention studies using randomised controlled trial design and quantitative methods. | brad.chan@yccece.edu.hk

Championing women working in health across regional and rural Australia – A new dual-mentorship model

Wozniak, T.M.; Miller, E.; Williams, K.; Pickering, A.

Live recorded presentation: https://youtu.be/uxtRigh0G-0

Mentoring is a critical component of career development and job satisfaction leading to a healthier workforce and more productive outputs. However, there are limited data on mentorship models in regional areas and in particular for women aspiring to leadership positions. Mentorship programs that leverage off experienced mentors from diverse disciplines have the potential to foster the transfer of knowledge and to positively influence job satisfaction and build capacity within the context of workforce shortage. This study describes a dual-mentorship model of professional development for women working in health in regional and rural Australia. We present the framework and describe the evaluation findings from a 12-month pilot program. Both academic and corporate mentors provided diverse perspectives to the mentees during the 12-month period. On average, corporate mentors met with mentees more often, and focused these discussions on strategy and leadership skills whilst academic mentors provided more technical advice regarding academic growth. Mentees reported an improvement in workplace interconnectedness and confidence at the completion of the program. We developed a framework for establishing a professional mentorship program that matches women working in regional health with mentors from diverse sectors including business, government, philanthropy and health, to provide a holistic approach to improving career satisfaction, institutional productivity and supporting a diverse workforce in regional or resource-poor settings.

Keywords: mentorship; resource-poor setting; regional Australia; health.

Author biographies:

Teresa Wozniak is enthusiastic about diversity of thought and building interdisciplinary professional networks. She leads a group at the Menzies School of Health Research, that aims to identify innovative tools to combat antimicrobial resistance. Alongside, her research, is passionate about supporting female scientist and founded the Women in Tropical Health, network. In 2018, she launched the first of its kind mentoring program - Catalyse mentorship that matches women working in regional areas with mentors from business and health. She is a role model, and the 2019-2021 Superstar of STEM, directly encouraging young women and girls to pursue a scientific career | teresa.wozniak@menzies.edu.au

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Facets of social and academic integration among male and female first year STEM students and prospective STEM teachers

Zander, L.; Niemann, T.

Pre-recorded presentation: https://youtu.be/mMfxrFqQKX8

When transitioning into academia, first year students face a number of academic and social challenges. As they navigate this new social microcosm, students' experiences can be profoundly shaped by their belonging to social categories. Numerous studies have documented a gendered hierarchy in STEM domains with female students facing negative competence stereotype. Another recent study (Ihme & Möller, 2015) points to the existence of yet another competence related social category: students' major. Prospective STEM teachers are expected to perform less well than fellow students who exclusively focus on one STEM subject. To better understand how these competence-related status dynamics unfold, we explored several constructs tapping into first year students' social and academic experiences: Discrimination (e.g., being subject of jokes), social and academic validation (e.g., being liked vs. being perceived as competent by fellow students), social and academic exclusion (e.g., feeling and observing that one is not part of fellow students' private vs. academic exchanges), and belonging uncertainty (e.g., questioning one's belonging to the study program). 282 Math, Chemistry, and Physics students participated in our survey at the beginning of their first semester. In our analyses, we examined the different aspects of social and academic integration as they differed for students' belonging to the two social categories gender (male vs. female) and major (STEM major vs. prospective STEM teacher). We further included the gender x major interaction term. Our analyses exposed an interesting pattern: In comparison to STEM majors, prospective STEM teachers felt like they were more generally discriminated against and less academically validated by their peers – irrespective of their gender. In contrast, STEM majors felt significantly less socially validated by their peers than prospective STEM teachers, again, regardless of their gender. On the other hand, female students reported significantly

higher belonging uncertainty when encountering difficulties than their male peers – irrespective of their major. Male students, in turn, reported significant higher levels of social and academic exclusion from peer exchanges than female students, regardless of their major. Taken together, our results underscore the relevance of social categories as they play out in the social and academic experiences of first year students. Our findings suggest that belongingness to different categories comes with distinct challenges revolving around two main themes: their competence-related fit within the new academic environment and their social validation and exclusion by fellow students. Implications for university educators, such as the design of target-specific activities in orientation weeks are discussed.

Keywords: prospective STEM teachers; gender; social and academic exclusion; social and academic validation; belonging.

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Theresa Niemann studied Teaching and Empirical Educational Research at the University of Kassel. Currently, she is a predoctoral researcher at Leibniz University Hannover. In her research, she is interested in social and academic integration and their influence on university students' learning and motivation. In the focus of her analyses are different student groups (e.g. gender, major) and the particular educational challenges and opportunities they face in their academic environment. | theresa.niemann@iew.uni-hannover.de

Lysann Zander is full professor of Empirical Educational Research at Leibniz University Hannover, Germany. She studied psychology at Humboldt University in Berlin, the University of California, Santa Barbara and Cal State Northridge. In her research, she seeks to uncover the mechanisms underlying the sometimes astounding congruence of students' self-perceptions and the social networks they establish within their learning environments, particularly when it comes to academic domains for which there are strong gender or ethnic stereotypes. She has been further involved in several projects developing interventions with the aim of fostering equal status peer interactions among students from different social groups. | lysann.zander@iew.uni-hannover.de

Parents and their essential role as gatekeepers in STEM
Zauchner, S.A.
Pre-recorded presentation: https://youtu.be/iZESqLQfHBg

The reason for the gender imbalance in STEM is a multifactorial process that is first and foremost produced by gender stereotypes. These have been researched with regard to attitudes, motivation, attributions, assessment of individual abilities or achievements. Also, a lack of role models, knowledge about STEM education and professions, and women´s media representation add to this imbalance. Parents are regarded to be the most essential gatekeepers for STEM because parental values establish the importance young people give to STEM and parents can motivate their children and influence interests at a very early stage. Though parents are often not aware of their essential role and frequently do not have the required knowledge to support their children, STEM initiatives hardly ever focus on them. This is where the "E-MINT" project comes in, developing an app that allows parents to play their role as coaches

for their children - especially girls - to get them excited about STEM education and careers. Besides the theories of (de)construction the project is theoretically framed by the recently developed Science Capital approach, which translates Bourdieu's cultural theory for the demands of science learning in the 21st century. A participatory research design was used - the needs analysis included semi-structured interviews with six STEM experts (5 female/1 male). Furthermore, four focus groups with in total 21 parents (12 female/10male) were held in three different regions of Austria. The results show that the science capital framework has proven to be a good way to address such a broad topic as STEM in a structured way. Everyday life in this approach is compared to a game where each person has different, transformable potentials which can be used and can interact with each other. We were not only able to map the multiple factors derived from the literature, the expert interviews and the focus groups in the development of the app but also in their exchange potential. The first evaluation results confirm that the reciprocity of the science capital areas (knowledge, attitudes, doing, and networking) makes much sense, when it comes to empowering parents in their role of their children's gatekeepers to STEM.

Keywords: gender; STEM; parents; science capital; (de)construction.

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POSTERS

1. Germany's continuing problem of record low numbers of women working in STEM. A comparison of women's STEM participation numbers from 1999 and 2018

Booth, E.; Mammes, I.

Pre-recorded presentation: https://youtu.be/cnsV3lkcVUs

The German labour market experiences a lack of skilled labour in the fields of science, technology, engineering, and mathematics (STEM). This issue raises questions regarding the number of women working in STEM. Both in the practical field, as well as in science and politics, the fact that more women must be attracted to choose STEM occupations is widely agreed upon. This stems not only from the wish to reduce the skill shortage, but also to achieve a more gender equal distribution of employees and improve the situation of women. 20 years ago, an analysis of data of women in vocational training, study courses, and occupations found a considerable gap between the percentage of men and women working in STEM. In Germany, several organisations, as well as the state, have been launching numerous initiatives aiming at attracting more girls and women to choose STEM occupations for multiple decades now. After more than twenty years, a reanalysis of the number of women in STEM seems overdue to revise the statistics and compare them to those analysed in 2000. The pivotal question is if emancipatory and political efforts are leading to an increased percentage of women working in the STEM-field. Therefore, this paper aims at offering a new overview of the numbers of women working and studying in STEM and comparing findings to those from 20 years ago. The German Federal Statistical Office and Census Bureau provide data for the analysis. Based on these data, the first step is to analyse current data, providing a summary of the numbers of women in vocational training, studies, and occupations in several STEM subjects and occupations. Subsequently, the newly acquired analysis is contrasted with earlier numbers. Results show that the overall share of women in STEM occupations today is still alarmingly low with 15.4 %. The number is even lower for women choosing vocational occupations in STEM with 11.4 %.; while the percentage of women studying in STEM is 29.3 %. Overall, the change expected to occur within the last twenty years is not apparent. These results are of relevance for further scientific research and highlight the significance for revised applied action when it comes to attracting more women to STEM. Also, an understanding of the underlying issues that still lead many women to avoid STEM and how to tackle those issues may be acquired as a follow-up of this analysis.

Keywords: developments in STEM; women's and men's participation in STEM; women in STEM; STEM labour market Germany; STEM labour market data

Author biographies:

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2. The BioCORE Scholars Program, a cohort model, improves academic attainment of female minority students in Biology

Brezynski, E.M.V.; Long, E.S.; Allen, M.J.; Wood, D.W.

Pre-recorded presentation: https://youtu.be/ygMU1Lws8CQ

Although women's representation in biological and medical careers has improved, women of color (especially Black, Latinx, American Indians and Pacific Islanders) are disproportionately underrepresented. Seattle Pacific University (SPU) has an algorithm, the Biology Placement Level (BPL), applied blind to all students at entry to university. It uses high school GPA and SAT scores to predict final BIOGPA. BPL2-coded students are predicted to struggle, while BPL3-coded students are predicted to succeed. Students of color, however, are overrepresented in the BPL2 category, while White students are overrepresented in the BPL3 category. Our intervention: In 2015 we created the BioCORE Scholars program. Ten to fifteen minority students are recruited annually via an online application form. Preference is given to BPL2 students of color and first-generation college students. The majority of scholars recruited are female (data analyzed is from a scholars group that is 93% female). Freshmen scholars form a cohort community that takes the same General Biology classes, attends weekly study workshops run by a near-peer minority learning assistant, has a minority peer mentor, participates in a residential week of hands-on summer lab research working directly with faculty, attends quarterly speaker meetings with scientists of color and takes part in a freshman-sophomore retreat. In addition, BioCORE students receive a scholarship of $1000, paid on completion of program requirements. As upperclassmen, scholars gain leadership experience by training to be a learning assistant or peer mentor. Results: Data from students who completed all three quarters of the General Biology sequence were analyzed using ANCOVA with pairwise Sidak-corrected post-hoc analyses. Comparing marginal mean difference in BIOGPA, relative to predicted BIOGPA, BPL2 BioCORE scholars (n=38) had significantly greater improvements than BPL2 non-scholars (n=89) and BPL3 non-scholars (n=177): ($p \leq 0.004$). When comparing marginal mean difference in BIOGPA, relative to predicted BIOGPA, for Non-scholar White Students (N=139), Non-scholar students of color (N=127), and BioCORE scholars (N=43), scholars demonstrated significantly greater gains than the two groups of non-scholars ($p<0.001$). The Non-scholar groups were not significantly different from each other ($p=0.380$). Scholars demonstrated >0.50 grade point improvement over predicted GPA compared to Non-scholars. The College of Arts and Sciences plans to extend this pilot program to other STEM departments. Study cohorts, peer mentors, participation in research, and community role models are readily translated in this environment at relatively low cost. This investment fosters a strong sense of belonging and enhances academic and leadership outcomes for female students of color.

Keywords: women; STEM; underrepresented; equity; learning assistant

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3. COVID-19 resilience: Agility & adaptation of gender equity programs to broaden reach
Cheng, E; Bautista, L; Angelini, M.; Giugni, A; Katuwandeniya, K.
Poster: https://youtu.be/OV7sd7YdvGg
Live poster presentation: https://youtu.be/USbQiKj-H_g

In 2020, COVID-19 posed unique challenges to our Women in Engineering and IT unit (University of Technology Sydney) across our people-centred programs. This paper shares our learnings from rapid iterative adaptation to online programs, and the opportunities to combine online engagement with in-person activities in 2021. The applied significance of sharing these learnings builds best practice and facilitates discussion around blended mode gender equity programming and collaboration opportunities. Summarising our pillar programs challenging core barriers to participation, COVID-19 learnings, and opportunities for 2021:
- *Primary and high school outreach*: challenging early barriers in 4-6 week in-curriculum programs with teachers and families in the classroom, introducing STEM projects and design thinking. Working closely with teachers, program delivery was restructured to online models of engagement through Zoom (including dialling in industry mentors); this online delivery then enabled reach to regional schools later in the year. The need for equipment required the development of video resources to train and support teachers in the classroom when our facilitators could only dial in. This strengthened teacher involvement and catalysed development of online STEM learning resources that are now part of the core program. Overall, outcomes were positive across teacher training, and feedback from participants and families.
- *'Lucy' industry mentoring*: annually pairing over 100 students with an industry mentor for 6 months, interpersonal rapport is critical. Heavily based on in-person networking and one-on-one meetings, events rapidly transitioned to Zoom (using facilitated breakouts), specialist online platforms such as Remo (enabling mingling amongst small groups), and online professional development workshops. In post-program feedback, outcomes were similar to previous years, with online interactions preferred by some participants. This year's program will be blended mode, with online mentoring continuing as an option, opening up geographical diversity for industry mentors.

- *Community engagement*: social connection fast emerged as a need to address isolation, wellbeing and work/life transitions. Rapid pivot of regular in-person social events to Zoom, activities were more frequent but for shorter durations (online fatigue). Themed events kept engagement up, and Microsoft Teams connected the community in-between events. Online events attracted different audiences (locational convenience matters); thus, 2021 events will be blended. Postgraduate students in the community are particularly affected with compounding isolation from families/friends (especially for international students), and the individualised nature of research projects. Research students were the first to return to campus; this cohort is thus catalysing the transition back to in-person and blended mode engagement.

Keywords: COVID-19; online; blended; engagement; community

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Eva Cheng is the Director of Women in Engineering and Information Technology, and Senior Lecturer in the School of Professional Practice and Leadership. With a background in telecommunications engineering, With a background in telecommunications engineering, Eva actively collaborates on social justice and community engagement in STEM diversity and humanitarian engineering, including working with Tech Girls are Superheroes and Engineers Without Borders Australia. | eva.cheng@uts.edu.au

Lucia Bautista is the Program Coordinator of Women in Engineering and IT at the University of Technology Sydney. She has a strong background in policy and political analysis and collaborating with the not-for-profit and corporate sectors for the delivery of programs. She is passionate about breaking down gender stereotypes and developing strategies to address social issues. | sahar.soleimanimatin@uts.edu.au

Dr Marco Angelini is the Outreach Coordinator of Women in Engineering and IT at the University of Technology Sydney. He was the project manager for Maths Inside. With a background in academic skills development, educational equity and the transition to higher education, he has taught humanities and science subjects at the London School of Economics, Queen's University of Belfast and the University of Technology Sydney. His research and publications include work on student engagement, academic literacies, philosophical thought and history. | Marco.Angelini@uts.edu.au

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4. Conceptual change of same-sex dyads interviewed while predicting then measuring displacement by a sequence of different materials

Chow, Y.Y.; McMaster, H.J.

Poster: https://youtu.be/qFhLP7p9qKg

Live poster presentation: https://youtu.be/USbQiKj-H_g

This study explores the Itakura method for facilitating conceptual change (Itakura, 1967). This method promotes student discussion through prediction then explanation of a concept using everyday materials. Dyads of same-sex friends in the same class (years 5 or 6), were prompted to make predictions, reach a consensus, then experiment and explain the rise in the level of water in a container when a sequence of materials were submerged. After each submersion, they could change their prediction for the remaining materials. The interviewer facilitated discussion but made no attempt to influence their conceptions. The aim was to gain insight into pre-adolescent children's developing conceptions about displacement, and how they are influenced by same-sex friends as they predict and observe this phenomenon.

Based on a written questionnaire given to their class, two female and two male dyads were chosen to pair friends where one child believed that displacement was caused by the weight of the submerged material and the other believed it was caused by its volume. Different materials having the same volume, were submerged sequentially from liquid to gel to deformable solid to solid cubes increasing in weight. Finally, a wooden cube was floated then pushed under the water. Children's beliefs were coded by their questionnaire response, their initial predictions in the task-based interview (three weeks later) and their explanations after each material was submerged. Speech patterns during the interview were analysed as affiliative or self-assertive (Leaper and Smith, 2004).

As expected, the boys' speech was more self-assertive and the girls' speech was more affiliative. One female dyad agreed with both volume and weight-based reasons and no firm conclusion resulted. The other female dyad was successful because one girl verbalised her thinking as the experimental evidence mounted. Her friend repeated her reasoning until she also understood it. In the male dyads, those with weight-based thinking became less confident during the experimentation. However, while admiring their friend's volume-based reasoning, they continued to express a different opinion, adding the idea that the displacement could be due to some sort of pressure. This study found that pre-adolescent children have unstable conceptions of displacement. It is recommended that teachers provide a safe space for both sexes to reason aloud by promoting the ideas of students who have correct reasoning, rather than correcting those who just want to agree with their friends or who want to express a different idea with which they see no problem.

Keywords: conceptual change; Itakura method; same-sex pairs; volume by displacement; student dialogue

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5. Connecting a community of postgraduate women in Engineering and IT

Katuwandeniya, K.; Soleimanimatin, S.; Hayati, H.

Poster: https://youtu.be/yruPXaH7rCM

Live poster presentation: https://youtu.be/USbQiKj-H_g

In mid-2019, Women in Engineering and IT (WiEIT) at the University of Technology Sydney (UTS) identified the need for a separate program dedicated to postgraduate women studying coursework and research in the Faculty of Engineering and IT. Launching in November 2019, the program has since grown organically: increasing in involvement numbers and initiatives, and transitioning to online platforms following the COVID-19 pandemic in March 2020. This paper shares the program learnings and the experience and feedback from the student-led program team, with a view to building best practice and collaboration in reaching, connecting and supporting a severely underrepresented but large student cohort. Postgraduate students face challenges distinct from those of undergraduate students in Engineering and IT fields. They are diverse and particularly isolated due to a) the independent nature of research candidatures and research topic specificity, b) nationality (significant proportion of international students), c) cultural background, and d) family circumstances (e.g., caring responsibilities). Thus, designing programs for this diverse student cohort is challenging due to the varying needs; however, the key commonality was the need for a connected community. To address the above challenges, we designed and launched 3 initiatives for postgraduate women with separate objectives:

- Women in Engineering and IT Ambassadors was initiated with the objective of creating an enthusiastic, closely-knit team of female volunteers from each academic school in the Faculty, so that research students from each school have a representative to voice the needs of their community. It started with 12 Ambassadors, and due to the success of the postgraduate initiative, the Ambassador initiative has now been extended to undergraduate students and staff.
- 'Let's Talk' is a safe space for discussions on topics commonly faced by the postgraduate and research community. Deliberately unstructured, these fortnightly sessions allow students to share their challenges without judgment, and develop friendships, which are extremely important for those who feel isolated. "Accountability partners", "personal branding" and "long-term planning" were three of the most popular sessions in 2020.
- A workshop series for professional development was motivated from the community in 2020 during COVID-19, to help navigate through tough times and keep motivated while working from home. The first session was a 4-day resilience building workshop, followed by workshops aimed at developing professional skills which are highly sought after in emerging tech and research careers e.g., storytelling, conference practices, innovation, moving beyond career barriers.

After 18 months of programming specific to postgraduate engineering and IT women, impact evaluation is currently underway. However, the evaluation measures are non-trivial, and outcomes are wide-varying: does the research community value life and professional skills to be more or less important than technical skills? How to best measure the feelings of inclusion and belonging, not just the number of participants? Will having research supervisors on-board with the program lead to more sustainable impact? How does impact vary between in-person and online engagement?

Keywords: postgraduate; community; workshops; ambassador;

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6. Leveraging YouTube to increase women's physics identity and motivation
Lee, H.; Eccles, J.
Pre-recorded presentation: https://youtu.be/hWnf6Z5AtNo

Gender disparity in some STEM fields still exist (National Science Board, 2018). The college years are important for sustaining women's interest in and identification with the physical sciences. (Kanny et al., 2014). But, for some women in the physical sciences there may be a disconnect between their own gender identity and their STEM identity. One way to enhance continuing motivation in STEM is through role models/mentors who can reinforce the importance of their STEM identity and the compatibility of having a strong and positive identity as both a woman and a physical scientist. Supportive role models/mentors can help reduce adverse experiences for students by promoting feelings of self-worth, providing opportunities for positive beliefs about personal competence, or attributing behaviors to controllable causes (Eccles, 2009). How can we increase role models/mentors accessibly to a wide audience in STEM? YouTube is a free, popular, and widely accessible platform that could provide positive role models/mentors for women and other underrepresented groups in physical science majors. In this qualitative study, we examined undergraduates' perceptions of Toby (Tibees' channel) and Alice's videos (AliceDoesPhysics' channel) showing female YouTubers majoring in physics. These 8 YouTube videos focused on students talking about their experiences in physics, such as their struggles as well as tips and resources for success. Both male and female participants reported that these images supported their growing "sense of

identification" with physics and helped them believe that "if they can do this, I can too." Exposure to these types of YouTube videos helped them feel a sense of relief that everyone struggles. Further, our participants thought that advice videos were more helpful than the day-to-day life videos. Finally, they reported that they would like to see additional videos that focused on building connections with same major students, revisiting similar arduous concepts in upper-division classes, and more specifically addressing women of color's concerns. Future researchers should create such videos for a more diverse range of backgrounds. With an NSF grant, we are currently creating more such videos that will be put in a library of YouTube videos from which students can select videos meeting their needs. We are testing these videos in community college physical science classes.

Keywords: YouTube; achievement motivation; STEM; gender; college students

Author biographies:
Hye Rin Lee is an education doctoral student at the University of California, Irvine with a concentration in Human Development in Context. Her research interests are self-reflection, academic interventions, online learning in education, measurement, and temporal motivation. Specifically, her research focuses on (1) creating an intervention that helps URMs persist and continue on in STEM majors via the social media platform, YouTube; and (2) examining the nuances deeply related to various measures of academic self-related motivational beliefs. | hyerl@uci.edu

Jacquelynne S. Eccles is a Distinguished Professor of Education at the University of California, Irvine and research fellow at the Australian Catholic University. She has conducted research on a variety of topics, including gender-role socialization, teacher expectancies, classroom influences on student motivation, and social development in the family and school context. She has made seminal contributions to the study of achievement-related decisions and development. Most notably, her expectancy-value theory of motivation and concept of stage-environment have served as dominant models of achievement during the school years, contributing to extensive research and reform efforts to improve the nature of school transitions. | jseccles@uci.edu

7. The role of careers advice in pursuing STEM by girls
Masri, A.; Tytler, R.; van Driel, J.; Miller, V.
Poster: https://youtu.be/BBhcWF3-FZQ
Live poster presentation: https://youtu.be/USbQiKj-H_g

Australia's 2015 PISA results showed that girls were three times less likely to expect to work in science and engineering professions than boys when asked what career they expect to be doing at the age of 30. Gender stereotypes, unconscious bias and other sociocultural issues are considered to be the major reasons that girls do not pursue STEM (Archer, 2013). While teachers, parents, siblings and peers are considered the most influential on girls' career decisions, formalised career advice has the potential to expand students' views of STEM career options and pathways. This paper brings together the literature on girls' participation in STEM alongside research and policy discussions of career advice in order to highlight the current role that career advisers play in girls STEM career decisions and to provide recommendations. This paper combines a review of Australian policy papers on career advice with a literature review,

complemented with interviews with stakeholders. A literature search was undertaken on academic publications and policy documents and reports in the public domain, focusing on Australia. Semi-structured interviews were undertaken with STEM career stakeholders. Research in this domain is fragmented and patchy. Recent policy and review papers in Australia show that careers advice varies in both quantity and quality. Career advisors have not necessarily had training and are usually not up to date with scientific knowledge and skills to assist students contemplating about a career in STEM. A UK study (Taylor, 2006) reported that the majority of girls (70%) believe that the career advice they received in high school was gender biased. Findings like this combined with evidence that girls form attitudes about STEM at an early age leads to the following recommendations: (1) Career awareness should start early, prior to girls becoming disengaged with STEM; (2) Career advisors need to collaborate with STEM teachers and families; (3) Career advice should target specific groups such as disadvantaged girls, and (4) Career advice needs to be better regulated to ensure that all career advisors have access to professional development, including specific training on gender bias. Both the literature and interviews indicate a need to make career advice more effective, for instance, by shifting the time spent on career advice from years 10-12 to years 7-9 and by investing in the quality of career advisors.

Keywords: Career advice; STEM participation; Gender

Author biographies:

Adam Masri is a PhD student at Deakin University and a casual academic at University of QLD. His thesis aims to explore girls' perceptions regarding studying physics and pursuing it as a future career. He obtained his Master of Education from University of Adelaide and his B.SC & B.Ed from Alexandria University. He taught general science, biology and physics across Egypt, Saudi Arabia, Kuwait, Qatar and Australia. His main research interests include the promotion of gender equality in STEM education. | jonesad@deakin.edu.au

Russell Tytler is Alfred Deakin Professor and chair in science education at Deakin University. His major research interests include student learning in science and pedagogies to support this, teacher learning, school change, and system reform, and rural science education and communities. | tytler@deakin.edu.au

Victoria Millar is a senior lecturer in science education at the University of Melbourne. Her research focuses on the influences on curriculum choices and changes as well as science participation across the education spectrum. Victoria has a background as a physics, mathematics and science teacher. | victoria.millar@unimelb.edu.au

Jan van Driel is a professor of science education at the University of Melbourne. He did his PhD at Utrecht University, The Netherlands on the teaching and learning of chemical equilibrium (1990). He was a professor of science education and director of ICLON-Leiden University Graduate School of Teaching, The Netherlands from 2006-2016. His main research interests are related to the development of science teachers' knowledge and beliefs in the context of teacher education and educational innovation. | j.vandriel@unimelb.edu.au

8. A conceptualisation of women in STEM's employability during career break transitions

Simone, J.

Poster: https://youtu.be/_gEBKbOWnCY

Live poster presentation: https://youtu.be/USbQiKj-H_g

McQuaid and Lindsey's (2005) employability framework together with Schlossberg's transition theory (1981) provides a combined conceptual framework of employability and career break transitions. This conceptualisation places emphasis on the connection between employability and transition, treating the career break as a series of transitions. This new conceptual framework provides an alternative perspective to understanding women in STEM's decision and experiences of employability, whilst they are navigating and managing changing circumstances and contexts when taking a career break. The development of this conceptualisation of employability and transition presents a theoretical synthesis, that is based on a review of the career development literature that specifically relates to the changes in women's employment patterns and careers. A qualitative approach using narrative methods will support the collection of a deep and rich quality of evidence and highlight the influences on women in STEM's employability when taking time away from the workforce. This will assist with the sense making, interpretation and explanation of the different and varying employability experiences when taking a career break. A doctoral study will test the validation and credibility of this conceptual framework on women in STEM who have taken a career break. In the absence of research findings, this conceptual framework expresses the responsibility of an individual to manage their work, career and employability along with the potential influences they are faced with when taking a career break. This conceptual framework aims to contribute to women in STEM's career development research, bringing together knowledge of career break, employability and transitional change. The findings from this study can potentially inform policymakers, practitioners, and business leaders with valuable knowledge to improve their workplace practices and career development policies for women in STEM when they take a career break. Such opportunities can further serve as an inspiration for women to return to the STEM workforce and continue to contribute their skills and knowledge within a pivotal industry.

Keywords: career break; employability; transition; conceptual model; women in STEM

Author biography:

Josephine Simone is a Doctor of Business Administration candidate at Victoria University, conducting a doctoral study into the career break and employability experiences of women in STEM. Josephine is a mother of four children and was a stay-at-home mother for ten years, contemplating options to return to work once her children had all commenced school. Prior to having children, her work experience was predominantly within research and consulting. Josephine is currently in the data collection phase of her doctoral research project. Josephine's other research interests include women's contemporary careers and women in the future workforce. | josephine.simone@live.vu.edu.au

9. Understanding young girls' STEM experiences, attitudes and aspirations

Spiteri, T.

Pre-recorded presentation: https://youtu.be/XnSgpYAt9-A

Extensive international research has found that girls possess less positive attitudes and aspirations towards STEM domains than boys (Sjøberg & Schreiner, 2005; Stoet & Geary, 2018). Additional research has found that attitudes and aspirations towards STEM domains develop by the age of 13 (DeWitt & Archer, 2015; Lindahl, 2005) and change little as individuals progress through school and into adulthood (Maltese & Tai, 2010; Tai et al., 2006). It is thus not surprising that girls and women are continually underrepresented in some STEM domains at school, university and in industry. Studying STEM aspiration development can help understand STEM participation, for instance, why girls do not participate in some STEM fields in later years (Moote et al., 2020). Consequently, the aim of this PhD study is to investigate the experiences of girls in integrated STEM education as they transition from primary to secondary school, and to understand how these experiences influence their STEM attitudes and aspirations. This descriptive study uses methods designed to gather information from girls' themselves about their integrated STEM education experiences. Data will be collected from a small sample of girls participating in an integrated STEM program at their school across years six and seven (age 11-13 years) via photographs and focus group interviews. The girls will photograph their experiences in their integrated STEM education and use these photographs as visual aids in subsequent focus group interviews in order to give in-depth descriptions of their experiences. Presented in this poster are the results of a pilot study conducted with a small sample of 11-13 year old girls in order to test the viability of the data collection and analysis procedures to be used in the main study. The results of the pilot and the main study will provide further evidence of the impact of integrated STEM education on girls' attitudes and aspirations towards STEM. These findings will potentially help inform the development and implementation of initiatives to support the increased participation of girls in STEM in primary and secondary schools.

Keywords: STEM education; girls; transition; experiences; qualitative study

Author biography:

Tabetha Spiteri has been a secondary STEM teacher and STEM coordinator at an all-girls school for the past decade. She is currently a PhD candidate at Monash University's Faculty of Education and is conducting research into the attitudes, aspirations and experiences of girls in STEM education during the transition from primary to secondary school. | tabetha.spiteri@monash.edu

10. A cultural-historical perspective on increasing girls' STEM engagement in early childhood: Conditions created by the Conceptual PlayWorld model

Stephenson, T.; Fleer, M.; Fragkiadaki, G.

Pre-recorded presentation: https://youtu.be/UrzQXQEWBXg

As societal needs change and STEM (science, technology, engineering and mathematics) solutions are offered, an increasing concern for the participation of girls in STEM has emerged. Research has consistently shown the unintended preferential treatment of boys by teachers during STEM teaching, and although well recognized, has seen limited change over the past decades. Gendered interactions, including microaggressions in the form of verbal, non-verbal, and environmental occurrences influence girls' identity formation from a young age, leading to a decrease in girls' STEM participation, continuing the trend of underrepresentation of women in STEM fields due to underlying gender equity issues. To improve this gender gap, is important to consider the beginning of the STEM pipeline, the early stages of education. Drawing upon the system of concepts from the cultural-historical theory including social situation, social situation of development and motives, this study explores the motivating conditions created by the Conceptual PlayWorld model - a new play-based model for the intentional teaching of STEM - for girls' STEM engagement in the early years. Using a holistic study design, video observations of interactions and experiences within and outside the Conceptual PlayWorld were gathered from 2 preschool teachers and 13 children aged 2.3 - 3.2 years. Data analysis was undertaken using a three-level holistic analytical framework in line with the cultural-historical tradition. The changing role of the teacher across the activity settings emerging within and outside the Conceptual PlayWorld is highlighted along with its impact on girls' STEM access and engagement. Findings support previous research surrounding the accumulation of microaggressions in free play settings that position girls away from STEM activity, which are minimised inside the Conceptual PlayWorld due to the changed role of the teacher. It is argued that the conditions created by this model positively shift interactional patterns to create motivating conditions for girls in STEM so that both girls and boys can have a strong engagement and interest in STEM from the very beginning.

Keywords: STEM; gender; early childhood; identity; engineering

Author biographies:

Tanya Stephenson is a doctoral student at Monash University. As an Australian Research Council (ARC) Kathleen Fitzpatrick Laureate Scholar, she is passionate about advancing early childhood STEM (science, technology, engineering and mathematics) education, particularly for girls in STEM, through evidence-based practices. Her study focuses on preschool teacher practices to encourage girls in STEM, contributing to a larger programmatic study at the Conceptual PlayLab, Monash University, towards developing a national evidenced-based model for the intentional teaching of STEM in play-based settings. Her research interests include STEM education, social equity, educational psychology and teacher professional development. | tanya.stephenson@monash.edu

Laureate Professor Marilyn Fleer holds the Foundation Chair of Early Childhood Education and Development at Monash University, Australia. She was awarded the 2018 Kathleen Fitzpatrick Laureate Fellowship by the Australian Research Council and was a former President of the International Society of Cultural-historical Activity Research (ISCAR).

Additionally, she holds the positions of an honorary Research Fellow in the Department of Education, University of Oxford, and a second professor position in the KINDKNOW Centre, Western Norway University of Applied Sciences, and has been bestowed the title of Honorary professor at the Danish School of Education, Aarhus University, Denmark. | marilyn.fleer@monash.edu

Dr. Glykeria Fragkiadaki is a Senior Research Fellow at Monash University, Australia. Glykeria has an academic background at European Universities and extensive teaching experience as an Early Childhood Educator and Director. She has also acted as OMEP's Patras Local Committee Secretary in Greece and been a tutor to several Professional Development Programs for Early Childhood Educators. Her research focuses on pedagogy and teaching in the early years, STEM education in early years, and cultural-historical theory and methodology. Her research work has been published in several international journals and book chapters as well as presented in international and national conferences. | glykeria.fragkiadaki@monash.edu

11. Are teachers' gender beliefs detectable in their students' attitudes to science/ scientists?

Barnard, R.P.; Watts, M.

Pre-recorded presentation: https://youtu.be/ufoELW4wkSU

The ASPIRES/Science Capital project (2009-2017, Years 6-13) was a longitudinal study to address the issue of STEM career aspirations and the low uptake of science subjects at 16+. It has focused on secondary/high-school students (Archer, 2013, 2015, 2017), and developed a 'Science Capital Teaching Approach' (Godec, 2017), specifically for secondary science teachers. Their theoretical model of science capital combines the following science-related (sub-)constructs:

a) Cultural capital (1. Scientific literacy, 2. Attitudes, values and dispositions, 3. Knowledge about the transferability of science into careers);
b) Behaviours & Practices (4. Consumption of science media, 5. Participation in out-of-school science learning contexts);
c) Social capital (6. Family science skills, knowledge and qualifications, 7. Knowing people in science-related roles, 8. Talking about science in everyday life);
d) and dependent variables (Future Science Affinity, Science Identity) (Archer, 2015, pp. 929-932).

One of their recommendations was to boost family science capital. They also reported how students lacking STEM-related aspirations at Year 5 are unlikely to develop them by Year 9 when students make their first subject choices (Archer, 2013, pp. 3, 5). This research, instead, focuses upon upper-primary and lower-secondary (Years 5-8) students to study:

i) teachers' science capital & attitudes (rather than that from students' homes);
ii) the changes in students' science capital and attitudes as they move through the primary-secondary transition; and
iii) with the aim of linking the two, i.e., student to their teacher.

The conceptual model hypothesised that teachers' level of science qualifications feed both their personal then professional attitudes. And this may impact most of their class members more than any influence from students' home. So far, some of England's few remaining middle

schools (Years 5-8, without phase-transition) have been surveyed in June 2019: (1) 658 students using the ASPIRES questionnaire and (2) their teachers (N = 18) using van Aldren-Smeets' (2012, 2013) Dimensions of Attitude towards Science (DAS) instrument. The theoretical framework for DAS covers both teachers' personal and professional attitudes towards science and technology including: (a) Cognitive beliefs (relevance, difficulty, gender); (b) Affective states (enjoyment, anxiety); (c) Perceived Control (self-efficacy, context) they believe governs teachers' Intent and Behaviour. Early findings, which indicate a significant dip in student science capital between middle school Years 5 and 7, were presented at the BERA conference (Barnard, 2019). In addition, teachers' professional anxiety and enjoyment related r = -.72 (N = 40) which diverged as their highest level of science qualification increased. Ongoing analysis of ASPIRES' eight sub-constructs and those from teachers' DAS survey will be reported on these middle school data and also on data to be collected in June/July 2020 from clusters of English primary schools and their linked secondary schools.

Keywords: science capital; attitudes; teachers; students; primary-secondary transition.

Author biographies:

Rich Barnard is a graduate physicist with a Masters in Primary Education (2015 from UCL IoE London). With his mathematician wife, Rich has four grown-up children. One identical twin and his elder sister pursued STEM-based education, while the other male twin and younger sister are not. All attended the same schools. So why weren't they all STEM kids. My research inspiration is to answer the question: 'Are scientists are born or nurtured by social influences at home or at school?' Rich's PhD research at Brunel University London is exploring teachers' impact on students' attitudes towards science.
| richard.barnard@brunel.ac.uk

Mike Watts is Professor of Education, Brunel University London, and Director of Internationalisation for the Department of Education at Brunel. He conducts 'naturalistic' people-orientated research principally in science education and in scholarship in higher education. He has conducted major studies in both formal and informal educational settings in the UK and abroad and has published widely on his research through numerous books, journal articles and conference papers. He enjoys exploring new technologies for learning and writing about creative (sometimes transgressive!) pedagogical approaches to learning and teaching. He is a National Teaching Fellow and a Fellow of the Institute of Physics, teaches at all levels and currently supervises 16 PhD students. | mike.watts@brunel.ac.uk

WORKSHOPS

Designing engaging STEM programs and resources for primary school-aged girls
Beekhuyzen, J.; O'Brien, N.; Catchpole, H.; Cheng, E.
Live recorded workshop: https://youtu.be/BXtLCGUswN0
(recording ends with breakout rooms)

This workshop will equip teachers with tools and techniques to engage girls in the practice and creation of technology linked to real-world outcomes through the principles of a gender inclusive learning environment. The applied significance is in building best practice in primary school STEM programs and resources, identifying collaboration and practice-based research opportunities. The workshop will include a 30-minute presentation on the 7 principles of an inclusive learning environment and best practice from four successful programs that engage girls in primary schools in technology practise and careers education: the 'Techgirls are Superheroes' program, the 'Grok Academy's Digital Technologies Challenge Project', the 'UTS STEM x Play Primary Program', and the 'Careers with STEM magazines'. This will be followed by worked examples that introduce primary coding projects using Scratch and micro:bits with links to Digital Technologies, Arts and Science curriculum, with opportunity to interact with the projects and group discussion on how these meet best practice around inclusiveness. Laptops and micro:bits will be provided and the practical component facilitated by our group of experts. The workshop is suitable for teachers and other educators and will equip them with cross-curricula strategies to engage girls in digital technologies.

Keywords: primary school, girls, inclusive learning, interacrive, technologies.

Presenter biographies:
Dr. Jenine Beekhuyzen, Creator of the Tech Girls Are Superheroes campaign, is a futurist with international recognition for her advocacy and leadership, her research, and her university teaching through which she has impacted tens of thousands of students over the past 15 years. As the Founder & CEO of the Tech Girls Movement Foundation, the past 6 years she has engaged over 8000 schoolgirls in STEM entrepreneurship across more than 1000 schools, matched with 1000+ mentors who have volunteered 7500+ hours of their time. She has also distributed 80 000+ free Tech Girls Are Superhero books to Australian schools. | info@techgirlsmovement.org

Nicola O'Brien is a computing education specialist at Grok Academy. She creates engaging teaching materials to introduce computer science and digital technologies to primary school students. She's determined to ensure equitable access to computing education for all Australian students and is proud to be part of Grok Academy. | nicola@aca.edu.au

Heather Catchpole. Specialising in STEM communications for 20 years for the ABC, Cosmos, CSIRO, Discovery Channel and more, Heather founded STEM-specialist media company Refraction Media in 2013. She's has worked with Google, Facebook and Pixar on virtual reality expeditions, created a virtual tour of a nuclear reactor, and distributed over 1.5 million magazines to students across the USA, Australia and New Zealand through the Careers with STEM brand. In 2018, Refraction Media was highly commended as Publish Australia's best small publisher and was twice shortlisted best startup in the Telstra Business Awards. Heather is the author of Ready, Set, Code! Primary coding book and publisher of Careers with STEM.

Careers with STEM magazines and the Women in STEM profiles aim to provide visible role models for Primary girls. | heather@refractionmedia.com.au

Eva Cheng is the Director of Women in Engineering and IT, and Senior Lecturer in the School of Professional Practice and Leadership at the University of Technology Sydney. With a background in telecommunications engineering, Eva actively collaborates on social justice and community engagement in STEM diversity and humanitarian engineering, including working with Tech Girls are Superheroes and Engineers Without Borders Australia. The UTS STEM x Play program is curriculum-mapped and delivered over 6-8 weeks in-class with Year 5/6 students, parents and teachers with the aim to catalyse generational perception change and shift girls' perception towards, confidence and interest in exploring with STEM in a co-educational environment. | eva.cheng@uts.edu

What about the M in STEM?
Carvalho, A.
Live recorded workshop: https://youtu.be/5DY_xJPV_Pk

The way Mathematics has traditionally been taught is holding girls back, as the emphasis on speed over deep understanding is discouraging them from selecting higher levels of Mathematics and maths related (STEM) subjects (Boaler, 2014, 2017). This workshop will provide insights into a system-wide professional learning initiative aimed at developing teachers' expertise and excellence in mathematical knowledge and pedagogy while building collective efficacy. Implications for improved STEM teaching and girls' engagement will be described. Mathematics teaching in Australia is under scrutiny. PISA results show that Australian students' performance in mathematical literacy has declined significantly between 2003 and 2015, with only 55% of students achieving the National Proficient Standard in 2015 (Thomson, De Bortoli, & Underwood, 2017). 76% of students will be taught mathematics by an out-of-field teacher for at least one of their first four years of secondary schooling (Prince & O'Connor, 2018). There is a pressing need for systematic, longitudinal professional learning programs that increase the capacity of those currently in the workforce responsible for teaching mathematics. In 2016, just 7% of female Year 12 students in Australia studied advanced mathematics compared with 12% of male students. Australia's Chief Scientist, Alan Finkel, emphasised the importance of teachers having expertise in mathematics as it is the subject with "a skill set that is fundamental to science, to commerce, to economics, to medicine, to engineering, to geography, to architecture, to I.T." (Finkel, 2018). Research shows that problem solving provides the inspiration and the means for students to learn mathematics (Sullivan, 2011). It can also be the catalyst for increasing teachers' passion for teaching mathematics as a reasoning, creative subject focused on thinking. The Mathematical Expertise & Excellence (MEE) initiative aims to increase the proportion of students studying higher levels of mathematics and maximise levels of numeracy attained by all students. The degree to which teachers hold shared beliefs in their capacity as a group to effect change has a powerful impact on student achievement. The building of collective efficacy has been central in the design of the MEE program. In this session, participants will learn about MEE as a strategic, longitudinal, system-wide approach which balances theoretical and practical aspects of learning and teaching through deepening teachers' content, syllabus and pedagogical knowledge. Participants will hear about the structure of the project, its intended outcomes and

experience a lesson using our pedagogical approach. Links between mathematics and other STEM subjects will be made clear during the session.

Keywords: mathematics.

Presenter biography:
Andrea de Carvalho is experienced in school and system reform in Melbourne, Canberra and Sydney. She supports the development of thriving collaborative cultures that build the collective efficacy of staff and maximise the educational results of students. Skilled in design and delivery of rigorous, practical professional development, Andrea presents engaging workshops, provides exemplary modelling of contemporary pedagogies, conducts personalised coaching, and facilitates effective mentoring. Striving for excellence, she has a passion for equity and is valued as a credible, effective and highly relational professional. Holding degrees at ACU and Deakin University, Andrea is pursuing a PhD at UNSW.
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Writing, reviewing and publishing in peer-reviewed journals
Gannon, S.; Scantlebury, K.; Herman, C.
Live recorded workshop: https://youtu.be/wprjJdbUsEs

This workshop aims to create a collaborative space to share insights on writing approaches, reviewing practices, and publishing strategies for scholars doing qualitative and quantitative research that eexamines and theorizes the interrelated experiences of gendered subjects in formal and informal education STEM settings. The workshop will provide important insights into the practices that shape writing, reviewing and being published in journals focused on gender research in STEM education settings.

The workshop has four objectives:
1. to provide insights from experienced educators, researchers and editors working with a range of qualitative and quantitative methodological approaches on how to maximize involvement in drafting, writing, reviewing and publishing for emerging scholars;
2. to share ‘top tips’ on how to design research projects with outcomes and publications in mind from the start in order to ensure greater impact for your work;
3. to discuss and exchange ideas on reviewing practices that can be employed when peer reviewing work for journals that does not fit conventional models and expectations of research in education; and
4. to create an open and collaborative space for scholars to share strategies, exchange information, and build networks.

The workshop presentation is led by experienced educators and researchers who are currently editors of major international journals (‘Gender and Education’, ‘International Journal of Gender, Science and Technology’, ‘Cultural Studies of Science Education’) and have a range of experience on the Editorial Boards of various international journals, designing and leading workshops on ‘writing articles for journals’ for academics. The workshop is designed to promote interactivity and discussion by first engaging participants in the review process as a helpful stepping stone en route to crafting excellent academic articles for inclusion in journals, recognising that journals publish what the specific aims, vision and scope of journal is. It will also promote discussion as to how papers shift through multiple drafts through the process of

journal submission and discuss authors' response and responsibility to reviewer and editors' suggestions for minor and major revisions.

Keywords: writing, editing, publishing, networking.

Presenter biographies:

Professor Clem Herman is Professor of Gender and Technology in the School of Computing and Communications at the Open University U.K., and is the founder and Editor in Chief of the open access 'International Journal of Gender Science and Technology'. Throughout her career she has developed and led projects to research and increase the participation of women in I.T. and other STEM fields, especially women returning after career breaks. From 2014 to 2019 she was Director of eSTEeM, the OU's Centre for STEM pedagogy (www.open.ac.uk/esteem) which promotes innovation, scholarship and enterprise in STEM open and distance learning. Clem is the University's Athena SWAN champion and chairs the OU Gender Equality Steering Group, as well as leading the Open University's widening participation work as part of the Institute of Coding, a national U.K. project to increase diversity in digital skills and education. | clem.herman@open.ac.uk

Dr. Kathryn Scantlebury is a Professor in the Department of Chemistry and Biochemistry at the University of Delaware. Her research interests focus on feminist/gender issues in various aspects of science education, including material feminism, preservice teacher education, academic career paths in academe. Scantlebury is a guest researcher at the Centre for Gender Research at Uppsala University, Co-editor in Chief for Gender and Education, Lead Editor for Cultural Studies of Science Education and co-editor of two book series with Brill Publishers. | kscantle@udel.edu

Dr. Susanne Gannon is Associate Professor in the Centre for Educational Research at Western Sydney University. Dr. Gannon is Co-editor of Gender and Education and Associate Editor of International Journal of Qualitative Studies in Education. She currently leads an ARC Discovery project: 'Gender matters: Changing gender equity policies and practices in Australian secondary schools' and was previously a coresearcher on ARC Linkage: ' From high school to higher education: Gendered pathways in information, communication and computer technology education' (UWS, Deakin, CSU). Using predominantly qualitative methods, her research addresses a range of equity issues in schools, higher education and beyond; pedagogical practices, curriculum and educational policies; trajectories of beginning teachers into the profession, and young people's aspirations for their futures.
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Engaging with the media for research impact

Schedlich, S.

Live recorded workshop: https://youtu.be/tTcqjyy2M8k

MCERA is an independent and impartial centre that contributes to better informed public debate on major issues by improving links between the media and the educational community. We promote the uptake of education research to the media and the public, and facilitate expert comment on educational issues. This session will discuss the importance of engaging, as a researcher, with the mainstream media; the current media landscape; and how public engagement can lead to impact. We will then workshop some research into mock public engagement plans to see how academic works can be translated to the wider world.

Keywords: media, impact, engagement, workshop.

Presenter biography:
Dr. Shannon Schedlich has been MCERA's CEO since October 2017. She has experience in government, community engagement, universities, change leadership and governance reform. She has held a number of positions across government, including as a senior political adviser and Ministerial Adviser (Education). Shannon holds a doctorate in History from the University of Newcastle. | shannon.schedlich@mcera.org.au