Intersectional Gender-Responsibility in STEM: Co-Creating Sustainable Arctic Knowledge Production

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In this article, insights about a global gender equality promotion instruments in science, technology, engineering and mathematics (STEM) are considered in the Arctic context to provide a gender-responsible view for the Arctic Yearbook 2020's Climate Change and the Arctic: Global Origins, Regional Responsibilities *theme. The paper's intersectional and gender-responsible approach addresses the diversity of people living in the Arctic in consideration of co-creating sustainable and responsible futures. Currently, gender perspectives are hardly integrated into the research processes, and horizontal and vertical gender segregation as well as diverse exclusions persist in science and technology in addition to disciplinary silos. In relation to this challenge, this article introduces one of the most recent global actions and policies to improve gender-responsibility in science and technology, namely the SAGA (STEM and Gender Advancement) tools, and elaborates their affordances in the context of Arctic knowledge production. Responsibility and sustainability demands that we rethink our interrelatedness and interdependency with the world in relation to knowledge production processes, as global and local citizens, with the capabilities for problem-defining and problem-solving. Thus we frame the main challenge as to advance multidisciplinary research affordances, co-creating the understanding and cultivation of our imagination in an aim to relate with care to sustainability and responsibility in and about the Arctic through knowledge production.*

Introduction

It has long been acknowledged that gender equality is a key driver for social and environmental development, as well as for health and well-being. Gendered innovations and a gender-responsible approach in scientific knowledge production, and especially in Science, Technology, Engineering and Mathematics (STEM) fields, contributes to scientific excellence and quality in outcomes, enhances sustainability, makes research more responsive to social needs and promotes the development of new ideas, patents and technology (Schiebinger et al., 2011-2018). Gender-responsible scientific approaches have become imperative in relation to scientific knowledge production and education for sustainability as men and women are not affected equally by climate change and globalisation, and their impacts on traditional and non-traditional economic activities in the Arctic (AHDR-II, 2015). Furthermore, within today's technology-driven knowledge society, the need to receive researched knowledge instantly to support decision-making has grown, while open science and open access publishing have made scientific knowledge more accessible to every

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citizen. Holt (2019: 107) states that "There are also the twin issues of increasing the inclusion of local knowledge and of moving debates about how to address climate change away from the exclusive control of 'experts' and into the public sphere." Citizens' science now encourages people to participate in the production of scientific knowledge by, for example, sharing their observations of nature (Heigl et al., 2019). Finland is currently preparing recommendations for science education that covers all human life. Also, the Right for Science, as part of the United Nations (UN) Declaration for Universal Human Rights, has become a significant global debate. Knowledge society is about reality with the means offered by digitalisation. Furthermore, the rationale, need and opportunities for the production of science-based decisions are better than ever. Recent emphasis on citizen science and the access allowed by digital technologies highlights that the Arctic region and related decisions, strategies and futures should also be accessible to the people of the region. Achieving this access requires cross-border, multidisciplinary and cross-sectoral inter- and intra-action (Barad, 2007) in the Arctic. Therefore we need to pay attention to how gender, Arctic localities, including Indigenous knowledges, access and science could afford to co-creating sustainable Arctic knowledge production.

We approach this challenge by asking how intersectional gender responsibility in STEM could operate towards sustainable knowledge production in the Arctic. We understand the Arctic as many, consisting of multiple Arctic realities as well as multiple Arctic sustainabilities (Tennberg et al., 2019). Situating also ourselves in the Arctic, we draw on our experiences of two ongoing education development and research projects that we are involved in at the University of Oulu. The projects are about studying readiness for climate actions among Higher Education (HE) students (Harmoinen et al., 2020) and improving policies for gender advancement in STEM fields (W-STEM, 2020). At the same time the perspectives from these cases pave the way for opening considerations whether the existing policy frameworks and epistemological and ontological parameters for gendering knowledge production in STEM and for accounting for entangled nature-cultural realities are sufficient. To respond to this challenge, we maintain it is crucial to contemplate voices that may be missing or ignored, considering gendered as well as Indigenous knowledges (IK), and take inspiration from emerging feminist new materialist and posthuman scholarship to enrich our discussion.

The gender perspective has been discussed and scrutinised in science in various ways ranging from feminist critique of the dominant and invisible male standard in science (e.g. Haraway, 1988) to a call for increased participation and more diverse roles for women and girls in STEM fields (e.g. United Nations Educational, Scientific and Cultural Organization [UNESCO], 2017a). Gender considerations have been found to be significant for improving the reliability of scientific knowledge production and improving individual research projects. Nielsen et al. (2018) argue that gender has an impact on three interrelated levels of research: 1) the composition of research groups; 2) the research questions presented within research projects; and 3) the research methods used. This approach can be summarised as *fix the numbers, fix the institutions and fix the knowledge.* It further concerns how science and research in general are managed in a gender-responsible way to strengthen high-quality research and societal empowerment (Nielsen et al., 2018).

Despite its apparent meaningfulness and impact for science and scientific knowledge production, the gender perspective has not been fully integrated into research processes in the Arctic (AHDR-II, 2015). The role and position of women was explored in a 'Women in Arctic Science and

Exploration' panel as part of UArctic Congress 2018—especially how policy, education, international collaboration and mentoring can support women's scientific careers and promote greater diversity in polar science. There has been a visible shift in the management structures of many polar organisations over the last 20 years, with more women hired in management positions, but still with little advancement in their roles. Thus, diversity should be taken on as a full package beyond the gender binary to include the race, age and sexual orientation of Arctic researchers, educators and managers. (Smieszek et al., 2018). Accordingly Sinevaara-Niskanen (2019) writes that endeavours towards greater equality and sustainability in the Arctic should reach beyond 'mere' matters of gender. This is also the focus of the University of Arctic (UArctic) an umbrella organisation, that has a collective aim to contribute to a sustainable North in an interdependent world (AHDR-II, 2015).

We contribute to this challenge of moving beyond gender binaries to consider 'intersectionality', as coined by Kimberlé Crenshaw (1995), and gender-responsibility, as used by Londa Schiebinger et al. (2011-2018). The combination of these two terms creates our departure point for this article *intersectional gender-responsibility in STEM,* which works towards two aims. First, it promotes sensitivity through the recognition of other simultaneous, intersecting socio-cultural categorisations in addition to gender. Second, it promotes scientific rigour and responsibility that recognises and accounts for the influence of gender and simultaneous socio-cultural categorisations in scientific research settings and reasoning.

In this article, our joint effort is to understand how failing to consider gender and other intersecting social categories in the Arctic scientific knowledge production related to STEM results in gaps in understanding and shortcomings in sustainability with limitations for a realization of the knowledge society and to implications for the entire planet. The authors of this paper come from diverse academic backgrounds, consisting of biology, geography, mathematics, physics, cultural anthropology, education and gender studies. This diversity is performed in the construction of this paper, as, in the following sections, we first establish why a STEM education itself is crucial for all citizens, drawing on experiences from current Finnish approaches to teaching STEM, and then elaborate on how the global SAGA tools may offer remedies for addressing gender equality in STEM fields. At the same time our expansive vision of intersectional gender-responsibility in STEM includes consideration of the diversity of people living in the Arctic, including Indigenous people and their knowledges, and discussions from feminist technoscience, particularly the intricate entanglements of human, nature, culture, climate and technology, built through following sections and elaborated more in the fourth section. With these considerations, we call for intersectional, gender-responsible and sustainable collectives for co-creating knowledge, which we see as a crucial step towards sustainability. We maintain that interdisciplinary 'cross-pollination' (Braidotti, 2019), and commitment to local realities and global policies are imperative to be responsive to sustainable human and 'more than' human Arctic futures and knowledge society.

Climate actions, scientific knowledge and education

Climate change is a severe problem and a complex, systemic challenge that requires knowledge, understanding and actions, especially from humans (Incropera, 2015). Transforming attitudes and actions to a more climate-friendly outlook is difficult in terms of individual perceptions (Harmoinen et al., 2020). Harmoinen et al. (2020) studied Finnish university students' reflections on their ability to affect climate matters through social activity and found that students ranked readiness for climate actions in social activity moderately low and lower than other climate actions considered in the survey. The data consisted of 1585 participants (65% women, 33.5% men, 1.5% other). Many respondents stressed the importance of factual knowledge and researched knowledge in building their own understanding. However, for human beings to arrive at sustainable solutions, in addition to acquired appropriate knowledge it is important to understand the individual, social and societal decision-making process and possible achievements at stake. Additionally we can reconsider the purpose of the entire 'scientific knowledge production'. Traditionally scientific knowledge has been understood as involving the production of knowledge (primarily) for human well-being and as an informant in decision-making processes (Holsman, 2001). Even today, we should ask ourselves whether science and knowledge production reaches all people and societies sufficiently? Is it as available for everybody as the Universal Declaration for Human Rights proclaims, giving an individual the right to science and to share in scientific advancement and its benefits? Wyndham and Vitullo (2018) posit that "[e]ssential tools for ensuring access include science education for all, adequate funding, and an information technology infrastructure that serves as a tool of science and a conduit for the diffusion of scientific knowledge" (975).

Climate change in the Arctic amplifies the consequences, for example the melting of permafrost releases methane, which in turn exacerbates climate change. The climate has always changed, both locally and globally. However, while the background to past climate change is natural, such as asteroid collisions and volcanic eruptions, the current climate change results from the increase in the amount of carbon dioxide in the atmosphere which is most likely the result of human activity. The current warming trend since the mid-twentieth century is proceeding at a rate that is unprecedented over decades to millennia. In August 2016, at the International Geological Congress 35IGC (http://www.35igc.org/) a group of experts declared a new geological epoch—Anthropocene—based on the effects of humans on Earth since the Industrial Revolution c. 1800 CE that began with the spread of agriculture and deforestation followed by the 'Great Acceleration' of population growth and industrialisation. The Anthropocene, a term proposed originally by atmospheric researcher Paul J. Crutzen (2002), began with the large-scale execution of nuclei visible in glacier drilling in 1950. The human effects of the beginning of this epoch are visible also for example the large-scale appearance of plastic debris, concrete and chicken bones, on Earth (Trischler, 2016). The Anthropocene is associated with the new, ongoing sixth wave of mass extinction, an increase in the amount of carbon dioxide in the atmosphere, sea-level rise and deforestation that threaten all species' survival and crucially influence human activities.

Climate change is a multidimensional, multifaceted phenomenon, which involves ethical and emotional nuances that are not simple to discuss (e.g. Harmoinen et al., 2020). For example, because water on Earth has circulated here throughout its existence, if there is drought and famine somewhere, the missing water must be somewhere else, in a place experiencing heavy rainfall and floods. Accordingly, climate change and its manifestation, look very different depending on the area. The interconnectedness of these phenomena is basic knowledge, which is studied in schools from primary school onwards. If we know how and why rainfall occurs and how to look at the uneven distribution of rainfall in different regions, we will be able to understand more about climate change. All these dynamics can be taught to all schoolchildren, but a stronger understanding and connection to everyday phenomena will help them to learn to make sustainable solutions and choices from a future perspective as well.

In Finnish education, every child and young person acquires fundamental knowledge and skills during basic education, such as civic skills for their lives and future tenure. The foundations of local curriculum in Inari strongly emphasize the importance of building one's own cultural identity and positive environmental relations, especially from a Sámi perspective (Inari, 2016). Education has long been subject-oriented, without making strong connections between different points of view. For example, aspects of the rain example presented earlier would be studied in physics in the context of thermal phenomena and humidity. In chemistry, the phenomenon would be examined in terms of the motion of molecules and the states and changes of substances, such as the water. Geography would consider the wind and air pressure, and biology would study the growth conditions and water cycle. That is, while a student covers all the key phenomena, the connections and significance between them in discipline-based shared education may remain thin. Since 2014, the national core curriculum of basic education has strongly highlighted multidisciplinary learning to help students practicing understanding of complexities and skills. In everyday and everyday situations, this information integration and information processing skill is central and important to citizenship knowledge (Finnish National Board of Education, 2016). In Finnish education, there is not a single subject encompassing STEM, but is there a need for that in the future? The concept of STEM is not used in Finnish education, but the concept of LUMA (https://www.luma.fi/en) has a very similar meaning that covers natural sciences, mathematics and technological examination.

Regarding the UN (2012) Framework Convention on Climate Change, the Doha work programme on Article 6 of the Convention recognises that education aims to advance sustainable development by promoting lifestyle changes and preparing both individuals and communities for the effects of climate change. As indicated by UN institutions, decisions concerning development need to be made on a societal level and not left only to individuals. This concerns advancement of gender equality as well. Since the 2015 United Nations General Assembly, education and gender equality are integral to the 2030 Agenda for Sustainable Development and distinct Sustainable Development Goals (SDGs). According to Cracking the Code report (UNESCO, 2017a) 28% of the world's researchers are women today. In 2016, member states adopted a decision on the role of UNESCO in encouraging girls and women to be leaders in STEM. Therefore, it is a global and societal responsibility to ensure that STEM fields are equally available and acceptable education and career choices for women and girls. It is important that also they can find possibilities and support to nourish their interest in scientific knowledge also within and about the Arctic.

Tools for STEM and Gender Advancement (SAGA) – also in the Arctic?

A recent development in gender policies and statistics has been the global SAGA initiative (UNESCO, 2019b) that promotes gender equality in Science, Technology, and Innovation (STI). The aim of the initiative is to assist in the improvement of the measurement and assessment of women's situation in STI, advancing the participation of women in STEM and increasing the recognition of women's achievements globally (UNESCO, 2018a, 2019b). It is a project launched by UNESCO in 2015 with support from the government of Sweden (UNESCO, 2019b). SAGA methodology, published in a multi-volume work (see UNESCO, 2018a, 2019b), includes tools designed to be used by policy-makers in reviewing national STI policies in particular to identify deficiencies in their current composition from a gender equality perspective, but it also contains tools that enhance the collection of gender-related data, which is expected to further gender equality advancement in STEM at different educational and research institutions.

The 'Science, Technology and Innovation Gender Objectives List' (STI GOL), the backbone of SAGA, is used as the common element in all the main tools, linking indicators with policy instruments (UNESCO, 2016, 2017b). STI GOL enables the classification of policies and indicators according to seven areas of gender objectives that are further divided into more specific goals (UNESCO, 2016). Regarding policies, the actual classification task is conducted using the 'STI Policy Survey' (collects information using a question set) and the 'SAGA Policy Matrix' (categorises the information based on the STI GOL) (UNESCO, 2017b, 2018a). The 'SAGA Indicator Matrix' guides the review of statistical information relevant to the evaluation of gender equality, offering an indicator list consistent with the objectives of the STI GOL (UNESCO, 2017b). UNESCO aspires to see the designed SAGA methodology applied as a global standard, recognizing however that adjustments may be required due to differing national or institutional structures and approaches (UNESCO, 2017b, 2018a).

The University of Oulu in Finland participated in the collection of institutional data on gender equality in STEM fields along with 15 Higher Education Institutions (HEIs) taking part in W-STEM, an Erasmus^{+} project that seeks to engage women in STEM (W-STEM, 2020). Drawing on our situatedness in the Arctic, experiences gained from the deployment of the data collection matrix—an applied SAGA Indicator Matrix—enable us to consider the affordances of the SAGA tools from the specific perspective of Arctic knowledge production taking into consideration the diversity of inhabitants in the Arctic, especially Indigenous knowledges and the diversity of gender.

Indigenous knowledges (IK), or Indigenous knowledge systems, are special capacities 'tailored to particular places and peoples and are trustworthy from a community standpoint' (Whyte, 2018: 75). The STI GOL does not mention Indigenous people or IK (see UNESCO, 2016), but the SAGA Policy Survey and Policy Matrix acknowledge them. The Policy Survey recommends considering whether the ministry's and high authority's examined policy instrument promotes indigenous knowledge systems and whether 'the Indigenous peoples and local communities' are among the beneficiaries or targeted groups (UNESCO, 2018b: 35). Also, a data collection section regarding measures and activities that universities and research institutions implement recommends identifying beneficiaries, including Indigenous peoples. Accordingly, the Policy Matrix describes Indigenous peoples and local communities as possible target groups of policy instruments (UNESCO, 2017b). However, the SAGA Indicator Matrix does not refer to Indigenous people or IK (see UNESCO, 2017b). We find this to be a limitation that should be taken into consideration when the matrix is practically implemented in the Arctic and appropriate alterations should be taken into account.

Regarding STEM, the SAGA project aims to include all people connected to the field (UNESCO, 2017b). Besides certified professionals pursuing a career in STEM, it comprises individuals who work in science and engineering (S&E) without a formal education, and who have this education but do not currently work in the sector. However, SAGA's S&E workforce division that uses the International Standard Classification of Occupations excludes a group 'skilled agricultural, forestry and fishery workers' (see UNESCO, 2017b: 36–38). Also, SAGA's definition of researcher that is from the Frascati Manual of the Organisation for Economic Co-operation and Development (OECD) (UNESCO, 2017b) is rather centred on theoretical knowledge: 'Researchers are professionals engaged in the conception or creation of new knowledge. They conduct research and improve or develop concepts, theories, models, techniques instrumentation, software or operational methods' (OECD, 2015: 162). Therefore, the traditional ecological knowledge (TEK) and occupation of a Sámi fisher may be considered as outside STEM, although traditional knowledge can be more complete than scientific knowledge especially at local level (see e.g. Joks & Law, 2017).

The above examples of choices and standards in SAGA make visible some of the tensions that can emerge when considering global tools in a local context. Yet, the integration of different outlooks is a valuable aim. For example, Leduc (2010: 227) suggests in *Climate, culture, change: Inuit and Western dialogues with a warming North* to ask 'how we understand and live with this complex reality in a more inclusive way'. Cajete (2018: 15, 22) views 'Native Science' as 'a people's science', and according to him, the often elaborate Native technologies have emerged to handle place-specific issues. Instead of aiming to create a global market where local knowledges are coded into 'the terms of a universal discourse', Gough (2013: 33) suggests creating conditions under which different knowledge traditions 'can be performed together'. The similarities and distinctions between Indigenous and Western Science need to be honoured (Lowan-Trudeau, 2015). Gillis et al. (2017: 203) use the term 'knowledge builder' to include diverse research systems 'available to discipline building beyond the Western science paradigm'. In the Sevettijärvi region, traditional Skolt Sámi knowledge served as the basis of guidelines for how to return the spawning areas of trout and grayling to their natural state in summer 2017 (Fotonoff, 2017). Local Skolt Sámi and officials cooperated in all aspects, and the project was the first of its kind in Finland (Fotonoff, 2017). Kimmerer (2018) has pointed to prioritising the cultivation of conditions for both knowledge systems' coexistence and their adaptive solutions, which is a necessary and sustainability-enhancing proposition.

Challenges regarding the advancement of diversity in Arctic knowledge production in connection to SAGA do not relate only to indigenous people but also to the questions of gender. The gender equality that the SAGA project promotes considers women and men (see UNESCO, 2017b), but no other gender positioning. This choice of a binary may be for practical reasons, but it is also reflective of the wider discursive practices of gender in gender equality policies, which do not necessarily align with the ways people experience their gendered subjectivities, as became visible during the use of the data collection matrix. The radical transformation, enabled by the full dissolution of female and male categories, that Heybach and Pickup (2017: 624) describe as lying 'dormant in STEM' is, at least to some university students in Oulu (in STEM or in other fields), an aim that is acted out: There are students who do not want to identify themselves by gender in forms such as questionnaires. This may, however, complicate the determination of the state of gender equality.

SAGA advances the gender equality in STI in the STEM sector instead of STEAM (Science, Technology, Engineering, Arts and Mathematics) due to a choice of focus as well as the challenges of collecting and analysing data about the arts (UNESCO, 2017b)—The SAGA initiative involves a burden of measurability. The politically valuable aims of SAGA towards acquiring data on women in STEM also engenders inadvertent exclusions particularly as the SAGA tool is rooted prominently on established Western standards and norms. Despite its intentions to promote gender equality, when brought to bear within the Arctic contexts, perspectives emerge that challenge acknowledging the diversity of people, experiences and knowledge systems in a more nuanced manner. Furthermore, instead of disciplinary silos, gender binaries and exclusive Western epistemologies and definitions, it is important to reflect upon and re-imagine the definitions of knowledges and sciences and the responsibilities that situated knowledge producers have.

Re-imagination for sustainable knowledge production

In various ways, the pressing questions of unsustainability, and particularly of the climate crisis as one of its urgent manifestations, have propelled scholars and educators to re-imagine sustainability, knowledge productions and education. As Malone and Truong (2017) have observed, '[w]hile the terminology might shift between countries, fields, and genres [...] it is certain we are all speaking about the same imperative—the desire to find new ways of theorising and educating about being with, and in relation to, the planet' (5). One of the theoretical and conceptual lenses for this re-imagination in Western academic discussion has emerged from post-anthropocentric theorisations. This thinking in recent social theory, including feminist scholarship (e.g. Barad, 2007; Braidotti, 2013; Haraway, 2016) recapitulates in many ways many earlier non-Western and Indigenous ontologies underscored by attention to the inseparability of nature and culture and the agency of non-human others, such as other animals, plants and spirits (Fox & Alldred, 2019; Rosiek, Snyder & Pratt, 2020).

We find this thinking generative for the discussion of responsible and accountable knowledge production in this paper. Firstly, the dissolution of humanist nature-culture and mind-matter dualisms offers ways forward from a conception of sustainability that can be considered to prioritize human interests (e.g. Alaimo, 2016). Instead, Fox and Alldred (2019: 124) summarise this new version of sustainability as one "no longer to be considered as a state to be achieved, but rather as a flow of multiple affects that produces capacities and potential in (post) human and non-human matter (Braidotti, 2011: 312-3; Parr, 2009: 161)." Furthermore, the focus on entanglements, intra-action and reconfiguring (Barad, 2007), rather than distinct entities, enables attention to phenomena of our socio-material reality not for what they are but what they *do*. This approach applies as much to policies like SAGA and sustainability as to practices of knowledge production; different epistemological, historical and material reconfigurations not only engender different knowledge about the world but also different realities, possibilities and capacities (e.g. Barad, 2007). In this sense, the practices of knowledge production (such as STEM) and the policies for its advancement (such as SAGA) are always non-innocent and implicated, making us responsible for a world "we have a role in shaping and through which we are shaped" (Barad, 2007: 390). Hence, the different ways we measure, define and categorise our nature-cultural realities, is not only a matter of understanding but of shaping particular realities.

In their introduction to *A Feminist Companion to the Posthumanities* (2018), Åsberg and Braidotti underline the imperative for a 'critical and creative framework for performative and generative accounts of technoscientific or other nature-cultural practices across disciplines and categories' (p. 18). We understand this call for creative and critical frameworks as useful to thinking about the co-compositions of intersectional, gender-responsible STEM in the Arctic. There is a widespread understanding that inclusion and access to knowledge production is a human right in and of itself (UNESCO 2019a). It is equally understood that open, inclusive, intersectional, gender-responsible practices of knowledge production are essential to address today's challenges (UNESCO, 2017a), such as human-induced climate change. In a sense, these two facets of inclusion also underscore the SAGA tool, which aims specifically to advance gender in STEM fields. However, we understand Åsberg and Braidotti (2018) to allude to an orientation that not only includes or grants access within the frames of existing structures and categories but troubles their very distinctions, their epistemological contingencies and performative exclusions and inclusions. This approach in which different epistemological, material, social and historical constellations co-create different worlds can also inform practices for capacitating sustainable knowledge production. As an academic endeavour, this might entail, as Reardon (2013: 192) argues,

> imagining other routes to knowledge and justice [...] that derive not from codified reactions but from responses to the specific conditions and consequences of knowledge production. Within universities, these spaces must not be seen as 'interdisciplinary' add-ons but as fundamental to what it means to discipline ourselves in a manner that allows us to know, respond, and care for a diverse range of liveable and desirable lives.

In line with the critical posthumanist project of Braidotti (2019), this could be understood as a challenge for capacitating and constructing conditions for "nomadic lines of flight" that cut across and recompose "the dominant knowledge production systems precisely through creating multiple missing links, opening generative cracks and inhabiting liminal spaces" (49). As we understand it here, this underlines the need to account for the conditions that influence our capabilities to make an epistemic contribution (Fricker, 2015) and highlights the transformative value and ethico-political significance of recomposing missing, ignored and marginalised epistemic openings. These are crucial connections within academia. For example, Koskinen and Rolin (2019) highlight the epistemic importance of Indigenous studies for scientific/intellectual knowledge. However, these new re-compositions of knowledge production may also trouble the established barricades of scientific knowledge, such as those of Indigenous ways of including, for example, spirituality, community and creativity in their knowledge systems/Native science (Cajete, 2018) or by fostering connections with creative, art and activist assemblages with the natural world (see e.g. Subzero collective, https://sub-zero.org/). When locating ourselves in the Arctic, and when acknowledging both the importance of gender policies in STEM and taking on to find missing links and liminal spaces, we find relevance in expanding from merely 'adding' gendered or Indigenous perspectives or voices into STEM. Instead, we make a proposition of imagining and taking responsibility for cultivating a situated STEM that is responsible and accountable for its social, material, historical and discursive contingencies, constitutive exclusions and materialising effects, and committed to stemming from and for the Arctic.

Stemming conclusions

Arctic situatedness is multiplicitous. It is sometimes defined as consisting of eight states of sparsely populated areas but also including urban hubs that are all undergoing constant transformation due to the global challenges posed by climate change, globalization and digitalization. Intersectional gender responsibility productively resonates with this multiplicity by bringing in diverse people with a variety of situatedness, standpoints and rich knowledge, skills, values and views. Furthermore, the Arctic is well known for its vulnerable non-human others, such as climate, glaciers, polar bears, oil, gas, minerals and Arctic sea routes, that are of major interest to researchers but also corporations. Responsibility and sustainability demand that we rethink our interrelatedness and interdependency with the Arctic in relation to equitable knowledge production processes and related policies.

In this paper, we have touched upon the issue of whether the global SAGA policy could be further co-designed for local applications in the Arctic to improve access and resulting affordances for situated STEM. Both gender equality policies and science policies are developed to improve equality, equity and excellence, as well as sustainability. These intertwined policies aim to define and enable sustainable knowledge production. The question is profoundly about an epistemic contribution, which is considered a human capability fundamental to ensuring human wellbeing and—we propose—quality of knowledge.

One of the main challenges is to advance multidisciplinary research affordances to co-create a multifaceted understanding and cultivate our imagination to relate with care to the Arctic through knowledge production. The definition of STEM/STEAM is part of that discussion. For instance, due to practical measurability-related challenges, the A for arts was excluded from the SAGA approach, resulting in other epistemology-related consequences. Co-creation requires the participation of a diverse group of people, but it also involves and benefits from a diverse set of methods, which we will learn to apply in collaboration with Indigenous knowledge holders and artists, such as those in the SubZero project. Additionally, the gender divide between the disciplines in the categories of 'natural sciences' and 'social sciences and humanities' is persistent and requires the consideration of institutional remedies that challenge organizations conducting research (including UArctic organizations) to implement situated and intersectional gender equality plans. Finally, what is ultimately at stake is learning to understand interrelated and interdependent human and other than human complexities and make connections collectively and co-creatively—being with and in relation to the planet.

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