

Chapter 3

Making and Taking Leadership in the Promotion of Gender Desegregation in STEM



**Mervi Heikkinen, Sari Harmoinen, Riitta Keiski, Marja Matinmikko-Blue,
and Taina Pihlajaniemi**

Abstract In 2016, the United Nations (UN) Member States adopted a decision on the role of the UN Educational, Scientific and Cultural Organization (UNESCO) in encouraging girls and women to be leaders in science, technology, engineering, and mathematics (STEM) and in science, technology, engineering, arts, and mathematics (STEAM). This decision poses a special challenge for many sectors in society and posits unique opportunities for women's leadership in higher education institutions (HEIs). This chapter opens by presenting views on overcoming gender segregation in STEM. The roles of women in leadership positions in the higher education STEM research areas of a large multidisciplinary university in a Nordic country are explored. The unique paths in which four of these women have progressed in their profession, position, and promotion of equality through their diverse and multiple roles within their HEI are examined. From this collection, intertwined opportunities in assuming

M. Heikkinen (✉)

Gender Studies/Values, Ideologies and Social Contexts of Education (VISE), Faculty of Education, University of Oulu, Oulu, Finland
e-mail: mervi.heikkinen@oulu.fi

University of Oulu, Pentti Kaiteran Katu 1, 90570 Oulu, Finland

S. Harmoinen

Teachers, Teaching and Educational Communities, Faculty of Education, University of Oulu, Oulu, Finland
e-mail: sari.harmoinen@oulu.fi

R. Keiski

Environmental and Chemical Engineering Research Unit, Faculty of Technology, University of Oulu, Oulu, Finland
e-mail: riitta.keiski@oulu.fi

M. Matinmikko-Blue

Centre for Wireless Communications (CWC), Faculty of Information Technology and Electrical Engineering, University of Oulu, Oulu, Finland
e-mail: marja.matinmikko@oulu.fi

T. Pihlajaniemi

Faculty of Biochemistry and Molecular Medicine, ECM-Hypoxia Research Unit, University of Oulu, Oulu, Finland
e-mail: taina.pihlajaniemi@oulu.fi

© The Author(s) 2022

F. J. García-Peñalvo et al. (eds.), *Women in STEM in Higher Education*, Lecture Notes in Educational Technology, https://doi.org/10.1007/978-981-19-1552-9_3

leadership in the promotion of gender desegregation in STEM are identified on a micropolitical levels. The chapter concludes by elaborating institutional strategies and synergies for overcoming gender segregation in higher education STEM fields from the perspective of leadership. This chapter ends with an annexed declaration useful for local policy development and practical action.

Keywords Gender · Gender equality · Gender segregation · Leadership · STEM

3.1 Introduction

Gender equality has long been acknowledged as a key driver of social and environmental development, as well as of health and well-being. Gendered innovations (Schiebinger et al., 2020) and a gender-responsible approach to scientific knowledge production (Heikkinen et al., 2020), especially in STEM, contribute to scientific excellence and quality outcomes, enhance sustainability, make research more responsive to social needs, and promote the development of new ideas, patents, and technology (Schiebinger et al., 2020). Particularly, gender-responsible scientific approaches have become imperative in scientific knowledge production and sex and gender analysis as well as gender equality plan are required for research funding such as by the EC's *Horizon Europe* (European Commission, 2021).

The EC actively promotes gender equality in research and innovation (R&I) within the European Research Area (ERA). Its overall goal is to co-create R&I environments as gender-equal and diverse, where all talents can thrive (European Commission, 2021). Furthermore, researchers are requested to integrate the sex and gender dimensions in their research projects to improve the quality and ensure the social relevance of their produced knowledge, technologies, and innovations (European Commission, 2021). Thus, gender equality is presented as an essential condition for an innovative, competitive, and thriving European economy. Gender equality is said to create more jobs and raise productivity, which are needed for green and digital transitions and to address demographic challenges (European Commission, 2021), as well as to achieve the Sustainable Development Goals (SDGs).

Gendered career progression patterns and gender segregation in the R&I sector present challenges that highlight the need to consider the influence of organisational structural factors on gender equality. In European Research Area women occupy only 24% of leading research group positions (grade A); are prevalently under-represented in STEM fields, among others, at varying degrees among the study fields; and account for less than 10% of patent holders (Directorate-General for Research and Innovation (European Commission, 2019). Vertical gender segregation in STEM as illustrated in Fig. 3.1: Vertical gender segregation in STEM, EU-28, 2013–2016, presents the proportion (%) of men and women in a typical academic career in STEM, EU-28 countries in years 2013 and 2016 (EURAXESS, 2019).¹

¹ Adopted from: <https://euraxess.ec.europa.eu/worldwide/japan/status-update-gender-equality-research-careers-europe-she-figures-2018> (accessed 25.11.2021).

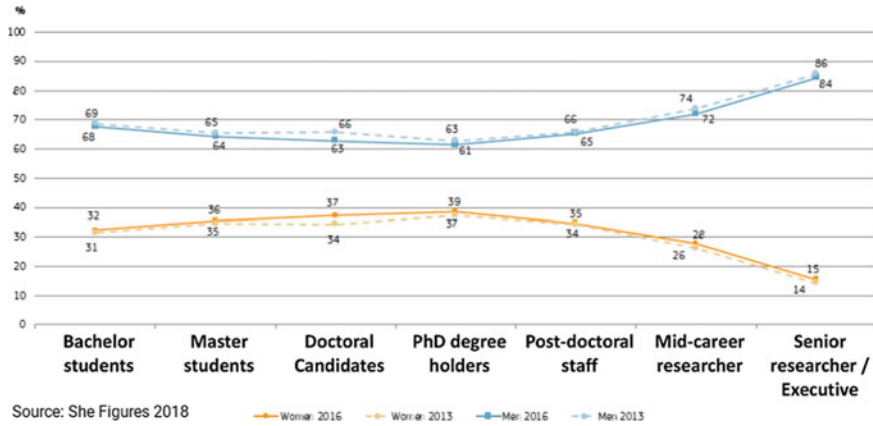


Fig. 3.1 Vertical gender segregation in STEM, EU-28, 2013–2016

The gender perspective has been discussed and scrutinised in science in various ways that range from feminist critiques of the dominant and invisible male standard in science (Haraway, 1988) to a call for increased participation and more diverse roles for women and girls in STEM (UNESCO, 2017a). Gender considerations have been found to be significant for improving the reliability of scientific knowledge production and improving individual research projects. According to Nilsen et al., (2018), science and research should be generally managed in a gender-responsible way to strengthen high-quality research and societal empowerment. They argued that gender has an impact on three elements of research: (1) the composition of the research groups; (2) the research questions in research projects; and (3) the research methods used. Thus, they suggested an approach that can be summarised as: fix the numbers, fix the institutions, and fix the knowledge - briefly, a structural change. However, women in leadership positions in academia face challenges in structures, systems, and mindsets (Alcalde & Subramaniam, 2021), that require further analysis.

3.2 Background

Over the last 20 years, there has been a visible shift in the management structures of many organisations, with more women hired in management positions, but still with little advancement in their roles (Smieszek et al., 2018). The roles and positions of women have been explored, and especially, how policy, education, international collaboration, and mentoring can support women’s scientific careers and promote greater diversity among scientists. Despite the apparent significance and impact of the gender perspective on science and scientific knowledge production (Buitendijk & Maes, 2015; European Commission, 2020), it has not yet been fully integrated into research processes globally (Heidari et al., 2016), or specifically in the

Arctic (AHDRII, 2015), and not even in the European Research Area ERA (European Commission, 2021).

Studies on women's leadership have shown that women are more likely than men to present transformational leadership characteristics that motivate innovation and growth through teamwork (Cheung, 2021). In the corporate world, companies with more female board members than other companies have been found to be more profitable (Sandberg, 2019). Why, then, are so few women appointed to top positions?

Gabriele Griffin and Marja Vehviläinen concluded their extensive research that spanned the United States, the United Kingdom, and the EU (Griffin & Vehviläinen, 2021), that context matters for understanding the dynamics of persistent gender inequalities in research and innovation (R&I) throughout the Western world in the twenty-first century. Their research included more recent and emerging STEM employment fields such as biotechnology, health technology, and digital humanities, which provided useful examples of the gendered R&I career struggles that are typical under the current regime of academic capitalism. The Nordic countries Finland, Sweden, and Norway have been ranking high in both the European Gender Equality Index and the European Innovation Scoreboard. However, specific everyday experiences of women working in R&I articulate persistent gender inequalities in the academe (Griffin & Vehviläinen, 2021). Each of the four researcher career stages—doctoral student, postdoctoral researcher, researcher/university lecturer, and research director/full professor—have different gender inequalities at play. Their interplay contributes to the durable inequalities, such structural elements and practices that are hard to be recognised and articulated, but what accompany women's research careers in the Nordic countries. Griffin and Vehviläinen (2021) write:

The Nordic version of the gender paradox in R&I (with the underrepresentation of women in top R&I positions and STEM fields) has to develop a gender equality that supposedly already exists (Martinsson et al., 2016, 1)

Women's careers are often more disrupted than men's, particularly in the new technology-driven knowledge economy. Griffin and Vehviläinen (2021) described the shift as that from a linear career path to an increasingly flexible one, which may even consist of parallel career paths. They presented the shift as having had a specific impact on women's careers, and identifying such impact makes for both a timely and urgent research topic. Those fewer female professors do provide important mentoring for younger female colleagues, but since they themselves are always in a significant minority, they can achieve only a limited elevator effect through these practices (Griffin & Vehviläinen, 2021).

3.3 Design of the Study

The recent studies both provide detailed understanding of gender segregation at the local level (Kaleva et al., 2019), and also identify and discuss on promising solutions (Ulvinen et al., 2021). This study complements the previous studies with

insights on roles and paths of women leaders in STEM fields at the university. The purpose is to understand better how both gender and gender equality promotion are intertwined in their academic career paths in the STEM fields. For this purpose, four women in top leadership positions in different disciplinary areas at a Nordic higher education institution (HEI) were selected and invited to contribute to a chapter and joint elaboration of the matter. Three of them were originally educated in a STEM discipline, and one, in life science. All their work relates to STEM fields when they participated in this study. Thus, the study method forms a novel application of autobiographical study (Järvelä, 1996) consisting of publicly available career stories online, usually in a concise form. All career stories are contributing to a collective biography (Davies & Gannon, 2006) of women in STEM leadership and an organisational case study (Heikkinen, 2012) as an overall attempt to understand organisational culture and situations for structural change.

These women in top leadership positions in STEM fields were approached to ask them if they were interested to co-author this chapter and to request their permission for us to utilise various publicly available materials on their careers and on them as STEM role models for this study. All four women accepted both the invitation and use of their public materials, and two of them expressed interest in co-creating Wikipedia profiles that they did not yet have.

This chapter explores the roles and contributions of women in leadership positions in higher education STEM fields of a large multidisciplinary university in a Nordic country. Based on the career paths of these four women leaders in STEM fields, the chapter explores the individual situatedness professionally, positionally, and in relation to the promotion of equality within an HEI.

3.4 Professional Profiles of Women in Leadership Position in STEM Fields

This chapter introduces four women in leadership positions in STEM fields at the University of Oulu. They are Vice-Rector in Research Taina Pihlajaniemi, Director of Sustainability and Regulation at 6G Flagship Marja Matinmikko-Blue, Dean of the Faculty of Technology Riitta Keiski, and Education Dean of the Faculty of Education Sari Harmoinen.

The four introductions are based on already existing public profiles on the women's accomplishments, such as their profiles on the University of Oulu website and their Wikipedia profiles.² Additional online sources on their academic career-related activities, such as the university news and gender equality-related publications, interviews, and videos were also viewed to gain a broader understanding of their current and past leadership positions. From these sources, short descriptions of

² European Science and Innovation Commissioner Carlos Moedas discusses on the International Day of Women and Girls in Science, 11th of February 2019 how Wikipedia profile could be a one way to create more visibility for women's STEM careers. Source: <https://youtu.be/YSgKLMcNjSE>.

their backgrounds, career paths, research interests, and tasks related to their leadership were drawn together. Their professional public image, leadership in diverse tasks, and impacts on gender and STEM-related matters were our particular areas of interest.

3.4.1 Medical Biochemistry

Dr. Taina Annikki Pihlajaniemi is a Finnish professor of medicine and collagen researcher. She is the Vice-Rector in Research at the University of Oulu for 2010–2025. In 2012–2017 she was a director of the Academy of Finland’s Center of Excellence in Cell-extracellular matrix research, which consisted of six research groups.

From 1996 to 2009, Dr. Pihlajaniemi was the scientific director of Biocenter Oulu and the director of the graduate school. Before assuming her position as Vice-Rector in Research, she served on the Board of the CSC—Center for Science Information Technology for 12 years, in the last four years of which she also chaired the organisation. Pihlajaniemi also served as the Founding Director of Biocenter Finland in 2006–2007, was a member of the Health Committee of the Academy of Finland in 1998–2003 and was a member of the Finnish Science and Technology Council chaired by the Prime Minister.

Dr. Pihlajaniemi graduated from the University of Oulu in 1981. From there, she went to Rutgers Medical School in the United States for three years as a postdoctoral researcher. In 1987, she had her firstborn. The same year, she became a Doctor of Medicine in Oulu and was appointed docent. In 1990, she received a professorship in Medical Biochemistry.

Dr. Pihlajaniemi is currently the Chairperson of the Equality and Non-Discrimination Board and has been leading a process of updating the Gender Equality and Non-Discrimination Plan of the University of Oulu for years 2022–2023.

Sources

Wikipedia: https://fi.wikipedia.org/wiki/Taina_Pihlajaniemi.

University of Oulu: <https://www oulu.fi/university/researcher/taina-pihlajaniemi>.

News: <https://www oulu fi/yliopisto/uutinen/pohjoispohjanmaan-palkinto-pihlajani emelle>.

Finnish Union of University Professors, Vimeo: <https://vimeo.com/32626134>.

3.4.2 *Telecommunications*

Dr. Marja Matinmikko-Blue (until 2017, Matinmikko; born 1979 in the Rovaniemi countryside) is a Finnish researcher. She is a docent at the University of Oulu and has been the Research Coordinator in 2018–2021 and the Director of Sustainability and Regulation since October 2021 in the 6G Flagship at the University of Oulu.

Dr. Matinmikko-Blue graduated from the University of Oulu with a master's degree in Industrial Engineering and Management in 2001. She earned a licentiate in Communications Engineering in 2007, a doctorate in Communications Engineering in 2012, and a doctorate in Industrial Engineering and Management in 2018. Her research interests are interdisciplinary, combining technology, business, and regulatory perspectives in the development of ICT solutions. Since then, Matinmikko-Blue's main research topics have been related to the regulation of radio frequencies, future 6G systems, and sustainable development.

In 2013, Finnish Foundation for Technology Promotion (Tekniikan Edistämissäätiö TES) selected Dr. Matinmikko-Blue as the Young Scientist of the Year. The panel selected her for forging active and successful collaboration between research, industry, and administrations to develop the mobile networks of the future.

Dr. Matinmikko-Blue worked at Nokia as an intern in 1999 and 2000, at the University of Oulu as a teaching assistant in 2000, and at VTT Technical Research Centre of Finland Ltd. (VTT) from 2001 to 2016 as a research scientist, senior scientist, and project manager. She joined the University of Oulu's Center of Wireless Communications in 2016.

She has published more than 170 scientific publications and prepared more than 150 contributions to national, European, and international regulatory bodies; chaired cognitive radio system studies at United Nations based International Telecommunication Union Radiocommunication Sector (ITU-R). She has been a lead writer in the White Paper on 6G drivers and the UN SDGs, a contributor to the linking of mobile communications with the UN SDGs and the mapping process and the further elaboration of sustainability as a challenge and driver for novel ecosystemic 6G business scenarios (Matinmikko-Blue et al., 2020).

Sources

Wikipedia: https://fi.wikipedia.org/wiki/Marja_Matinmikko-Blue.

University of Oulu: <https://www oulu fi/university/researcher/marja-matinmikko-blue>.

News: <https://www.oulu.fi/6gflagship/news/director-marja-matinmikko-blue>.

Shaking up Tech: <https://shakinguptech.aalto.fi/uratarinat/marja-matinmikko-blue>
Women In Digital: <https://www.youtube.com/watch?v=neUjTsZImOg>.

3.4.3 *Environmental and Chemical Engineering*

Dr. Riitta Liisa Keiski (born Kalliokoski) is a Finnish professor. She holds a Professorship in Mass and Heat Transfer at the University of Oulu and has been the Dean of the Faculty of Technology since 2015.

Dr. Keiski graduated from the University of Oulu with a master's degree in Process Engineering in 1981, a licentiate in Technology in 1984, and a doctorate in Process Engineering in 1991, with her research focus on heterogeneous catalysis, environmental engineering, and reactor design. Since then, her main research topics have been related to sustainable development and green chemistry and technology. She also served as a Vice-Rector of the University of Oulu in 2006–2009.

At the start of 2011, the Finnish Association of Professors elected Dr. Keiski Professor of the Year 2010 for being a researcher, developer of postgraduate education, and highlighter of issues related to research ethics and equality. Her research interests include globally important research topics related to sustainable development and green chemistry and technology. In 2013, she was awarded a research grant by the Tapani Järvinen Environmental Technology Fund.

Dr. Keiski was awarded an honorary doctorate by Åbo Akademi University in 2018. She has also received *Doctor Honoris Causa* honors from the National Engineering University in Lima, Peru in 2015 and the Corvinus University of Budapest in Hungary in 2014.

Dr. Keiski served as a president of NORDTEK in 2017–2019 and as a member of the Board in 2016–2020. She was a member of the Research Council of Natural Sciences and Engineering of the Academy of Finland from 1998 to 2000 and its Chairperson from 2001 to 2006, a Vice-Chairperson of the Research Ethics Advisory Board in 2007–2010, a member in 2010–2013, and a Chairperson from 2019 to 2022.

During the years 2010–2012 Riitta Keiski has served as a Chairperson of the Gender Equality Board of the University of Oulu. Gender equality mainstreaming has been part of her leadership and she has acted as a role model for girls and inspiration for students in green engineering and sustainability (see e.g. Saavalainen 2020). Besides, she has been a member of the working groups for Gender Equality Plans of the Academy of Finland and the University of Oulu.

Sources

Wikipedia: Riitta Keiski https://fi.wikipedia.org/wiki/Riitta_Keiski.

University of Oulu: <https://www.oulu.fi/yliopisto/tutkija/riitta-keiski>.

Finnish Union of University Professors, Vimeo: <https://vimeo.com/32625698>.

Science for Girls, interview: <https://www.tiedettatytoille.fi/riitta-keiski/>.

3.4.4 *Mathematics and Physics*

Dr. Sari Harmoinen is a lecturer on subject studies, mathematics, and physics at the Faculty of Education of the University of Oulu. She was appointed as docent on STEAM teaching and learning at the University of Turku 2020. Before teaching at the University of Oulu, Dr. Harmoinen was a high school mathematics and physics lecturer at the city of Oulu and a secondary school mathematics, physics, and chemistry. As the Education Dean of the Faculty of Education at the University of Oulu in the past six years, she has been responsible for all curriculum development and for the quality of education at the faculty. Together with her colleagues, she is developing two minor study subjects: Sustainable Development Studies (SDS) and STE(A)M. The SDS is expected to be launched in 2022.

Dr. Harmoinen has contributed widely to the quality and development of education both nationally and internationally. She was a member of the EUA peer group in 2019; Vice-Chair of FINEEC's Evaluation Council and member of FINEEC's Higher Education Evaluation Committee in 2018–2022; and a member of the Teacher Education Development Programme of the Ministry of Education and Culture.

According to the study on university students' readiness for social activity in climate actions (Harmoinen et al., 2020), students are interested in climate change but need reliable fact-based information on it. However, students are already considering contributing to climate actions.

Sources

Wikipedia: https://fi.wikipedia.org/wiki/Sari_Harmoinen.

University of Oulu: <https://www oulu.fi/yliopisto/tutkija/sari-harmoinen>.

News: <https://www oulu.fi/fi/uutiset/ilmastonmuutospuhe-kyllastytaa-nuoria-mutta-saa-aikaan-myos-tekoja>.

3.5 **Lessons Learned on Gender and STEM Leadership**

In the previous chapter, the successful and unique careers of four professional women in STEM and related fields at the University of Oulu were briefly presented based on already existing publicly available online materials. These women have been working as researchers and teachers, research group leaders, innovators, role models, supervisors, and supporters of younger female STEM professionals. Their scientific achievements in their own academic research areas—in medical biochemistry, telecommunications, environmental and chemical engineering, and in teaching of mathematics and physics—have been remarkable.

Furthermore, they have been elected to positions at the very top of their entire university: as the Vice-Rector in Research (Taina Pihlajaniemi), the Dean of the Faculty of Technology and former Vice-Rector in Education (Riitta Keiski), Director in Sustainability and Regulation of the 6G Flagship (Marja Matinmikko-Blue), and Education Dean of the Faculty of Education (Sari Harmoinen). As part of these listed administrative academic duties, they have also put in efforts to promote gender equality in STEM fields in various projects and campaigns and even more broadly, as one of them has chaired the Gender Equality and Diversity Board (GEDB) of the university, and one is the current Chair of the GEDB.

By elaborating these four unique careers, we were able to compile these women's multiple international professional roles in STEM fields and in relation to gender equality promotion in their university. As a result of this collective action their individual leadership roles as influential women in STEM fields become even more visible. Gradually it becomes apparent, that through their professions, institutional positions, duties, and responsibilities they were influencing further on attraction, access, and retention of other women in their STEM careers, as well as sustainable development in general and UN SDG's in particular.

These women are in their 40 s, 50 s, and 60 s. They all originate from Northern Finland and from the sparsely populated countryside municipalities, from places such as Haapajärvi, Halsua, Rovaniemi, and Rovaniemi countryside. They all have extensive international experience through their research and development projects. Despite their international academic careers and networks, they are affiliated to the University of Oulu. Two of them have built their careers at the University of Oulu and two of them have built a career first outside the university—one in the public sector and the other, in a state owned non-profit company. The following table presents the main public leadership channels of the four women working in STEM and related fields, as they appear in the public data: academic professions, administrative positions, and appointments to gender equality promotion tasks and projects (Table 3.1).

Many women in STEM fields receive requests to join various projects and campaigns to attract more women into the field (Brunila et al., 2005). Such campaigns and projects as the Shaking up Tech, Women in Digital, Science for Girls, Women in Mining, Women IT in addition to W-STEM appear in data. These projects include strategies for structural transformation through implementation of systematic institutional measures, which quite blatantly aim to expose gender as an organising principle at the institution (Garcia-Holgado et al., 2020; UNESCO, 2017b; EIGE 2016). Such transformative practices include gender mainstreaming in all institutional actions, gender equality planning (GEP), as well as sex and gender analysis of research projects (European Institute for Gender Equality (EIGE, 2016). However, these tasks require at least human resources, so leadership to improve institutional gender equality is needed and in addition to that a collective, systematic commitment for its actual progression and for implementation of GEP.

Two of the leaders have chaired the Gender Equality and Diversity Board (GEDB) of the University of Oulu. The main role of the GEDB is to draft the university's GEP,

Table 3.1 Channels for women’s leadership in STEM—profession, position, and promotion of gender equality

Name	Profession	Position	Promotion of gender equality
Dr. Taina Pihlajaniemi	Professor in Medical Biochemistry	Vice-Rector in Research	Chair of the Gender Equality and Diversity Board
Dr. Marja Matinmikko-Blue	University Researcher in Telecommunications	Director in Sustainability and Regulation of the 6G Flagship	Shaking up Tech, Women In Digital
Dr. Riitta Keiski	Professor in Chemical Engineering (Mass and Heat Transfer)	Dean in the Faculty of Technology, Former Vice-Rector in Education	Former Chair of the Gender Equality and Diversity Board, Science for Girls, Women in Mining
Dr. Sari Harmoinen	University Lecturer on Physics and Mathematics Didactics	Education Dean in the Faculty of Education	Women IT, W-STEM

to monitor its implementation and to revise it every other year. The GEP includes an evaluation of the current gender equality situation, statistical information on the number of human resources and salary levels in different job categories and selected institutional gender equality issues for improvement with defined measures and targets, timetable and named parties responsible for implementing those measures, and indicators to measure improvements towards targets (EIGE, 2016).

In addition to gender equality promotion women have been taking active roles in development activities related to the UN Sustainable Development Goals (UNESCO, 2017a) in universities. This has become apparent for instance in the White Paper on 6G Drivers and the UN SDGs led by Matinmikko-Blue et al., (2020), which describes the role of telecommunications in Agenda 2030. Also, minors in the Sustainable Development Studies (25 credits) and STE(A)M Studies (25 credits) under planning led by Sari Harmoinen are fostering educational capabilities for future professionals that will help them overcome their STEM subject silos and discuss global issues such as climate change (Harmoinen et al., 2020) on a transdisciplinary manner. Furthermore, supervision of postgraduate students in the Development of Sustainability Assessment Tool and Criteria for early stage process design projects (Saavalainen, 2020) has been in the core of activities in Riitta Keiski’s academic work.

It is quite challenging to get women appointed to the top management positions in STEM-related fields and also more broadly to the top administration at the University of Oulu. First, it is highly likely that due to fierce competition the top positions will be filled with a candidate who is selected among the majority group of professionals from STEM fields. However, in those STEM research fields, which have the largest

faculties in the University of Oulu, women are underrepresented, increasing likelihood that the minority position can create unconscious biases and thus hindrances for their career promotion, and against their access to the top positions (Frith, 2015) unless addressed by institutional support mechanisms (Husu et al., 2011).

3.6 Discussion—Strategies and Synergies for Women in Leadership

These four professionals have been and are important role models, encouragers for the STEM fields, and public speakers for campaigns for more gender equality in academia. They have built networks and alliances with SSH disciplines at the institutional, national, and international levels. Two of our focus women have a long-term affiliation with the university. In addition to an excellent academic record being familiar with one's Higher Education Institution, known and respected by colleagues may raise one's chances of having a leadership position there. Additionally a mentor's support is valuable (Husu et al., 2011). Two of the current women leaders have spent considerable time working outside the university right after their graduation providing them invaluable experience. Contacts to regional actors, municipalities, companies, and other research institutions are assets for career building also within University and for a leadership position in STEM fields.

Within the University of Oulu, institutional awareness of gender segregation as the underrepresentation of women in the STEM fields as more of a sustainability-related problem has increased. Global actions for gender desegregation are needed in both the STEM and SSH fields (Microsoft, 2017a). Identified barriers to women's entry into the STEM fields (UNESCO, 2017a) are just parts of the problem and thus, are enticing to solve for a start. Detailed understanding of the problem both on European (Bettio & Verashchagina, 2009) a national (Brunila et al., 2005; Microsoft, 2017b) and at the local level has increased (Pursiainen et al., 2018; Kaleva et al., 2019). Promising practices to solve the situated challenges have been identified and discussed further by various locally influencing actors (Brunila et al., 2005; Heikkinen et al., 2014; Ulvinen et al., 2021) during past two decades.

The W-STEM project has enabled networking, collaboration, and further articulation of the locally appearing challenges but also formulation of aspired-for solutions within an HEI. Synergies within our own local university, with W-STEM consortium partners and more extensively, through international networking have been and are empowering. Our local W-STEM work related to theoretical and conceptual development is contributing to closing the gender gap in STEM. This practical work took the form of articles published in the Arctic Yearbook 2021, entitled "Intersectional Gender-Responsibility in STEM: Co-Creating Sustainable Arctic Knowledge Production" (Heikkinen et al., 2020) and "The SAGA of Sustainable Development: Gender and Other Differences in Knowledge Production of HEIs in the STEM Field". The latter is an analytical project description published in the Finnish Gender Studies

journal called *Sukupuolentutkimus* (Heikkinen et al., 2021). Furthermore, a piece of an academic discussion on an institutional policy enforcement aimed at structural transformation, “Gender Equality in STEM Programs: A Proposal to Analyse the Situation of a University about the Gender Gap”, was published in the IEEE Global Engineering Education Conference proceedings (Garcia-Holgado et al., 2020).

3.7 Conclusion

Gender-based differences in participation in science, technology, engineering, and mathematics (STEM) fields have been apparent in higher education for decades (Brunila et al., 2005). According to the United Nations Educational, Scientific and Cultural Organization (UNESCO, 2017a), in (2014–2016), just around 30% of female college students worldwide selected STEM-related areas as their areas of study. The lowest proportion of women studied technology, manufacturing and construction, science, mathematics and statistics, and information and communication technology (ICT). One topic that has been brought up in literature is the Nordic gender paradox—a behavioural pattern among Western women of tending not to seek careers in STEM despite their success in school, due to which women remain a minority in STEM (Griffin & Vehviläinen, 2021). Within this broad global challenge, identified barriers to women’s entry in STEM fields (Microsoft, 2017a) are particularly challenging to solve. Global actions are needed to address gender segregation in both the STEM and Social Sciences and Humanities (SSH) fields by solving the identified root causes of the problem (Bettio & Verashchagina, 2009).

How could we provide appropriate support to our W-STEM project partners solving issues on gender segregation in Latin America, when we have not been able to solve them appropriately in Europe, including in global gender equality leaders Nordic countries? Certainly, we can learn from each other and hopefully, from our mistakes, so that we would not repeat them, but rather co-create new gender responsible and sustainable ways of seeing, being, and becoming with STEM and STEAM (Heikkinen et al., 2020) and further making and taking leadership.

In the W-STEM project, we have discussed with the consortium partners on critical science political issues such as the appropriateness to attract more women into STEM fields as change agents, as well as related geographical, societal, and cultural issues. Due to the course of W-STEM project we attempted to generate inspiration for locally tailored, evidence-based approaches for gender desegregation both in Latin America and in Europe to support such work also elsewhere. It seems that it is the way forward—to think globally and act locally.

Globally available online gender equality resources provided by UNESCO and EU have been beneficial for the local work. The UN STEM and Gender Advancement (SAGA) tool (UNESCO, 2017b) offer remedies for addressing gender equality issues in the STEM fields within an institution, including leadership. The European Institute for Gender Equality (EIGE) provides useful applicable promising practices for institutional gender equality work through the Gender Equality in Academia

and Research (GEAR) tool (EIGE, 2016). These SAGA and GEAR tools could be systematically utilised as part of the institutional GEP process, but most importantly in addition to leadership, the institutional gender equality work needs committed people, a community of practitioners—CoP's, that would benefit on interorganisational networking, support, and exchange of promising practices (Thomson et al., 2021).

Therefore, it is worth sharing that the University of Oulu launched its own Declaration on Responsible Science (Appendix) in 2020. The declaration includes gender responsibility, as follows:

We take into account the implementation of gender equality and diversity in the composition of research groups and research decision-making. We improve the scientific quality and the societal relevance of the produced knowledge, technology, and innovation by integrating gender analysis in research content.

Local Declaration on Responsible Science and European Responsible Research and Innovation (RRI) approach,³ as well as diverse ways to improve research integrity (Mejlgaard et al., 2020), pave the way for further intersectional gender equality mainstreaming at the HEIs. These approaches provide a set of useful tools for all leaders who take time from academic research for gender equality promotion at their institutions, for both women, men, and people who identify themselves differently. Thus, the administrative challenge is to provide appropriate academic merit for an individual on those institutional gender equality promotion efforts since they require serious personal input and leadership. Besides creating an equal culture and climate in HEIs is important for health and well-being of academics, it is also a profound matter in co-creating excellence in the academic outcomes.

Acknowledgements The authors acknowledge the Erasmus+ Programme of the EU in its Key Action 2, “Capacity-building in Higher Education.” We also thank Project W-STEM, “Building the future of Latin America: Engaging women into STEM” (Reference number 598923-EPP-1-2018-1-ES-EPPKA2- CBHE-JP), for the collaboration and important work in the field. The authors are solely responsible for the information and views expressed in this paper.

Appendix

Declaration on Responsible Science

The University of Oulu promotes open and responsible science, responsible conduct of research, sustainable development, equality and non-discrimination in research, and responsible research assessment.

We follow the responsible conduct of research, the principles that are endorsed by the research community, that is, integrity, meticulousness, and accuracy in conducting research, and in recording, presenting, and assessing the research results.

³ Responsible Research and Innovation tools: <https://rri-tools.eu/> Accessed 29.11.2021.

We promote sustainable development in all our research activities and take into account its ecological, cultural, social, and economic dimensions.

We are committed to freedom of scientific research and to promoting open access to research knowledge.

We take into account the implementation of gender equality and diversity in the composition of research groups and research decision-making. We improve the scientific quality and the societal relevance of the produced knowledge, technology, and innovation by integrating gender analysis in research content.

We are committed, by signing the Finnish Declaration for Open Science and Research 2020–2025, to: promote openness as a fundamental value throughout the research community and its activities, strengthen societal knowledge base and innovation, and improve the quality of scientific and artistic research outputs and the educational resources based on them, and the fluid mobility and impact of research outputs throughout society.

We are committed, by signing the DORA Declaration, to the development of research assessment and responsible use of metrics. When assessing research, we take into account the value of all research results as well as a wide range of different indicators, including qualitative indicators such as the impact on society.

We support the goals of the European Open Science Cloud (EOSC) to bring together open science data services and data produced in the EU to make the use of services and the sharing of research results as simple and easy as possible.

References

Responsible conduct of research and procedures for handling allegations of misconduct in Finland (Finnish Advisory Board on Research Integrity).

The European Code of Conduct for Research Integrity (European Federation of Academies of Sciences and Humanities).

The United Nations Sustainable Development Goals.

Sustainability and responsibility theses of the UNIFI (Universities Finland).

Bonn Declaration on Freedom of Scientific Research
Gender Equality (Responsible Research and Innovation Tools)
Promotion of equality and non-discrimination at the Academy of Finland
Vademecum on Gender Equality in Horizon 2020
Declaration for open science and research
DORA Declaration
EOSC Declaration.

Source Responsible research.

<https://www.oulu.fi/en/science-arctic-attitude/responsible-research>.

References

AHDRII, Nordic Council of Ministers. (2015). Arctic human development report: regional processes and global linkages. <https://doi.org/10.6027/9789289338837-15-en>.

- Alcalde, M. C., & Subramaniam, M. (2021). Women in leadership in academe still face challenges in structures, systems and mind-sets (opinion). Inside Higher Ed. <https://www.insidehighered.com/views/2020/07/17/women-leadership-academe-still-face-challenges-structures-systems-and-mind-sets>.
- Bettio, F., & Verashchagina, A. (2009). Directorate-general for employment, social affairs and equal opportunities European Commission. Gender segregation in the labour market. Root causes, implications and policy responses in the EU. European Commission's Expert Group on Gender and Employment (EGGE). <https://op.europa.eu/en/publication-detail/-/publication/39e67b83-852f-4f1e-b6a0-a8fbb599b2>.
- Brunila, K., Heikkinen, M., & Hynninen, P. (2005). Difficult but doable. Good practices for equality work. University of Oulu, Kajaani University Consortium. Kainuun Sanomain Kirjapaino Oy, Kajaani. http://www.kajaaninyliopistokeskus.oulu.fi/proj/womenit/difficult_but_doable.pdf.
- Buitendijk, S., & Maes, K. (2015). Gendered research and innovation: Integrating sex and gender analysis into the research process. Advice Paper, 18. <https://www.leru.org/publications/gendered-research-and-innovation-integrating-sex-and-gender-analysis-into-the-research-process>.
- Cheung, F. M. (2021). The “state” of women’s leadership in higher education. *International Briefs for Higher Education Leaders* nbr, 9. <https://www.acenet.edu/Documents/Womens-Rep-in-Higher-Education-Leadership-Around-the-World.pdf>.
- European Commission. (2021). Gender equality in research and innovation. https://ec.europa.eu/info/research-and-innovation/strategy/strategy-2020-2024/democracy-and-rights/gender-equality-research-and-innovation_en.
- Davies, B., & Gannon, S. (2006). *Doing collective biography: Investigating the production of subjectivity*. Open University Press.
- Directorate-General for Research and Innovation (European Commission). (2019). *She figures 2018*. Publications Office of the European Union. <https://doi.org/10.2777/936>.
- Directorate-General for Research and Innovation (European Commission). (2020). *Gendered innovations 2: How inclusive analysis contributes to research and innovation - Policy review*. Publications Office of the European Union. <https://doi.org/10.2777/316197>.
- EURAXESS. (2019). Status update of gender equality in research careers in Europe: She figures 2018. <https://euraxess.ec.europa.eu/worldwide/japan/status-update-gender-equality-research-careers-europe-she-figures-2018>
- European Institute for Gender Equality (EIGE). (2016). Gender Equality in Academia and Research (GEAR) tool. <https://eige.europa.eu/gender-mainstreaming/toolkits/gear>
- Frith, U. (2015). Understanding unconscious bias. <https://royalsociety.org/topics-policy/publications/2015/unconscious-bias/>
- García-Holgado, A., Mena, J., García-Peñalvo, F. J., Pascual, J., Heikkinen, M., Harmoinen, S., García-Ramos, L., Peñabaena-Niebles, R., Amores, L. (2020). Gender equality in STEM programs: A proposal to analyse the situation of a university about the gender gap. In *IEEE Global Engineering Education Conference* (pp. 1824–1830). <http://hdl.handle.net/10366/142961>.
- Griffin, G., & Vehviläinen, M. (2021). The persistence of gender struggles in Nordic research and innovation. *Feminist Encounters: A Journal of Critical Studies in Culture and Politics*, 5(2). <https://doi.org/10.20897/femenc/11165>.
- Haraway, D. (1988). Situated knowledges: The science question in feminism and the privilege of partial perspectives. *Feminist Studies*, 14, 575–599. <https://doi.org/10.2307/3178066>.
- Harmoinen, S., Koivu, K., & Pääsky, L. (2020). University students’ readiness for social activity in climate actions. *Discourse and Communication for Sustainable Education*, 11(1), 134–152. <https://doi.org/10.2478/dcse-2020-0012>.
- Heidari, S., Babor, T. F., De Castro, P., Tort, S., & Curno, M. (2016). Sex and gender equity in research: Rationale for the SAGER guidelines and recommended use. *Research Integrity and Peer Review*, 1, 2. <https://doi.org/10.1186/s41073-016-0007-6>.
- Heikkinen, M. (2012). *Sexist harassment as an issue of gender equality politics and policies at university. Academic Dissertation*. University of Oulu.

- Heikkinen, M., Pääsky, L., & Harmoinen, S. (2021). Kestävän kehityksen SAGA—Sukupuoli ja muut erot korkeakoulujen STEM-alojen tieteellisen tiedon tuottamisessa. [The SAGA of Sustainable Development—Gender and other differences in a knowledge production of HEIs STEM fields]. *Sukupuolentutkimus*, 2, 38–43.
- Heikkinen, M., Okkonen, E., & Selesniemi, J. (2014). Segregaation tila Pohjois-Pohjanmaalla [The stage of (gender) segregation at the Northern Ostro-Bothnia]. <http://segregaationtila.blogspot.com/>.
- Heikkinen, M., Pihkala, S., Pääsky, L., & Harmoinen, S. (2020). Intersectional gender-responsibility in STEM: Co-creating sustainable arctic knowledge production. In: Heininen, L., Exner-Pirot, H., Barnes, J. (Eds.), *Arctic Yearbook 2020*. Akureyri, Iceland: Arctic portal (pp. 175–188). https://arcticyearbook.com/images/yearbook/2020/Scholarly-Papers/9_Heikkinen_et_al.pdf.
- Husu, L., Hearn, J., Lämsä, A. M., & Vanhala, S. (Eds.). (2011). Women, management and leadership – Naiset ja johtajuus. NASTA Women’s leadership project final report. Hanken School of Economics Research Reports 72. https://wiki.aalto.fi/pages/viewpage.action?pageId=95748875&preview=95748875/96207129/Nasta_loppuraportti.pdf.
- Järvelä, M. L. (1996). *Why hath this lady writ her own life...?: Auto/biography from feminist perspectives*. Oulun yliopisto, kasvatustieteiden tiedekunta (Vol. 2). Northern Gender Studies Publication.
- Kaleva, S., Pursiainen, J., Hakola, M., Rusanen, J., & Muukkonen, H. (2019). Students’ reasons for STEM choices and the relationship of mathematics choice to university admission. *International Journal of STEM Education*, 6, 43. <https://doi.org/10.1186/s40594-019-0196-x>.
- Martinsson, L., Griffin, G., & Giritli-Nygren, K. (Eds.). (2016). *Challenging the myth of gender equality in Sweden*. Policy Press. <https://doi.org/10.1332/policypress/9781447325963.001.0001>.
- Matinmikko-Blue, M., Aalto, S., Asghar, M. I., Berndt, H., Chen, Y., Dixit, S., Jurva, R., Karppinen, P., Kekkonen, M., Kinnula, M., Kostakos, P., Lindberg, J., Mutafungwa, E., Ojutkangas, K., Rossi, E., Yrjölä, S., & Öörni, A. (Eds.). (2020). *White paper on 6G drivers and the UN SDGs*. 6G Research Visions 2. University of Oulu. <http://urn.fi/urn:isbn:9789526226699..>
- Mejlgaard, N., Bouter, L. M., Gaskell, G., Kavouras, P., Allum, N., Bendtsen, A.-K., Charitidis, C. A., Claesen, N., Dierickx, K., Domaradzka, A., Elizondo, A. R., Foeger, N., Hiney, M., Kaltenbrunner, W., Labib, K., Marušić, A., Sørensen, M. P., Ravn, T., Ščepanović, R., Tijdink, J. K., Veltri, G. A. (2020). Research integrity: Nine ways to move from talk to walk. *Nature*, 586. <https://www.nature.com/articles/d41586-020-02847-8>.
- Microsoft. (2017a). Study: Why don’t European girls like science or technology? <https://news.microsoft.com/europe/features/dont-european-girls-like-science-technology/>.
- Microsoft. (2017b). Tutkimus: Miksi suomalaistyöt eivät kiinnostu luonnontieteistä? [Research: Why Finnish girls do not get interested on natural sciences?] <https://news.microsoft.com/fi-fi/2017b/03/02/tutkimus-miksi-suomalaistyot-eivat-kiinnostu-luonnontieteista/>.
- Nilsen, M. W., Bloch, C. W., & Schiebinger, L. (2018). Making gender diversity work for scientific discovery and innovation. *Nature Human Behaviour*, 2, 10. <https://doi.org/10.1038/s41562-018-0433-1>.
- Pursiainen, J., Muukkonen, H., Rusanen, J., & Sari, H. (2018). Lukion ainevalinnat ja tasa-arvo. [High School subject choices and gender equality.] No series. Oulu. <http://jultika.oulu.fi/files/nbnfi-fe201803135965.pdf>.
- Saavalanien, P. (2020). Sustainability assessment tool for the design of new chemical processes. University of Oulu, Faculty of Technology. Ph.D. thesis. <http://urn.fi/urn:isbn:9789526227719>.
- Sandberg, D. (2019). When women lead, firms win. S & P Global. https://www.spglobal.com/division_assets/images/special-editorial/iif-2019/whenwomenlead_.pdf.
- Schiebinger, L., Klinge, I., Sánchez de Madariaga, I., Paik, H. Y., Schraudner, M., & Stefanick, M. (2020). Gendered innovations in science, health and medicine, engineering, and environment. <http://genderedinnovations.stanford.edu/>.
- The United Nations Educational, Scientific and Cultural Organization (UNESCO). (2017a). Cracking the code: Girls’ and women’s education in science, technology, engineering and mathematics (STEM). UNESCO. <https://unesdoc.unesco.org/ark:/48223/pf0000253479>.

- The United Nations Educational, Scientific and Cultural Organization (UNESCO). (2017b). Measuring gender equality in science and engineering: The SAGA toolkit. SAGA working paper 2, UNESCO. <https://unesdoc.unesco.org/ark:/48223/pf0000259766>.
- Smieszek, M. G., Prior, T., & Matthews, O. (2018). Women of the Arctic: Bridging policy, research and lived experience. *Arctic Yearbook*. <https://arcticyearbook.com/arcticyearbook/2018/2018-briefing-notes/297-women-of-the-arctic-bridging-policy-researchlived-experience>
- Thomson, A., Palmén, R., Reidl, S., Barnard, S., Beranek, S., Dainty, A. R. J., & Hassan, T. M. (2021). Fostering collaborative approaches to gender equality interventions in higher education and research: The case of transnational and multi-institutional communities of practice. *Journal of Gender Studies*. <https://doi.org/10.1080/09589236.2021.1935804>.
- Ulvinen, V. M., Vaara, H., & Kaleva, S. (2021). *Report on the best STE(A)M practices in Finland and in Oulu region*. University of Oulu, Faculty of Education. University of Oulu Study Materials Series, E18. <http://jultika.oulu.fi/files/isbn9789526229928.pdf>.

Open Access This chapter is licensed under the terms of the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>), which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

