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Seeds of transformative learning and its pedagogical implications on a conference-based university course for environmental and geosciences

Joula Siponen[1,2], Janne J. Salovaara[1,2], Karoliina Särkelä[1,3], Inka Ronkainen[4], Salla Veijonaho[4], Veli-Matti Vesterinen[4,5], Isabel C. Barrio[6], Laura Riuttanen[1], Katja Anniina Lauri[1]

[1]Institute of Atmospheric and Earth system Research (INAR), University of Helsinki, Finland
[2]Helsinki Institute of Sustainability Science (HELSUS), University of Helsinki, Finland
[3]Water, Energy, Environmental Engineering research unit, Faculty of Technology, University of Oulu, Finland
[4]Faculty of Educational Sciences, University of Helsinki, Finland
[5]Department of Chemistry, Faculty of Science, University of Turku, Finland
[6]Faculty of Environmental and Forest Sciences, Agricultural University of Iceland, Reykjavík, 112, Iceland
Correspondence to: Joula Siponen (joula.siponen@helsinki.fi), Institute for Atmospheric and Earth System Research, P.O. Box 4, 00014 University of Helsinki, Finland

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Abstract.

Expertise in Arctic climate change requires not only a deep knowledge of the physical processes but also an awareness and understanding of the region's complex socio-economic dynamics. In this study, we explore students' learning experience on a university course where students of environmental and geosciences attend the Arctic Circle Assembly conference, introducing them to a wide range of stakeholders and viewpoints from geopolitics to Indigenous perspectives. With a qualitative inquiry, we study the students' sense of belonging and transformativeness of the learning process, and how those might influence the development of the students' professional identity. Interviews in the event, written reflections of the students and post-course in-depth interviews reveal elements of the transformative learning process, in which the students' sense of belonging played a role: lack of belonging to the expert community induced dilemmas and belonging to the student group enabled joined reflection. However, some dilemmas do not seem to lead into transformation. Therefore, as pedagogical implications of our findings, we highlight the importance of facilitation of critical reflection and discourse of the learner's values and beliefs. Facilitation should consider students' prior learning and background and include building of trust and belonging in the learning community, enabling the challenging reflections. We suggest that flexible pedagogies and approaches of transformative climate change education have potential to mould students' professional identity and widen their perspectives on what it means to be a responsible scientist or expert in the Arctic context.

***Keywords**: transformative learning; sense of belonging; university pedagogy; climate change education; Arctic climate change expertise*

1 Introduction

The Arctic climate is warming three times faster than the global average (Zhou et al. 2024), having profound implications for ecosystems, economies, and societies, and requiring immediate action. The region has become an arena for conflicting interests and complicated geopolitical development (Andreeva et al. 2024; Østerud and Hønneland 2014). Indigenous communities advocate for the protection of their traditional ways of life, cultural heritage, and sustainable use of local resources. Environmental NGOs call for conservation of vulnerable Arctic nature and biodiversity and for the mitigation of climate change impacts, emphasizing the significance of the Arctic to the Earth's climate as a whole (Overland et al. 2019). At the same time, nation-states seek to assert sovereignty and secure access to oil, natural gas and rare minerals, as new areas open up for resource exploration and transport (Blunden 2012)—activities that are intrinsically linked to economic systems and extensive exploitation of nature behind climate change. Such contrary motivations are complicated by the current geopolitical tensions increasing the importance of resolving the issues of Arctic governance, resource exploitation, and responsible use of the environment (Kapsar et al. 2022; Young 2010). To ensure a sustainable and equitable future for the Arctic, multi-sectoral cooperation is needed. This entails incorporating science, and Indigenous and local knowledge in informing decision-making (Andreeva et al. 2024), which requires transformative changes in institutions, values and cultures (Wheeler et al. 2020). Hence, addressing climate change in the Arctic represents an adaptive challenge rather than purely a technical one, asking for systemic solutions (Gillard et al. 2016), co-learning, as well as willingness to rethink normative assumptions and practices.

Education is a critical tool for both individual and societal transformation, building the necessary capacity to address climate change, and other crises intertwined (Kronlid and Lotz-Sisitka 2014; Leite 2024; Mochizuki and Bryan 2015; Wals and Benavot 2017). Education can raise climate science literacy (Kubisch et al. 2022), encourage sustainable climate action individually and collectively (Kenis and Mathijs 2011; Leite 2024), and strengthen capabilities to innovate, adapt to environmental changes holistically (Krasny and DuBois 2019) and think autonomously (Mezirow 1997). To develop such

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Preprint. Discussion started: 19 February 2025

transformative climate change competence, a transdisciplinary approach that integrates scientific, socio-economic, and contextual dimensions of understanding is needed (Siponen et al. 2024).

This poses a challenge for geoscience education. The role of environmental and geoscience students and experts in this transformative effort is multifaceted. They are involved in bringing complex scientific data as accessible knowledge to wider audiences—bridging the gap between research and public engagement (Illingworth et al. 2018). Through involvement in societal activities, they can help societies adopt systems thinking and make evidence-based decisions (Shrivastava et al. 2023). The experts in Arctic climate change must grasps the interplay between physical processes—such as ice melt and permafrost thaw—and their cascading effects on global climate systems, ecosystems and local livelihoods, as well as the socio-economic challenges, such as the aforementioned pressures of resource extraction, geopolitical competition, and the rights of Indigenous communities. This interconnectedness of systems and the need for navigating ethical considerations, requires reflexivity from the practitioners and researchers working in the Arctic. They need to be able to critically assess their own agency, for example, in recognizing how their work can influence policies, perceptions, and actions within the Arctic. It is evident that geoscientists have a role in informing and engaging in climate action, but competencies supporting this role, such as systems thinking, normative thinking or interpersonal skills, are not necessarily widely incorporated into higher education of geosciences (Riuttanen et al. 2021). Another critically important, yet overlooked part of climate science education, in general, is policy literacy (Selin et al. 2017).

In this study, we explore students' perceptions on a course "Arctic Circle", where they are exposed to and get to engage with real-life (geo)political, environmental, cultural and economic discussions focused on the Arctic. Through interaction with other stakeholders in real-life context and the focus on student empowerment, belongingness and active learning, the course represents flexible pedagogies (Matheson and Sutcliffe 2017; Ryan and Tilbury 2013). In this learning setting we observe the appearance of two established qualitative theories in educational research: sense of belonging (SOB) (Hagerty et al. 1996) and transformative learning (Mezirow 2009), aiming at showing their role in the development of university students' Arctic expertise and expert identity. Our research questions are:

1) What elements of the transformative learning process can be recognised, and what aspects transformed?
2) How did the pedagogical approach support the students' expertise development, and what are the implications to developing education further?

We approach the transformative learning process by focusing on three steps: realisations and disorienting dilemmas; critical reflection and discourse; and outcomes. This study aims to add to the discussion on transformative learning among geo- and environmental sciences, and the utilization of flexible pedagogies to cultivate contextually relevant climate change expertise.

1.1 Case: "Arctic Circle" course

The "Arctic Circle" course lends its name from an annual event to which the students participated on the course. Arctic Circle Assembly welcomes annually a multisectoral audience of approx. 2,000 participants, as stakeholders of Arctic issues, to discuss, for example: geopolitics and security, climate change, Indigenous perspectives and rights, economic and sustainable development, as well as scientific research and innovations. The conference is organised in Reykjavík, Iceland, with a full three-day programme of plenary and topic-specific sessions to receptions, movie screenings and round table discussions: "Arctic Circle is the largest network of international dialogue and cooperation on the future of the Arctic and our Planet. It is an open democratic platform with participation from governments, organisations, corporations, universities, think tanks,

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Preprint. Discussion started: 19 February 2025

environmental associations, Indigenous communities, concerned citizens, and others" (https://www.arcticcircle.org/about, accessed 13.9.2024). Historically, the Arctic Circle network was built on political grounds in 2019 and led by the former president of Iceland Ólafur Ragnar Grímsson.

The "Arctic Circle" course is a master level course given by the Agricultural University of Iceland. The course was originally designed specifically to a Nordic Masters' Programme in Environmental Change in Higher Latitudes (EnCHiL), where students study geosciences, environmental sciences, and social sciences. The EnCHiL programme does not specifically address themes related to politics and business that are visible in the Arctic Circle Assembly. Therefore, this course was developed to expose students to a side of Arctic sciences that they might not yet be familiar with, and to reflect on their own role and identity.

The learning outcomes, respective learning activities and assessment tasks of the course are shown in Table 1 and course timeline in Figure 1. One in-person session was held to prepare the students for attending the assembly. One of the teachers of the course has previously been involved in organizing the conference and thus was able to provide an empirical perspective to the event and offer some guidance on navigating the programme to find suitable sessions. To motivate the students with plans and topics of interest their fellow students chose to attend at the conference, each student presented their participation plans to their peers in an online session prior to the conference. After the conference, the students were given 1-2 weeks to reflect on the experience before a joint discussion session was held. The course concluded with the students submitting a report on one topic presented at the assembly and a reflection on their overall experience of the event (Assignment instructions are included in the Appendix A). The teacher facilitated the learning sessions and interacted with the students actively during the sessions and the event. The course group was small: 13 students in total, with many students being familiar with the teacher from previous studies. During the conference, the students were accommodated in the same location for two nights, provided by the university.

The pedagogical approaches of this course can be seen to reflect transformative climate change education (Leite 2024) in many respects: transdisciplinarity and real-world connection—students face the real-world contexts in the event; cultural responsiveness—students engage with different knowledge systems, such as Indigenous knowledge; collaboration—the course structure is built around discourse; phenomena-based—students work on a theme of their choice, taking various perspectives, and searching information independently; place-based—with the strong Arctic focus. The combination of approaches can be considered novel in the field of environmental sciences and geosciences.

Intended learning outcomes	**Learning/teaching activities**	**Assessment tasks**
1) Gain knowledge through various academic fields that contribute to Arctic studies and increase the depth and understanding in their field of specialisation 2) Have knowledge and understanding of the role and interaction between different stakeholders, including local and national governments, private businesses, non-governmental organisations and the public	1) In-person introduction session before the assembly (2 teachers present) 2) Online session before the assembly for students to present their plans (1 teacher present) + introduction to the research	1) The course report (70% of the grade)—an academic essay on a topic of their choice 2) A networking exercise (20%) where they must interact with (at least two) other

https://doi.org/10.5194/egusphere-2024-4097
Preprint. Discussion started: 19 February 2025

3) Understand the relevance of economic and social issues in the Arctic 4) Be able to evaluate the suitability of the different methods of analysis and complex scientific issues for research and decision-making related to Arctic studies	3) Active participation in the assembly 4) In-person discussion session after the assembly 5) Writing a reflection on the assembly and own experience & a report on one session topic	participants at the conference 3) A reflection exercise (10% not graded, but just "pass/fail")

Table 1 "Arctic Circle" course structure: intended learning outcomes, learning and teaching activities as well as assessment tasks

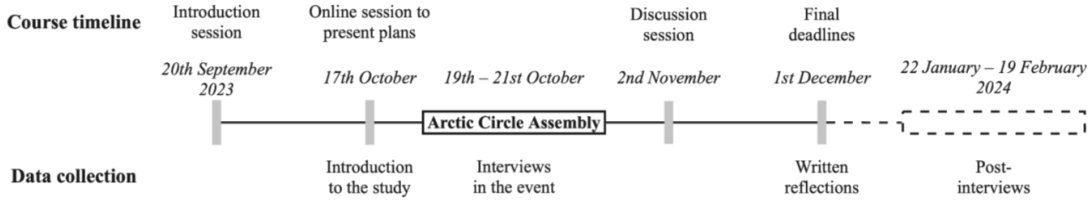

Figure 1 Course timeline with data collection

2 Theoretical framing

Transformative learning is described as a process of gaining new insight and models of thinking through facing a disorienting dilemma, reflecting on the new experience and one's relation to it critically, eventually leading into action engagement (Mezirow 2009). It is originally sourced from the field of adult education (ibid.), where the learner can be expected to have already formed a somewhat stable identity that can transform (Kegan 2009). We have chosen to talk about transformative learning, instead of learning in general, specifically to highlight learning outcomes that go beyond informational or instrumental, meaning significant changes in one's ways of being in, relating to and experiencing the world beyond cognitive structures (Hoggan 2016). These changes can concern e.g. the learner's worldview, self, epistemology, ontology, behaviour and capacity (Hoggan 2015). In the context of sustainability (higher) education, Aboytes Rodriquez and Barth (2020) identified from literature learning outcomes such as: increase of new knowledge and practical skills; reconstruction of values, norms and perspectives; increase in the sense of, self-awareness, agency and empowerment; development of critical, systems and complex thinking; and social learning (reinforcement of social relationships, social mobilisation and activism). Sipos et al. (2008) concluded that transformative education should include all three aspects: cognitive/thinking, behavioural/doing and emotional/feeling—in other words head, hands and heart.

Aboytes Rodriguez and Barth (2020) identified elements of the transformative learning process, learning outcomes and learning conditions in sustainability education. They divide the process into steps of prior learning, disorienting dilemma, critical reflection, discourse and action following Mezirow's theory (e.g. Mezirow 2009). Prior learning refers to the learner's existing frame of reference that is built on previous experiences and learnings, and that selectively shapes the expectations and attitudes that the learner approaches new experiences with and acts (ibid.). Disorienting dilemmas appear when new experience doesn't fit to the existing frame of reference of the learner. In this context of a flexible pedagogy course, the dilemmas can be

https://doi.org/10.5194/egusphere-2024-4097
Preprint. Discussion started: 19 February 2025

expected to be structured and unintended, meaning that they arise from the nature of the learning activities without the teacher triggering them intentionally (Rodrigues Aboytes and Barth 2020). To address the appearing dilemmas, critical reflection on the relevant assumptions, perspectives and information is needed, including one's own but also others. Communicative discourse has a key role in justifying one's beliefs by seeking consensus with others through understanding their differing points of view and the context of the assumptions (Mezirow 2009). For the learning to be transformative, the reflection and discourse are expected to lead into the previously mentioned significant changes in the learner's frame of reference, that allow more informed action and critical approach to new experiences.

Sense of belonging (SOB) is seen as a key personal state resulting through introspective realisation of feelings of being an (integral) part of the surrounding system or environment (Hagerty et al. 1996). In our case, the system and the environment include 1) a course, "Arctic Circle", utilizing a conference as a learning activity, and 2) the related groups of people. SOB connects to a sense of purpose and meaning, and in a learning context it can manifest in students feeling accepted, respected, included, or supported by others in the social environment (Allen et al. 2021; Goodenow and Grady 1993). SOB shapes students' holistic experience and has been shown to influence retention and overall success in studies (Thomas 2012). Students that feel belonging are more active learners, and experience learning easier and more enjoyable (Kahu et al. 2022). In addition, SOB in STEM studies has been shown to support career interests (Xu and Lastrapes 2022).

To study and promote students' SOB, several frameworks aim to distinguish aspects of the learning context that influence student's belonging. Different domains have been suggested as relevant for SOB, including academic sphere, social environment, social participation and physical environment (Cohen and Viola 2022) or academic and social engagement, surroundings and personal space (Ahn and Davis 2020). Belonging in an academic setting can be influenced for example by participation in the teaching situations, self-efficacy and interest towards the study subject and feeling of its relevance to one's own career path (Kahu et al. 2022). Familiarity of the studied subjects or people around is a precursor for belonging (Kahu et al. 2022). Naylor (2017) also showed that a chance to personalise one's studies to be meaningful to oneself can create positive academic belonging. Physical environment or surroundings as living space or geographical and cultural location can be an important aspect of belonging through attachment and emotional connection to the place.

Allen et al. (2021) suggested that to increase individual and collective SOB four elements should be considered: motivation, competencies, perceptions and opportunities for belonging. Lacking skills, motivation and/or chances to belong, can create feelings of alienation, powerlessness and meaninglessness that then hinder learning, in addition to having possible negative health effects. Plenty can be done along these lines in terms of course and curriculum design to support the students' SOB in their studies. As the students' expertise develops and they start to build their professional identity inside or outside academia, the targets of SOB transform as well, from a study and learning community (Myyry et al. 2024) towards a community of practice (Jackson 2016; Wegner 1998). Attending an event like the Arctic Circle Assembly can be an important experience for building students' expert identity.

As Illeris (2014) pointed out, what transforms in transformative learning can be exactly that—the learner's identity. Identity is tied to one's perception of the groups they belong to, hence also to their SOB. Gjøterud and Krogh (2017, 9) stated that "transformative learning originates from intersubjectivity and humans' bodily relations to the world". In this intersection of social relations and their reflection seems to lie a set of keys to transformative learning experiences—from the disorienting dilemmas that may rise as one reflects their belonging to a context, to the pedagogical spaces that develop and nurture belonging, trust (Burke et al. 2016; Matheson and Sutcliffe 2017) and positive social identity in the learning community (Myyry et al. 2024), to transforming the very identity.

https://doi.org/10.5194/egusphere-2024-4097
Preprint. Discussion started: 19 February 2025

In this flexible pedagogy study context, attending the Arctic Circle Assembly as a learning activity may shake the learners' identity and SOB. In the event, students of geo- and environmental sciences are actors in close and active interaction with the socio-cultural context in the Arctic. In this process they develop their Arctic expertise by being exposed to an expert community and a context outside their own academic field of study. We have recognised that literature on interdisciplinary courses utilizing expert events as well as studies on interconnectedness of SOB and transformative learning is limited. Therefore, we want to widen the discussion by exploring the students' learning experience in this specific higher education setting.

3 Materials & methods

We employ qualitative, exploratory methodology based on the students' subjective accounts on their learning experience. We collected the following material (see timeline in Figure 1): semi-structured interviews in English in the event (N=9 out of 13 students on the course); written reflections (N=9); and hour-long semi-structured interviews post-course (N=4). In the reflections the students were given the freedom to choose what they reflect on from the following topics: what they learned, what they enjoyed, whether they experienced interaction challenging, and whether they gained a broader understanding on Arctic issues (see Assignments in Appendix A). Most students reflected on all of them, only two leaving out reflection on challenges in interaction. Interviews in the event focused on the students' SOB in the event and on the course, and how they felt about their own expertise in the context of the event. The pre-interviews were conducted by three of the co-authors and they were recorded and transcribed. The in-depth post-course interview, conducted in Zoom by the first author, focused on the students' learnings and possible transformations. Therefore, they were conducted one to two months after the final deadlines on the course to allow the students' experience to simmer and possible transformations to start finding their shape. Also, the post-interviews were recorded and transcribed, and extensive interview notes (Bryman 2016) were taken by the interviewer. The guiding questions of both sets of semi-structured interviews (King and Horrocks 2010) are included in Appendix B.

The participants of the study were a mixed group of students. Five bachelor students and one master student were studying in Iceland as exchange students. Two students were taking part in the Nordic Masters' programme Environmental Changes in Higher Latitudes. One student lived in Iceland and was studying in a master-level program there. According to their own record, the students represent the following fields of study: forest and nature conservation, forestry and landscape architecture, ecological sciences, governmental systems, natural/environmental sciences, landscape construction and environmental science and law, as well as environmental and natural resource economics. From the post-interviewed students two were bachelor and two master students.

The entirety of the collected material was initially coded by the first author, who is outsider to the course and was not present in the event. Initial coding was done inductively to allow emergence of new insights (Elo and Kyngäs 2008) and it led to ideas of the connection points between transformative learning process and SOB. Based on the gained insight, the coding was then further developed, fine-tuned and organised deductively focusing on recognising the steps of transformative learning, namely disorienting dilemmas or realisations, critical reflection and discourse, and the outcomes as transformed frame of reference (Rodríguez Aboytes and Barth 2020; Mezirow 2009), as well as students' experience of their SOB and where it interacted with the learning process. Some of the initial inductive codes remained under those, newly introduced, higher level categories and some were combined, renamed or deleted according to their relevance. The coding results were discussed and reflected amongst the co-authoring group at multiple iterations along the analysis process and the results found their final form in the writing process. The analysis is influenced by the existing experiences and knowledge of us authors, consisting of backgrounds in educational sciences, as well as environmental and atmospheric sciences. The authors have recently studied SOB in the

https://doi.org/10.5194/egusphere-2024-4097
Preprint. Discussion started: 19 February 2025

context of environmental and atmospheric sciences education, to which this study acts as a continuum. In addition, as one can argue that the transformative learning process is only relevant as a whole and as a dynamic, ever-changing and continuous process (e.g. Mezirow 2009) and therefore nearly impossible to unambiguously analyse from the material at hand, we have focused on pointing out elements of it and their interactions with the students' descriptions of their SOB. The direct quotations of the students are used to support the transparency, rigour and credibility of our results (Lincoln and Guba 1985; Elo and Kyngäs 2008). In the Results the students are referred to by IDs AC1 to AC9 and the materials as 'pre', 'refl' and 'post' referring to the interviews in the event, written reflections and post-course interviews respectively.

4 Results

Students described several realisations leading to disorienting dilemmas, reflections based on those realisations as well as resulting transformations in their frame of reference. The presentation of results in the following subsections is based on these three steps of transformative learning.

4.1 *In-situ* realisations to disorienting dilemmas

The students' realisations emerged from how they related to the content of the event, or to other participants, or to the political or cultural impression. The realisations reflected contradictions that the students experienced regarding ideological standpoints, intentions, ways of communicating, attitudes, and perspectives. Hence, how the "real world", portrayed at the Arctic Circle Assembly, differed from the students' expectations and dispositions, in other words their existing frame of reference.

An important source of the dilemmas was an experienced lack of SOB, especially to the expert community. The students described their SOB in general being influenced by the lack of familiarity to the people, topics and the cultural context of the event—how they perceived themselves fitting or adapting to the learning context. Most students felt they were primary members of the student group, and only a few of them felt they belonged also to the expert community. For example, students felt rather *intimidated* by professionals that seemed to have strong networks at the event. AC2 described their feelings as follows:

> "I did not really feel like I was belonging there, because it was just a bunch of businessmen in suits walking around and meeting their colleagues, [...] or science people that had a lot of knowledge, and I was just feeling like a little student being there, not knowing a lot of stuff and just curious to learn new things" (AC2 post)

However, some students felt more belonging to the event. Some thought themselves to be part of the researchers and scientists' community because of their assumed shared university background, while for example AC7 felt belonging to the event because of their shared interests:

> "I just feel like it's a lot of individuals that can do many things together and therefore I feel like I belong here [...] I think [I belong to] young environmentalists that need actions because of their future. […] I feel belonging in assemblies that are connected with the climate crisis and environmental matters, because I have a bachelors' degree in that matter and most of my time goes to something connected with that" (AC7 pre)

They even thought they could have hosted a session at the event, suggesting that they saw themselves more equal to the other participants. In general, the students' perception of their expertise and relation to the expert community relied on the breadth and width of their knowledge, as expressed in statements such as: "I feel like I don't have the knowledge that the other ones

https://doi.org/10.5194/egusphere-2024-4097
Preprint. Discussion started: 19 February 2025

have" (AC2 pre) or "I'm interested in the stuff but I do not know a lot about it yet" (AC3 pre), or as one student described: "Engaging with other participants proved to be challenging for me, as I felt like more of a listener and observer throughout the conference—rather than a 'true' participant who could contribute value" (AC6 refl).

This perception caused students to limit their engagement with others than their peers: "Many of us struggled to interact with other participants because we simply didn't really know how to and felt that we 'didn't have anything to offer' for the participants we were interested in" (AC9 refl). They also stated that they have the right knowledge, but not the *expertise* yet, seeing themselves as an expert in the future. One saw the event as an important learning experience towards expertise:

> "I don't feel like an expert because [...] I'm still student, but I'm sure that attending to the sessions and listen to people at speaking to people I learned a lot a lot more so I'm not an expert but I'm sure my knowledge is bigger, [...] way more than before" (AC5 post)

How specifically the students saw themselves to belong to the event was evidently influenced by their SOB to the other participants and the contents. The students stated to have expected more scientific content, discussions on nature, strategies to tackle climate change, and opportunities to gain new knowledge. Where instead they perceived the conference to mainly focus on business and politics and somewhat disregard the attention to specific measures of solving Arctic challenges. This perception was shared, in one way or another, by every student. For example:

> "We were expecting something [...] something more on the scientific environmental side and we didn't expect so much economy, so much geopolitics [...] even though it's important. And we didn't expect so much greenwashing. I mean it was really visible, nobody cared, and we were like 'ah, okay that's the thing'. That surprised us" (AC5 post)

Others described similarly: "I had hoped that I would learn a lot about new scientific results [...] however, the sessions mostly talked about all the problems we already know [...] or new business ideas" (AC3 refl), or: "[...] after all those sessions I was still realizing that there's something going really wrong in the whole behaving of people in general with all that wealth and the acting of the economics" (AC8 refl).

These realisation of conflicts in values, regarding themes such as vague political talk, false advertisement and visible greenwashing, left the students feeling disappointed or even sad. At the same time, they gained new insight, as stated by AC7:

> "The assembly did not provide me with a broader understanding of current environmental issues in the Arctic, but it did open my eyes towards the political challenges of the Arctic: for example, how sailing will become different with no ice in the Arctic. And I found it weird that sometimes they spoke about the opportunities of climate change" (AC7 refl)

Another often mentioned topic that evoked feelings and realisations among the students was the issue of representation of different groups at the event, such as Indigenous peoples or youth—as the future stakeholders, actors and decision makers. To most students, issues related to Indigenous perspectives were new. They felt that the representatives of Indigenous peoples in the Arctic and young people, while invited to the event seemingly equally, didn't get their voice heard as much as those talking about economy and (geo)politics. At the same time, the students found the presentations and talks from the Indigenous viewpoints to be the most meaningful and thought-provoking: "the Arctic Circle Assembly was not really doing what they advocate and advertise for, it was just kind of: 'yeah we're doing these talks and we're giving people voice' but then actually they kind of didn't" (AC2 post). Which again felt like a disappointment and a contradiction of values:

https://doi.org/10.5194/egusphere-2024-4097
Preprint. Discussion started: 19 February 2025

> "I do think it is important to acknowledge that the event is still mainly about money and power. There are constant expressions that radical change is needed, but no one is really performing this change. There is recognition for indigenous voices to be heard, but indigenous voices were still put in the background of the Assembly. There is mention of youth in some sessions, but the youth are still not being listened to" (AC1 refl)

Here too, while these contradictions felt somewhat personal and, in a manner, unsolvable, many of the students mentioned the importance of being present at the event. They were able to learn through personal stories and viewpoints empirically, whether through viewing a documentary movie, hearing a presentation at the event, or simply experiencing the contradictions and challenges other people seemed to face in such a global arena:

> "[...] I already knew before that there are some issues related to the indigenous communities that they don't really have a voice and that they are being suppressed and these topics were brought up in the Arctic Circle again, so for the first time I could see with my own eyes how it is and not just on Instagram or on social media and actually hearing them talking by themselves about this stuff was different and then also to see that the issues are real and it's even in the Arctic Circle assembly [...]" (AC2 post)

Altogether, experiencing these topics that many of the students were familiar with, but in a new real-world context, was often thought of as very impactful: "[...] assembly allowed me to understand the Arctic better and the many different perspectives helped a great deal. [personal stories] enriched my understanding of what problems people are facing in the Arctic" (AC1 refl), and: "[...] presentation that left a lasting impression on me and kept me thinking was a screening of a film followed by a discussion. [...] I wasn't aware of the current situation of the Inuit and how they continue to suffer and be oppressed [...]" (AC6 refl). The same sentiment was felt throughout different represented groups: "I was really amazed because it was talking about the situation of Indigenous people in Greenland [...]" and "In one session there was also a kind of exchange of comments between Maori, that was explaining the ecosystem services with the sea in the Pacific Ocean, and a whaler from Iceland" (AC5 post).

4.2 Reflecting to settle the dilemmas

Various and numerous mentions of self-reflection, of differing degrees, were present in the students' descriptions of the event and the course. For example, AC1 reflected on their own motivation, agency and future responsibility as a researcher, especially considering the people and contradictions in the Arctic; while AC2 reflected on the role of young people in the future and how their engagements had developed their thinking to be more critical; and AC5 reflected on their broadened awareness from exposure to Indigenous and other cultural representations. AC8 reflected these in relation to their belongingness saying:

> "I think it was not a bad thing that I didn't have the feeling of belonging there but [instead] it was a good thing to get out of [my] box and that helps me a lot, it was an memorable experience" (AC8 post)

The students recognised the importance of their peer student group for their learning and reflection. SOB to the group played a major part in discourse and critical reflection. The students reflected their SOB stemming from the different elements that they shared with the students, and to an extent with the other participants of the event. These elements included aims, interests, values and frustrations, but also the physical space, the experience and joint reflections. AC1 stated that they were glad to have

https://doi.org/10.5194/egusphere-2024-4097
Preprint. Discussion started: 19 February 2025

shared the experience of reflecting on their own agency, responsibility and, also, the right to be part of an event in the Arctic with the other students, and elaborated on how it brings hope:

> "It's very nice to know you're in the same boat, you know? You're just students and you are there because the opportunity was presented to you and you said yes [...] you realize that things aren't going the way they maybe should, but then it's really nice to realize that these people of your generation are thinking the same way" (AC1 post)

Also, personality traits and interpersonal skills of the students are a factor. For example, while having challenges in interacting with other participants, AC2 was still happy about the opportunity to attend the event with people that they already knew and felt that interacting with the other participants was easier together with the other students, where AC5 didn't feel a strong connection to other students. AC6 and AC8 found peer interaction challenging, but still felt belonging to their group, and both were okay to attend more alone, and AC4 wanted to focus more on the content anyways. Altogether, lack of SOB seemed to negatively influence engaging with other participants.

For AC2 the joint discussion and reflection with other students had a major influence on how they related to the event: "the more I talked with the other students about their experiences the more I kind of understood what is going wrong here" or to AC5: "we had kind of the same ideas, […] someone more extreme, someone more in the middle way but the idea is, we were kind of in this same area". Thus, realising that everyone is on the same page can be an influential experience. This highlights how the reflective learning experience depends on the students' prior existing frame of reference and on SOB the student has to their group, through shared understanding and processing of the experience.

The students described gaining important new insight concerning, how money and power act as the main forces of action and there is a lack of actionable plan, but also how some are actually working for change, as for example AC5 stated: "I acquired insight into the challenges in making decisions to safeguard the environment, the political landscape, and the socio-economic state of this crucial region of the world. It necessitates collaboration with a multitude of people from across the globe" (AC5 refl). While plenty of the reflected learning felt important and meaningful, they were harder to directly link to critical reflection and significant changes in the students' frame of reference. Some of the realisations and conflicts of values that the students experienced seemed to be disorienting to the students and as such had an impact on their learning outcomes, appearing as transformative learning.

4.3 Learning from the disorienting dilemmas

In our search for possible transformative learning, we aimed to explore the course outcomes to the *aspects of the learner that change* (Hoggan 2016), e.g. the student's epistemology, worldview, expert identity, and themselves in general. Some recognised changes in their behaviour as well. While many of the learning outcomes, described below, connect to the dilemmas presented earlier, it is indeed tricky to distinguish, whether learning happens at the initial realisation leading to reflection, or is an end result of the reflection—acknowledging that in cyclical and dynamic learning processes, both are encompassed.

Students recognised gaining a broader perspective, for example, to the Arctic's socio-economic situations and challenges, and matters related to Indigenous peoples and perspectives—that seems to have led to changes in the students' worldviews. For instance, insight into the Indigenous communities, their way of living and thinking, were new to many students, who later recognised that these were perhaps the most important learning outcomes of the experience:

https://doi.org/10.5194/egusphere-2024-4097
Preprint. Discussion started: 19 February 2025

> "I knew about, for example, Indigenous knowledge [...] but I attended a couple of sessions about [it] and that opened even more my mind about this kind of topic, the importance of it. It expanded my knowledge about that and my conscience" (AC5 pre)

AC1 reflected: "there was so much inequality and still so much governance and policies that is just contradicting [Indigenous] way of life and being able to realize that was very important" (AC1 post).

In connection to feeling things represented unequally at the event, another realisation that shifted the students' thinking was the observed lack of action or viable action plans for tackling the commonly recognised challenges. AC2 concluded that to their view, the whole point of the event was "to make business with each other but not really actually changing something" (AC2 post). This made, for example, AC7 feel disappointed and quite hopeless: "I would like to improve what way we speak about actions and what point we want to reach, not just where we are now [...] I don't know how much we're gonna get from [such] assemblies" (AC7 pre). Students found their role (and agency) quite difficult against the large institutions most vocal and visible at the assembly:

> "I'm getting used to the way that those things go [...] it's still some institution that's kind of relying on oppression and exploitation and then it's just kind of the way things go now. And you hope it's going to change in the future and you really hope that your generation is gonna do differently but there's so much uncertainty in that as well so yeah, there's a sense of hopelessness and also a sense that I am not able to change anything" (AC1 post)

Many students thought that even if you wouldn't be able to change things, it is important to fully acknowledge the situation. The shared frustration was something that also brought the students together and heightened their SOB and opportunities for reflections. AC2 described how their critical thinking was developed at the course: "I think I would look more critically at what they're actually doing [in an event like this]" (AC2 post) and AC7 reflected on the importance of critical thinking: "these assemblies should be used in a specific way for a more positive and meaningful outcome [...] I learned how important it would be to have a critical eye when attending these assemblies" (AC7 refl).

Regardless of their critical views, many students acknowledged the importance of understanding such familiar issues as climate change and its global scale in this real-world contextual situation (e.g. Arctic geopolitical landscape):

> "that was really interesting to have like a little peak to the rest of the world unlike the research world [...] to learn more [about geopolitics] [...] if you want to study something like what I'm studying right now I think it's really important to know every aspect of the issue of climate change in the Arctic" (AC5 post)

AC8 said: "it was really nice to get a feeling for the challenges and problems the Nations in the Arctic circle are facing in the past, present and future" (AC8 refl).

Some also thought the event to be an "eye-opener towards the important topic of youth engagement" (AC7 refl). Students underlined how they felt the importance of listening to diverse (e.g. Indigenous and young) voices in decision-making and in science and in general the necessity of collaboration for finding solutions. Students connected this new awareness of diverse perspectives to their disciplines and future work, for example as Arctic experts—hence, to themselves:

> "[...] if I ever were to work on any conservation, I at least, am able to recognize that my way of thinking is not going to be the right way—that I really need to listen to people and that's kind of regardless of where you are globally that

https://doi.org/10.5194/egusphere-2024-4097
Preprint. Discussion started: 19 February 2025

> you really need to listen to what people's needs are" and: "you kind of forget that there are still people that live there and have their entire lives there and that they will always be there [...] as a scientist, being able to give back to communities, you know, to share your results and to help their way of life and their livelihood." (AC1 post)

In a similar vein, students related to the personal stories and recognised the importance of plural perspective in solving these issues, suggesting a more open and reflexive epistemology:

> "you're always looking for the best results and numbers and stuff but then we kind of fail to acknowledge how important it is that we're still just telling our story and science is just a tool in the greater kind of an idea" (AC1 post)

Awareness of different ways of knowing and the oppression experienced by Arctic people seemed to lead into a new sense of humility and agency in how the students would approach doing science in the future: "we are in the Arctic and raising [collaboration] to a global level, you know? [...] the whole time I was there, was like: who am I to do anything here? But I do realize that I am someone and I do, yeah, I do matter in a sense" (AC1 post).

Some gained clarity in their career goals by, for example, finding new research needs, as AC5 described it, or becoming more familiar with the existing research community that the students aspired to become a part of, as AC2 reflected on: "It was looking up to them. Like okay, they really know their stuff and at some point in my life I will hopefully also know that much." (AC2 post)

Lastly, the students' newly gained insight and skills were taken as incentives to act and to make changes in their behaviour. As one student stated: "I acquired knowledge in how to effectively communicate with people from diverse professions and realities, along with those who share my field of study" (AC5 refl) and another described, in relation to their studies: "The assembly gave me motivation to work hard on my studies to someday be part of it and be able to see actual changes" (AC9 refl). The students also saw their attained knowledge and experience something worth sharing with other students, not on the course: "I can spread my knowledge to my friends or if there's a discussion, I can bring up my experiences from the Arctic Circle" (AC2 post). However, not all felt the experience to be worth the contradictions, as one concluded: "I will not recommend this to anyone since this is nothing more than people trying to sell their greenwashing ideas" (AC4 refl).

5 Discussion and conclusions

The "Arctic Circle" course appears as an example of a transdisciplinary and possibly transformative higher education climate change learning experience (Leite 2024) for geo- and environmental scientists. The student experiences examined through interviews and written reflections have pedagogical implications with which transformative learning in higher education could be supported, as well as rhetorical implications regarding the role of experts acting for climate change.

By getting to face the plural socio-economic realities of the Arctic, evident in the Arctic Circle Assembly, the students had impactful realisations regarding the content of the event and their own role and place there. These realisations can be seen as disorienting dilemmas: as experiences conflicting with the students' existing frame of reference (Mezirow 2009). Students described their expectations not being met through emotions such as disappointment, hopelessness and sadness, indicating, for example, experienced conflicts of values and approaches to issues important to them. Critical reflection and management of the emerging dilemmas, alone and together with the learning community, is a key for their frame of reference being potentially transformed, and for their individual identity (Matheson and Sutcliffe 2017) to develop. The students' descriptions did not always show direct causality from dilemmas to transformative outcomes, but rather to attaching new meanings or perspectives

https://doi.org/10.5194/egusphere-2024-4097
Preprint. Discussion started: 19 February 2025

to their existing understandings (Leite 2024). Transformative learning has been said to emerge from the interaction of the learner's state of readiness and the quality of the learning environment (Sterling 2011). Therefore, as an implication to flexible pedagogy, teacher facilitation could be strengthened to encourage the students to face the emerging dilemmas and to critically reflect their own values, beliefs and feelings related to them. This facilitation should be also based on the learner themselves: such as their background education and attitude towards learning. In addition, personal capabilities and characteristics showed to influence the (transformative) learning experience, for example, through varying capabilities for interaction, or skills for reflection. Facilitating self-reflection and discussions with peers on students' existing knowledge, perspectives and expectations prior to the conference, and learning experiences alike, could help students to better self-regulate their learning experience. Here, utilizing the diversity of the student group, in discussions to pluralise their perspectives, can be beneficial (Matheson and Sutcliffe 2017).

Based on the materials, SOB—or the lack of it—appears to have an important role in inducing dilemmas that can disorient. SOB was also an important supporting element in the students' shared discussions on their own values and expertise development. However, it is good to recognise that seeking belonging might in some cases lead to avoiding conflict or disagreement. This could be seen as a risk to further polarization (*us* vs. *them*) between the students and parts of the assembly. Again, the facilitation of critical reflection on students' own values and beliefs is critical, and requires building a learning environment of trust, where disagreements and differing perspectives can be voiced and discussed safely (Matheson and Sutcliffe 2017). In an ideal situation, critical reflection and constructive discourse would lead to an increased sense of agency, opposed to hopelessness, both visible in the students' contemplations on their learning in this setting. We see here a potential implication to geoscience education: on how to integrate transformative learning, transdisciplinarity and flexible pedagogies in their teaching and higher education curricula. Leite (2024) proposes action-oriented and community-based approaches as a medicine to hopelessness at the face of the "unsolvable" climate change. In this learning setting, engagement in action with one's own hands (Mezirow 2009; Sipos et al. 2008) could mean, for example, participation in the event with their own session, as one student suggested. In addition, the strong feelings that emerge when facing contradictions—the emotional aspects—could be approached through artistic or other creative methods (Leite 2024), perhaps connecting to the formats present in the Arctic Circle Assembly, such as film.

The exposure to the plurality of Arctic issues and perspectives seems to have resulted in widened views and increased understanding of the setting that many of the students see themselves working in as they transition towards being Arctic experts. At the conference, the students were able to associate with a community of practice (Wegner 1998), and some felt that they had agency in this context, while also their interpersonal and communication skills improved. They saw their future role as Arctic researchers with responsibility over how science should be done: taking people into account, for example by listening to differing voices; being open to various ways of knowing; and assessing their own and surrounding normativities critically. Thus, this type of an experience as a flexible pedagogy course, can also support geo- and environmental science students' career planning, and the development of their multidisciplinary professional identity and transferable work-life competencies in general. From the perspective of geoscience education and professionalism, building a bridge between multisectoral arenas—such as Arctic Circle Assembly—has clear benefits to both communication and impact of geosciences in the Arctic (Illingworth et al. 2018). Better awareness of not only the environment, but the people who live in it, the economic ties that complicate it, or the geopolitical tensions that complexify it, are vital viewpoints of the Arctic context, when the actor's aim is to contribute to solving real-world challenges. For now, the real-world context has perhaps felt rather detached from the students' experiences, and as this study shows, exposure outside the academic ideals proved fruitful for the students' professional identity development through transformative learning.

https://doi.org/10.5194/egusphere-2024-4097
Preprint. Discussion started: 19 February 2025

We acknowledge that this study focuses on a single course of a programme with a relatively small cohort of students, which might limit the implications in other educational contexts. Additionally, the students' prior knowledge was not measured pre-course, making it challenging to assess isolated changes or transformations (Hoggan 2016) in other means but student reflections and theoretical hypotheses. Related to this, as the course was conducted over an intensive short period, potential long-term impacts of the learning experience remain a question as is typical to such research. Future research should further investigate transformative learning in flexible pedagogies of transdisciplinary settings, specifically focusing on their prior frame of reference, to provide more understanding of the interplay between SOB and transformative education.

To conclude, we recognise the transformative potential of the "Arctic Circle" course as a flexible pedagogy learning setting, where the students are exposed to the plurality of Arctic issues and perspectives, fostering a deeper understanding as well as a sense of responsibility as Arctic scientists in the future. The students' reflections revealed a disconnect with the values and representations in the expert community presented by the Arctic Circle Assembly. Perhaps, the goal of higher education, also in geosciences, should not merely be to mould the students into the existing community of practice, but to empower them to critically assess and reshape the structures around them, building communities that reflect their own values and support their agency as contextual climate change experts. Supporting development of such competence, benefits from transformative, transdisciplinary, and flexible pedagogies, that put the focus on facilitation of critical reflection and on building a learning community of trust and belongingness.

Author contribution statement

SJ, SK, SJJ, LKA, RI, VVM, and VS participated in the conceptualization of the study and methodology. BIC taught the studied course and provided information on the course structure and pedagogies. SK, RI and VS conducted interviews at the event. SJ, SK and SJJ planned the post-course interviews with comments from other co-authors. SJ conducted post-interviews and the initial content analysis. Second round of analysis was done with comments from SJJ, VVM, LKA and RI. SJ prepared the original manuscript draft with contributions from SJJ, BIC, LKA and RL. All co-authors reviewed, edited or commented on the final manuscript. LKA acquired funding for the ABS We Belong project and RL for the ClimComp project.

Conflicting interests

The authors declare that they have no conflict of interest.

Ethical statement

This study was performed under ethical guidelines from the University of Helsinki. However, explicit review by the ethical research board for this study was not mandatory.

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https://doi.org/10.5194/egusphere-2024-4097
Preprint. Discussion started: 19 February 2025

ChatGPT has been utilized when summarizing themes of the conference program, searching for relevant literature, and for text editing on a sentence level. Avidnote has been used to search for relevant literature.

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https://doi.org/10.5194/egusphere-2024-4097
Preprint. Discussion started: 19 February 2025

Appendices

Appendix A

Course description (given to the students)

The Arctic is experiencing accelerated changes. The economic and sociopolitical relevance of the Arctic is expected to become more important in the near future as climate change makes natural resources and transport routes more accessible. While these changes will create economic opportunities, they also pose threats to fragile ecosystems and societies. The extent and the thickness of sea ice in the Arctic have decreased dramatically in the last decades, especially during the summer months. Sea ice melting facilitates natural resource exploration in the high north, which is estimated to host 13% of the world's undiscovered oil and 30% of undiscovered natural gas reserves. Moreover, the retreating and thinning of the ice opens up new trade routes.

In this course students will participate in an international meeting, the Arctic Circle Assembly (http://www.arcticcircle.org/), that takes place annually in October in Harpa, Reykjavik. During the meeting students are required to attend at least three sessions on topics of their choice and will write a report after the meeting. In addition, students will attend two classes, one shortly before and one after the assembly.

Description of assessment: Evaluation will be based on written reports (three assignments) where the students summarize and discuss one of the topics presented at one of the three sessions attended, reflect on their participation in the assembly and develop their networking skills. Students have to send in their reports no later than four weeks after the Arctic Circle Assembly.

Assignments

Reflection on Arctic Circle (10% of final grade)

You will have to provide a short reflection on your participation in the Arctic Circle Assembly 2023. Please comment on one or several of the following questions:

- what have you learned by attending the Arctic Circle Assembly?
- had you attended this type of events before?
- what did you like best/worst of the event?
- did you find it challenging to interact with other assembly participants?
- did the assembly provide you a broader understanding of current issues in the Arctic?

Networking exercise (20% of final grade)

Conferences are important, not only because of the transfer of knowledge, but also because of networking possibilities. One of your assignments during the Arctic Circle Assembly 2023 will be to hang out during the coffee breaks and get to meet some new people. For this assignment you will have to talk to at least two people (including if possible one speaker

https://doi.org/10.5194/egusphere-2024-4097
Preprint. Discussion started: 19 February 2025

at the conference). You will have to introduce yourself, and ask them the following questions (or something along these lines):

1) What is their name and where do they come from?
2) Did they give an oral presentation at the conference?
3) Is this their first time attending the Arctic Circle Assembly?
4) How does their work or daily life relate to the Arctic?

Report of session (70% of final grade)

During the Arctic Circle Assembly you will have to attend three sessions (including one plenary session). You will have to choose one of the sessions as the topic to write a short report. You can choose if you want to focus your report on the specific topic discussed during the session, or some issue related to the session's topic that was brought up during the discussions in the session.

The report should be around 1,500-2,000 words long (without the list of references). You will have to use relevant references where needed to support your statements. Please, include all references cited in the text in a list of references at the end of the document (this list of references does not count towards the word limit); if you have any questions about the use of references, please ask Isabel. You will have to include at least three relevant references related to the topic presented. Please try as much as possible to use sound scientific evidence to support your statements, and try to use scientific articles as references.

Please organize the text in a clear, structured way, starting with a short introduction that presents the topic, then going more into details and finally coming up with some conclusions. Keep in mind that this is an academic text, so you should avoid subjective references or personal opinions (as opposed to the reflection exercise, where we are specifically asking you for your opinion). The idea with this exercise is that you explore a bit more one of the topics presented in the sessions. You will have to read at least three other papers related to the topic (those you will cite in your reference list). This exercise will provide good practice for your reading and writing skills.

Appendix B

Interviews ad-hoc at the event (conducted by three different interviewers)

Warm-up

- What have you been doing, what are you planning to do/participate?
- Do you find this event interesting? What in it? What is most interesting?

Knowledge & Expertise

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Aim is to find out 1) what the student's perception of their expertise is and how it is related to the assembly, 2) if they potentially feel connected to the assembly that way and 3) if they are motivated to be part of the groups of experts that are present at the event, and 4) how do they personally relate to the Arctic area.

- What are you studying (in EnCHiL or in landscape restoration)?
- Do you have any plans after graduating?
- How familiar are you with the themes of this event? Are you studying these themes?
- What is your expertise? Is it represented in this event?
- Are the themes of the event part of your career plans?
- Are you from the Nordics/Arctic? What's your relation to the area?

Social interaction

Aim is to find out 1) who the student has interacted with 2) who they would like to interact with and 3) how "socially orientated" they are towards the assembly.

- Have you talked with people here?
- Are you going around alone or in groups? Are you looking to network with people?
- Who are you planning to talk to for your exercise? Why?

Learning

- Do you feel like you are learning here? What?

Belonging

Aim is to find out 1) do the students feel welcome and comfortable at the course or the assembly, 2) what are the groups that they associate themselves with (with using the information gained in the previous parts of the interview, 3) where the students potentially feel like belonging to.

- Did you feel welcome to the course? What created it?
- Did you feel welcome to the assembly? What created it?
- What is the group that you belong in this event?
- Do you fee like a part of the expert community here? Do you see yourself part of them in the future?
- Do you feel like a part of the student group here?
- Do you feel like a part of the…. which ever group has come up in the discussion.
- Do you feel like you belong here? What is 'here' and how do you feel to be a part of it?
- Do you feel like an outsider here? Why?

Post-interviews (conducted by one interviewer)

What did you learn?

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- Change in existing knowledge
- Different things such as skills, knowledge, about the world, about arctic...

Did something transform?

- Knowing differently now
    - How did it change how you understand the themes or how you feel, think or behave?
- Relating to themes/concepts/people differently
    - Perceiving your own role or responsibility differently?
    - Sense of own expertise—Feeling more like an expert now?
- Intention to seek for transformation?

How do you see your sense of belonging to connect to transformative learning/experience on the course?

- How did your sense of belonging change during the experience?
- A connection between your (transformative) learning and sense of belonging
- Did it enable or reversely-enable?