

# Embodied eco-embroidery

## Creative craftsmanship in sustainable STEAM-education

Janne Robberstad<sup>1</sup>, Randi Veiteberg Kvellestad<sup>2</sup>

Western Norway University of Applied Sciences, Oslo Metropolitan University

### Abstract

The UN Sustainable Development Goal 4 (SDG4) addresses equal access to quality education, focusing on literacy, numeracy and the field of science through STEM subjects (Science, Technology, Engineering, Mathematics) – seemingly forgetting the importance of developing practical skills like craftsmanship. STEAM includes Arts into STEM, where the arts represent several independent artistic forms including music, theatre, dance, visual arts, crafts and so on.

In this article we focus on education for sustainable development through craftsmanship in embroidery. In a transdisciplinary collaboration that includes art, craftsmanship has its own innate value. Our research question is: In which ways can creative collaboration in embroidery enhance a sustainable STEAM education learning experience?

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<sup>1</sup> [janne.iren.robberstad@hvl.no](mailto:janne.iren.robberstad@hvl.no)

<sup>2</sup> [randiv@oslomet.no](mailto:randiv@oslomet.no)

We attempt to find answers to this by looking into how STEAM collaboration may affect the ways we teach craftsmanship, and the challenges and opportunities of doing so in a holistic transdisciplinary project, with a focus on ecological sustainability.

Three groups of teacher-students help examine how crafts may contribute to building ecological awareness in themselves and an audience through conveying meaningful artistic narratives. Their embroideries were inspired by the UN's Decade of Ecosystem Restoration. The results were shared through the Global Science Opera, an international STEAM education initiative.

Our analysis of the research data is influenced by posthumanizing creativity, which emphasises ethically contributing world citizenship through embodied, collaborative creativity between creator and creation. This journey of *making* and *being made* shows a reciprocal relationship between humans and non-humans. The slow-art of embroidery invites the students into an embodied dialogue with the materials, tools, techniques and the scientific topics within this transdisciplinary context. As researchers, we wonder how this dialogue and in-depth experience affected the students' attitudes and actions towards sustainability. We found that the data supports the embodied, co-creative embroidery process, that it improved the students' craft experience, and it also increased the understanding and respect for the challenges we currently face in our new eco-reality.

**Keywords:** embroidery, quality education, transdisciplinary, craftsmanship, STEAM-education

## Introduction

The UN's Sustainable Development Goal (SDG) 4 is dedicated to education through promoting inclusion, quality and equity, and it can also play a critical role in fostering sustainability given that it enables the success of the other SDGs (UNESCO, 2006 & 2017). Recognising this ethical responsibility, universities training (pre-service) student teachers bear an extra responsibility, as these teachers will in turn educate the coming generations.

SDG4 offers no direct references to practical skills. As STEAM (Science, Technology, Engineering, Arts and Mathematics) education gains ground, researchers argue that the integration of Arts into STEM is a contemporary enhancement connecting it to the real-world problems of the 21st century (Braund & Reiss, 2019; Colucci-Gray.et.al, 2017).

Though many aspects in SDG4 are connected directly or indirectly to the benefits of crafts education, we lack an explicit focus on craftsmanship and the act of creating, and hereby suggest an inclusion of a practical skills literacy.

Educating basic skills within craftsmanship are important as one of several solutions. We argue that good crafting skills are basic for employment, for decent work and entrepreneurship, for building affluence and good health in a society. There seems to be a relational process between thinking and doing. When you create a community between students, nature, arts and technology through a creative and democratic process, a holistic understanding may arise. In this context, the embroidery itself may convey factual, scientific messages.

The context for the eco-embroidery project is that of the Global Science Opera (GSO) – an international STEAM education initiative, a signature pedagogy within science-art transdisciplinarity, connecting people in creative collaboration ([globalscienceopera.com](http://globalscienceopera.com); Straksiene et al., 2022). The GSO's goal, answering principle 62 of UNESCO's Incheon Declaration, addresses real-life challenges with up-to-date science.

Our educational goals for this project are threefold: training students in the craftsmanship of embroidery, providing them with practical experience in transdisciplinary intra-action in STEAM, and to collaborate creatively. Our research goal is to look at ways in which crafts can improve quality education and enhance a holistic learning experience (Klafki, 2014), through embodied transdisciplinarity and creative collaboration. Our research question is defined as follows: In which ways can creative collaboration in embroidery enhance a sustainable STEAM education learning experience?

## **Theory**

There is a much needed, ongoing discussion in the STEAM field regarding the nature of collaboration between the two fields of arts and science (Meeth, 1978; Bresler, 2002). The arts often play the role of 'spicing up' science education to 'make it fun'. In our embroidery implementation, we admit to turning things around here, looking instead at what science can add to arts education.

### ***Posthumanizing creativity***

UNESCO's Incheon Declaration describes the learning process as when children 'begin engaging in intensive meaning-making of the self and surrounding world, building the

very basics for being healthy, caring, competent and contributing citizens' (UNESCO et al., 2016 p. 39). This embodied experience is advocated by Chappell (2018), who emphasises contributing to one's world citizenship through collaborative creativity. Her posthumanizing creativity theory advocates for an ethical, empathetic and engaged education by expanding our understanding of who 'the others' are of whom we collaborate with (Chappell, 2021). This describes how we as creators not only shape what we are creating, but how the creation in turn shapes us too (Chappell, 2018).

The embodied educational experience can be defined as a holistic, sensory, internal integration of deeper understanding, knowledge and skills (Chappell et al., 2019). In our project, this included collaboration between the students, the embroidery and the ecology of the ecosystems – the first consisting of a social intra-action, the second a practical, tactile exploration, and the third a more conceptual, philosophical and ethical understanding. The embroidery novices' learning process thereby became journeys of becoming for the students, where they influenced each other as well as the materials, tools and techniques. Additionally, this involved how they in turn were influenced, even slightly changed, by the other actants, human and nonhuman, including the overall conceptual topic (Chappell, 2018). As such, embroidery can be used as an entryway into understanding this intra-action.

Considering our ecological challenges, we suggest that teaching craftsmanship can be a powerful tool in posthumanizing eco-education, one which must acknowledge the intra-action between the human and nonhuman. This relationship in a creative collaboration is easier to understand once one first recognises that you cannot execute craftsmanship alone without the intra-action of materials, tools and space.

It is vital in STEAM education that all subject fields are treated as equal and on their own terms in order to propel a project forward. This can then influence the students' development, something that is further enhanced within this ethical eco-education. By working with ecological sustainability both on a conceptual and practical level, the didactical method embraces the holistics of the students themselves: their intellect and emotions, their curiosity and creativity (Klafki, 2014). Indeed, the teacher-students had to apply these traits as they embarked on their embroidery journeys.

## **The Craftsmanship of Embroidery**

The creation process of embroidery is slow. According to Swedish textile artist Annika Ekdal, the act of embroidering takes *time*: time becomes visible through embroidery.

This visibility bestows respect for the art of embroidery (Robach, 2013). Robach (2013) elaborates in that the slow process is positive: one must calm down and make room for silence and reflection. In our time when almost everything happens at such a fast pace, allowing the slowness to become visible is relevant to SDG4. Slow art describes a meditative state connected to contemplative art, as another way of looking at something (Reed, 2017). In connection to crafts, slow art emphasises a slowness in the creative exercise, a process which requires courage and patience.

Embroidery is considered in many cultures to be a non-threatening, feminine activity, but it was used actively by the suffragette movement during their struggle for gender-equality, as a means of political expression (Wheeler, 2012). Artist Betsy Greer (2014) draws a connection between quiet activism and crafts through *craftivism*, which she defines as creating something that asks questions and foments dialogue (Greer, 2014). Where Guerilla embroidery merely expresses strong opinions, craftivism focuses on contributing towards a better social and political world (Greer, 2014). Norwegian artist Nina Vestby engages youth across several countries through what she calls *social embroidery*, encouraging them to tell their stories through thread (Vestby, 2021).

Sennett (2009) elevates crafts by discussing them with great respect and insight, emphasising that good quality achieved in a work of art relies on the embracing of a sense of curiosity towards the material. Targeted craftsmanship is an important part of such creation – something that is not presumed, but rather, achieved (Sennett, 2009). People learned a craft that they later can benefit from in a sustainable manner, either for a self-sustenance lifestyle, to express themselves artistically or as Robach argues: ‘[to] see crafts as a path to quality of life’ (2012, p.15). We therefore argue that to elevate the creativity and connection to the craft, the students should produce their own images, telling *their* story, sharing their views as part of their arts and design education.

According to Wenger (1998), small communities of practice develop a common repertoire of resources: experiences, designs, tools and ways of meeting recurring challenges through dialogue, intra-action and co-research. These shared social characteristics have a positive effect on the artistic expression of the embroidery, as confirmed by our data.

## Research design, method choices and analysis

The project took place at OsloMet, Norway<sup>3</sup>. Three teacher-training classes participated: two first-year undergraduate degree classes, each with twenty students, who worked in smaller groups inside the classrooms, of which the focus was working with SDG14: *Life under water*. The project also includes one postgraduate class with three students who chose to work outdoors with SDG15: *Life on land*.

The empirical data is mainly qualitative (Saldana, 2014; Kvale & Brinkman, 2009):

- Informal and semi-structured interviews conducted via Zoom in one large group-setting. The students shared their experience of co-creative activity, science-knowledge, and competence-building in sustainability.
- Questionnaires answered by nine students sharing experiences connected to sustainability, and transdisciplinary collaboration between embroidery, science, and opera (human and non-human).
- In-depth, narrative interviews with two of the three postgraduate students working outdoors.
- Written reflections connected to Padlet provided by all students in all groups.
- Photographs of the finished embroideries too help illustrating the acquired crafts skills, design decisions and the messages the students wished to convey.
- Teacher observations and intra-action with students.

The information given in these six settings form the basis of this research. Due to geographical reasons only one researcher could lead the classes in the actual implementation, which made it important to conduct the interviews and questionnaires through digital tools for a greater understanding.

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<sup>3</sup> Oslo Metropolitan University (OsloMet) is a state university in Oslo, a merger of several former vocational colleges in the Greater Oslo region. It has around 20,000 students and 2,200 employees. <https://www.oslomet.no/>

The UN's Decade of Ecosystem Restoration inspired the scientific topic for the annual Global Science Opera production 'Thrive', with new made opera music, and thereby also includes this embroidery-project. The students engaged in the GSO signature method (Straksiene et al., 2022) which included embodied engagement in inquiry-based, in-depth transdisciplinary exploration and experimentation through circular creative collaboration. The embroidery is passed around in a group circle and everyone contributes. The method also includes an introduction into the scientific topic – in this case, ecosystem restoration – conducted by researchers within this area of expertise. The students continued gathering information about the topic to strengthen their process, making sure the science was correct.

The students are training to become arts and crafts teachers and a goal of this study is that the students will be able to transfer their experiences to their own practice. A Report to the Norwegian Parliament (Storting) emphasises the importance of subject immersion where the students gain an understanding of concepts and relationships over time within a given subject. They also gain a holistic understanding of subject fields, which enables them to solve problems and tasks in new contexts (Stortingsmelding 28, 2015-2016).

The students were more than informants, in accordance with the Responsible Research and Innovation's principle of researching *with*, instead of *on* the students (European Commission, 2016). They participated interactively with each other, the topic and the materials in the project. The analysis focuses on how to facilitate education in practice-based activities where science and arts are involved, and the students' reflections around this. The ethical considerations that arise when students are inter-actively engaged in a transdisciplinary sustainability-project, are important elements in training for the teacher-profession. Tone Pernille Østern describes research within arts and crafts as 'meaning-seeking, productive and ethical methodological practice' and how 'art, aesthetic practices, and research methodologies are in a constant state of becoming and movement' (Østern, 2017, p. 1). Indeed, knowledge is never static or complete, it is in a constant state of development as new understandings emerge (McNiff, 2013).



Figure 1. Idea-development – first sketching, choosing the right materials, then starting embroidering. Photo: Randi Veiteberg Kvellestad

Design Thinking (DT) was actively used in the training of the teachers-in-training. It is a solution-oriented, real-world focused, problem solving method of approaching any challenge (Gudipati & Sethi, 2016). Four keywords describe the phases in a design process: *feel*, *imagine*, *create* and *share* (Goldman & Kabayadondo, 2016; Sotiriou et al., 2021). The quick turn-over of ideas, testing, sharing and evaluating, is especially designed to find a good solution without wasting valuable resources. The combination of this fast-moving methodology with the slow-art of embroidery in a circular creative collaboration yielded interesting data. The finished embroideries were shared through the GSO to a global audience.

### **Analysis**

We found that DT did not cover all aspects of the results given by the data. Using the GSO's pedagogy as an educational gateway and focusing on posthumanizing creativity somewhat tinted our research-glasses when looking for 'glow moments', which can be understood as data that stands out, either by being challenging, extraordinary, typical, exciting or intriguing in other ways (Chappell, et al., 2019). Searching for different categories to classify our findings from posthuman research-method, we arrived at these four keywords: *relevance*, *engagement*, *collaboration*, and *embodiment*. Just like they are in real life, these terms are also interconnected and overlapping in this study.

## **Results discussed and organized through four keywords**

These keywords are a product of our own minds, informed and inspired by our understanding of the UN's Declaration of Quality Education (UNESCO et al., 2016); of posthumanizing creativity's approach to ethical, transdisciplinary education (Chappell, 2018); and by our personal experience with embroidery and crafts-education.

The keywords are over-arching in the sense that they may enhance developing craftsmanship literacy. Simultaneously, they encourage a holistic understanding of connections between subject-fields as well as the core values of human dignity, democracy and participation, and sustainable development (Utdanningsdirektoratet, 2020).

### ***Relevance***

By *relevance*, we refer to two aspects of embroidery. First, how embroidery is an up-to-date and relevant craft, with its contributions to modern day craftivism, turning it from a cute Granny-craft or old fashion-ornamentation, into a contemporary aesthetic and setting.

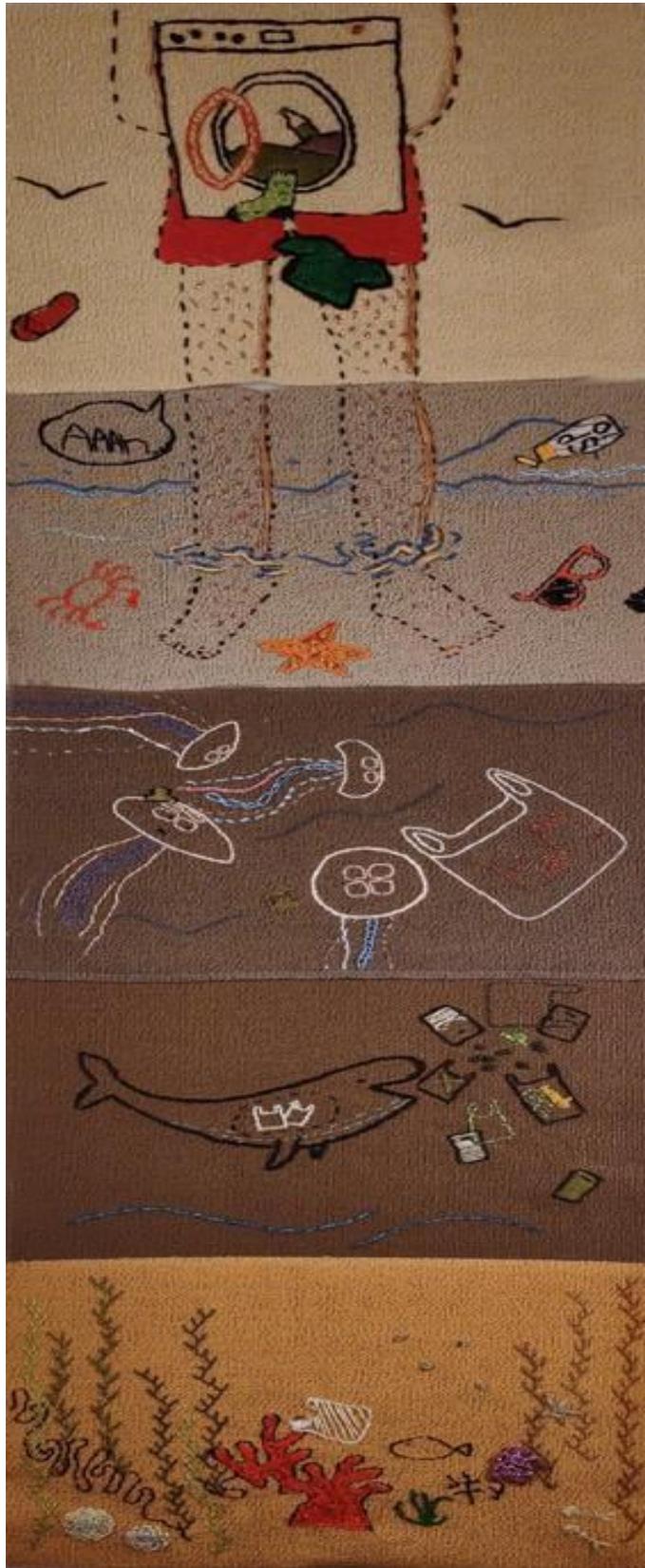
The relevance of the craft proves its connection to SDG4 of ensuring quality education, as craftsmanship training has always been considered an important part of education towards vocational work-life. There are several fortunate side effects to crafts education as these skills are highly transferable, in fact, merely practicing fine motor skills is convenient when it comes to countless aspects in life. In addition, these skills can train your patience, your empathy, and your creativity. Mastering a skill gives you a sense of healthy self-confidence. In addition, we appreciate how it provides time and space for reflection, and its transfer of both tangible and intangible tacit knowledge. The student teachers showed signs of collective tacit knowledge, when they composed, explained and compared their own ideas with their fellow students. This tacit knowledge achieved through material experience will be developed and refined throughout their entire lives (Roback, 2012).

Secondly, the traditionally perceived soft-spoken communication conveyed via embroidery raises its voice in the debate addressing real-world problems, such as our critical ecological reality. Short-sighted, selfish overconsumption is a factor in the world's increasing resource deprivation, with the textile trade being among the top five most polluting industries worldwide, depending on which criteria you compare (Howell, 2021).

The textile industry's impact on nature was referred to in the discussions, the embroidered images themselves and in the evaluation (figure 3).

By participating with their narrative embroideries, the students showed how the use of needle and thread opened doors for creative work both individually and as part of a social setting. These simple tools served as actants in the creative process, simultaneously as the students collaborated with each other in groups, expanding their experience with soft materials and the slow processes in a creative learning environment. Using traditional expressions in a new and unexpected setting, may benefit the craft, the message and the context. In our project, the embroidery actualised ecology, specifically focusing on the topics of *life below water* and *life on land* (Figure 4).

There is also an inherent protest in properly learning a craft-skill, as a counterweight to buying a cheap, mechanically produced, fast fashion version of embroidery. Mastering a skill like embroidery can include sustainable self-sufficiency skills like mending, redesigning and taking care of your garments. Though the students increased their own awareness during the project, one of them pointed out that 'it feels a bit like preaching to the choir, as the people that care about sustainability and restoration of ecosystems already do, and the ones who don't, won't necessarily be engaged by the project.' This is making a valid critical point, concerning the increasing politicalisation of our common ecological challenges (McKay, 2021).



Working with the topic of restoring ecosystems affected the students in aesthetic, practical, and ethical choices. One student reflected: 'I think we wanted a proper result, thinking about the sustainability of ecosystems. We did not want to make something that was to be thrown away, so you thought through what you wanted to convey through the embroidery you made. It felt like ... trying to come up with something not only repeating something that is said over and over again, but [something that] managed to illuminate something in a new way. This was something that was part of the creative process.' This can be seen in Figure 9, where the group took a sarcastic viewpoint on sea-level rise in Venice. Another student expresses how she was translating what she is learning about nature's vulnerability into expressive use of colour and stitching in her embroidery. 'One had to think through different ways of expressing the challenges and opportunities of man and the sea', she reflects. (Figures 3, 4 and 5).

*Figure 2.* 'Water pollution', image of group-work in eco-embroidery.  
Photo: Randi Veiteberg Kvellestad



*Figure 3.* The title of this group's respective work was: 'What if Nature strikes back?'  
Photo: Randi Veiteberg Kvellestad

The students used different means in conveying their messages, considering how the material, techniques, and tools helped define the motif and transmit meaning. It all came together – the scientific inspiration, the tactile creation-process, the reciprocal influence in the group collaboration – to create narrative textiles which expressed their thoughts and feelings. The relevance of the stories told are closely connected to the students' engagement in the topics.



*Figure 4.* Highlighting current issues like melting ice-caps, overfishing and ocean-pollution, sustainable energy-sources and fossil fuel production. Photo: Randi Veiteberg Kvellestad



### ***Engagement***

By engagement we refer to the students having a conscious relationship with their own lives and their place on Earth, choosing their form of actions and paving new arenas for (self-)exploration. The act of actively engaging in creating a better future, bringing hope to oneself and others, and expressing oneself creatively are all signs of a healthy life-attitude. Here, the collaborative group process may spark discussion and reflection, build awareness, and finally a deeper understanding for each other and the topic at hand (see Figure 5).

The empirical data showed us the student teachers' reflections on nature and ecology, science and STEAM-education, pedagogy and learning, as well as the creative process itself – that being, all areas connected to their role as future teachers and world citizens.

Our data confirms a general increase in awareness connected to the ecological situation, especially the respective ecosystems the students were working on. They all had previous knowledge of the issues, but several students confirmed that the project reminded them of the importance of the problems. Some of them stated that they already had a strong relationship with nature and used the project as a platform to express themselves, both artistically and through advising their fellow students.

The students reflected on the materials being used in the project and connected it to the general lack of availability of sustainable products. Showing basic knowledge in how materials can affect nature, they aimed toward the best possibilities the setting allowed, using 'unbleached cotton canvas that does not separate chemicals or microplastics when washing, and cotton thread' (Figure 2).

Addressing ecological issues in education – finding a good balance between facts and hopefulness – can be challenging (Sterling, 2002; Hes & Du Plessis, 2014). This difficult balancing act was clear among several of the students. As one student explained: 'It opens my eyes to the trend towards the destruction of our ocean. But it also gave us the opportunity to think of new solutions.' A fellow student takes this further, showing a connection to mental health and anxiety: 'As I often have a pessimistic view on the condition of our nature and oceans, I definitely felt less alone through collaborating and creating together. It was nice to use an artistic and creative medium to communicate something that is hard to process, and yet feels so real. It also gave me new energy to see other group members' more positive outlook.' This is one area where STEAM in arts and crafts can be of help, in presenting concrete practical design-solutions that are

ecologically sustainable. By being given the tools of eco-design know-how, students can actively choose more sustainable options, and hence feel empowered and that they are able to make a difference (Robberstad, 2017).

The project also affected the students' views on the educational learning-arenas. One of the students working outside, expressed a wish to turn her own research-attention to 'the fact that the learning arena is not just within the classroom'. Inspired by the experience, she wishes to explore this learning realm further through her upcoming master's thesis. A fellow student expressed the dormant possibilities readily available in 'using nature as a learning arena, it's just there waiting to be explored. Especially now with a focus on a sustainable perspective that we will include in schools and in all educational courses.'

Being outdoors also invited the students to experiment with different natural materials, as they tried sewing on moss, leaves, between branches, etc. (Figures 6 and 7). This became part of an important tactile experience. As one student recalls: 'I remember the first time I had to sew through the large leaves... it was cool to put the needle through the leaf. It was a completely different feeling than sewing on fabric. It was a separate feeling, it was satisfying ... when you did it. (...) It was an unfamiliar feeling.'

The students expressed how their embroidered leaves became visual symbols of how humans need to 'mend' nature: 'We come as doctors to sew and fix nature. To kind of sort things out, be environmentally friendly and sort of symbolically sew and repair and put together. We walk around here and tread a little carefully in the forest and try to sew it together.'

This shows a critical reflection and ethical consciousness regarding their own human influence on nature, and what traces they leave behind. They were careful in using sewing thread of organic material that would disintegrate and decompose. However, posthumanism would question our roles as the 'saviours' of nature, something the students did not reflect over, even if after one month on from the initial embroidering, they went back and observed the traces of their work (Figure 6).



*Figure 6.* 'Mending nature?' Experimenting with embroidery, using natural materials (cotton-thread) that would gradually become nature. Photo: Raquel Sans



*Figure 7.* Tactile experimentation with red thread on green moss. Experimenting with embroidery in and on nature. Photo: Raquel Sans

The issues within the UN goal triggered the students' inspiration and engagement in environmental subjects. In this project the students worked collaboratively on a common end-product. Hence the students inhabit several roles, those of: creators, co-creators, and viewers. In addition, they served as discussion and reflection-partners for each other. Which leads us to the next area of focus: collaboration.

### ***Collaboration***

The Incheon Declaration outlines collaboration as a cornerstone for a peaceful future, advocating a humanistic perspective, extending to *all* people. We refer to different levels of humanistic human intra-action between the students in the groups, and the posthuman intra-action between the humans and non-humans, specifically between the students and the materials, tools, techniques, and scientific topic (Chappell et al., 2016; Chappell et al., 2019). The latter will be addressed in the next chapter.

An active creative collaboration can expand the horizon of possibilities, trigger issues of trust, inspire deeper discussions on challenges and lighter social conversation building within the group-community, as the groups in our study experienced (Wenger, 1998).

Traditionally, embroidery is often a time-consuming solitary exercise, but here, the students were instructed in the *circular creative collaboration*, where every group-member contributed on every embroidery (Robberstad et al., 2020). The GSO-method emphasises creativity as a collective process; the idea process shows how ideas build upon each other, in a democratic manner. Each student made sketches for their own narrative idea, but passed it on before beginning to stitch on their neighbour's cloth (Kvellestad, 2018; Kvellestad, Stana & Vatn, 2021). The student who originated the idea was the last to receive the almost finished embroidery and could add the finishing details. In this collective process, the embroideries developed and changed, sometimes in unexpected directions, as they were passed on. This process strengthened the embroideries both in content and technique, as the sum became larger than its part, when students both complimented and complemented each other's embroideries.

There is a distinction between *cooperation* and *collaboration*, where teamwork in a design process shows differences in levels of participation (Ness, 2016; Kvellestad, 2018). When groups cooperate, the participants communicate, but with minor processual contact. In a collaborative relationship, however, participants engage and interact with one another. New possibilities emerge and the interaction leads to a co-ownership of the design (Rochelle & Teasley, 1995; Kvellestad, 2018). The distinction in definitions relates to the embroidery designs, clearly describing the communicative and relational processes (Kvellestad, 2018). Collaboration is a pillar in the GSO pedagogy, between subject fields and groups of people. Hence, the GSO aims for intra-action – that is, an even higher level of enmeshed collaboration.

We recognised both approaches in our project. The cooperating students completed their own task and then passed the piece on to the next person. In the collaborative groups, however, the participants asked questions, had dialogic conversations about materials and designs, and intra-acted with one another in mutually responsive ways. The indoor groups showed more collaborative tendencies within their groups, while the outdoor group worked in a more solitary manner. However, the outdoor group showed a deeper connection with the materials, opening up to creative posthuman intra-action with non-human actants (Chappell, 2022).

Small group conversations raised critical questions regarding overconsumption, pollution and environmental issues. With this experience, the student teachers may offer sustainability-insights to their future pupils and accomplish great objectives in the classroom-context.

However, introducing the concept of circular creative collaboration into the project caused surprise, even some scepticism at first. The self-proclaimed perfectionists admitted facing trust issues, having a very set mindset on how they wanted their sketch to be executed. But as the project progressed, they saw how others' ideas and interpretations improved their own contributions, and the benefits of the collaborative process became a revelation. Afterwards these students were among those who admitted to having learned something from the collective process.

The students agreed that the collaboration enhanced the richness in the content, with a broadness in messages in the artwork as they had all contributed with their unique perspectives. They didn't see the final result until it was returned to them for the last details. One student noted that: 'As a group, I felt like we increased each other's creativity by working on each other's pieces'. Another student stated that the circular collaboration brought more enthusiasm and drive to the project. The group dynamic seemed strengthened through the sharing of hopes and worries connected to the ecosystems, which additionally increased eco-awareness. The students valued the freedom in the task to experiment and improvise artistically, and were inspired by how the embroidery itself evolved and changed. It is difficult to measure the effect of the music created for the opera on the students' creative process, however one student group explains how the music composed for the opera influenced their creative process. The music affected the rhythm, density, length and direction in lines of the stitches in the embroidery. They explained: 'The music was rich and energetic as reflected by our lines. (...) In addition to making the different lines and colour compositions, we played a lot on 'upside-down' scenarios which resulted in playful embroideries – in accordance with changes in the song along the way. Music influenced our stitches through our subconsciousness' (Figure 8).



*Figure 8.* 'Life under water ... where I come from', group work showing the connection between the playful lines of embroidery inspired by the rhythm and changes in the opera-music. Photo: Randi Veiteberg Kvellestad

The students express that transdisciplinary science and arts-collaboration is a good way to gain more breadth of knowledge in a fun way. Although 'fun' is not the main aim here, it should not be underestimated as an important motivational factor in a meaning-seeking process (Østern, 2017). The students also articulated a positive attitude toward the circular creative collaboration, as it made them more conscious through the group-process. As one student explained: 'I became more aware of my own creative expression, and enjoyed seeing the methods and creativity of those I collaborated with.'

### ***Embodiment***

By embodiment in this article, we specifically mean the internal, personal integration of skills and knowledge. By utilising a holistic approach to learning, merging the best of theory and practice, the slow-art of craftsmanship expands the sensory exploration for the 'Digital natives' or 'Touch Generation' through tactile thinking (Hakkarainen, Hietajärvi, Alho, Lonka & Salmela-Aro, 2015; Hansen, 2020). Slow-art is closely connected to the practice of craftsmanship, the transfer of tacit, tangible and intangible knowledge, experience and execution. As one student expressed: 'We

worked so hard and intensively with this embroidery. It felt like it became part of my hands.'

Thinking about the craft can be traced through to how the students engaged with the scientific topic, became more aware through informational material and through group-discussions, and their engagement in sustainability re-ignited that in several of the students. As stated by Adamson, 'thinking through craft is a useful exercise, and never more so than when it creates uncertainty' (2007, p.169). In this sense, crafting also serves as a means of dealing with uncertainty itself, by channelling thoughts, feelings, and fears through wordless artistic communication.

The outdoor-group entered an 'unknown' situation when they took their embroidery-kits with them into the forest. They had a stronger sensory experience, a closer intra-action with nature, their experience was enhanced by their voluntary exposure to the elements. The elements of nature were a scenery, surrounding their creative activity, and it influenced their process and product, as is encouraged in posthumanizing creativity.

The students' approaches were also more experimental – they were not merely creating an image of nature, they embroidered *in* nature, *on* leaves, moss, and trees. They refer to the 'flow' of their inner creative process, losing track of time (but not place, the natural forces very much present), immersing themselves in the process, almost entering a meditative state with repetitive stitching. One of them shared that: 'In this process I had the needle and thought I would see where the needle takes me and it was meditative, it was like, in a way, I had to trust myself, that I should do something beautiful in the end. ... It was a very good feeling really.' Their reflections imply an embodied co-embroidering activity. Defying the rain and cold, they kept going, finding the embroidery all-consuming. They re-visited the site a month later to document the progression of their artwork, after being exposed to the natural elements. Nature gave new experiences, expanding their practical understanding of nature and what a classroom can be.

The dialogic intra-action with material can also be found in the indoor group. When asked about their creative process, one student connected a sustainable mindset to how the group included all surfacing ideas. By exploring them, seeing how the embroideries developed as they were passed between them, the students are adopting this fundamental openness in the creative learning-process. One student reflected on their intra-action with the materials expressed: 'I felt the materials worked with us in the way that it was possible to bring new ideas to the cloth and mix new

stitches into the old ones, on top of or even underneath. This was very convenient when we were collaborating.'

This experience seems connected with their embroidery beginner-status, not yet fully mastering the technique: 'In the beginning, it felt like the threads had more control, as I still got to know how it worked on the canvas, and how the surfaces turned out. As I went on, it felt like I steered the process most of the time.' This showed an element of equality, with a collective training process where they helped each other.

In the outdoor group, one of the students described the experience of sewing through the large leaves as a completely different feeling than when sewing on fabric, 'an unknown feeling', recalling the satisfaction of stabbing the needle through the leaf. She added that when the rain started, it became more difficult to embroider, making the thread stick, and the leaves break. Yet they still admitted: 'But this is so much fun, it's such a great experience, we have to come up with more like that. There is so much out there, we just have to keep trying. Something has opened up inside me.'

This description of the educational learning process by the students attests to the embodiment of knowledge and skills. Their holistic sensory experience with the tactile craft and topical surrounding is embraced through their engagement. It also shows reflections upon their upcoming teaching-practice. When the student teachers express a wish to use nature as an alternative classroom, it can be seen as an invitation to develop a personal relationship with nature for their own future students. This in turn may enhance a stronger sustainability engagement in wanting to protect nature for future generations.

### ***Engaged embodiment, ecology and embroidery in education***

This project has given valuable insight into working co-creatively with embroidery in a STEAM-education setting. Recognising the importance of including craftsmanship in education, we see both challenges and opportunities. The project showed the benefits of quality-craftsmanship beyond vocational training and how a collective creative process can bring richer results than that of a solitary process. Craftsmanship is valuable in its own terms and can be enriched through transdisciplinary collaboration with science.

Our journeys of becoming or that of our life journeys could and should be a life-long learning-venture of quality education. Crafts education expresses a holistic approach to knowledge as it is a natural combination of theory and practice. Furthermore, it can be a sensory exploration of tacit knowledge through learning by doing. Finally it can also generate a satisfying feeling of achievement when creating a finished product, it

provides the opportunity to practice fine-motor skills, and to explore aesthetics and creativity, all of which are useful in other areas of life.

One disadvantage of this, however, is that this is resource-demanding teaching, and we do not have evidence of how long the engagement stays with the students.

Collaboration, both inter-human and between humans and non-humans, is vital in tackling the ecological challenges of the 21<sup>st</sup> century. A decentering of the human and the consideration of non-human co-creatures' lives and well-being, could raise an important discussion of priorities, including in education. Crafts education may prove a helpful tool in understanding and appreciating the non-human actants. Applying this in a STEAM-education context, where the scientific topics are related to real-life, ethical challenges, may in turn awaken empathy for non-humans. We recognise the students' re-discovery of nature through the co-creative process, embodying their own experience through tactile exploration, expanding their perception of what a learning-arena is and expanding their notion of collaboration to include non-human actants. Quality craftsmanship in general is essential in executing the practical re-designing of a more ecologically sustainable world (Robberstad, 2017). This requires qualitative training in crafts. Engaging as a co-researcher in this STEAM-project has inspired one of the postgraduate students to continue exploring nature as an outdoor classroom in her own master's thesis research.

## **Conclusion**

How can creative collaboration in embroidery enhance a sustainable STEAM-education learning experience? Our research-project shows some ways in which the craft of embroidery may contribute to improving quality education and enhancing a holistic learning experience through embodied transdisciplinarity and creative collaboration. Our analysis shows how transdisciplinary collaboration with science can make embroidery relevant, and vice versa, for instance when communicating 'wicked problems', such as achieving ecological sustainability (Chappell et al., 2019). The unexpected is more easily noticed, like when this traditionally perceived romantic, non-threatening artistic expression of embroidery is used to convey critical messages, it may invite new thoughts and increase consciousness around a topic. The slow art of embroidery seems to call on the students to reflect on their values and beliefs. They engage by connecting with their thoughts and feelings, and communicate these through tactile, textile expressions. Embroidery introduces a new approach to circular creative collaboration, emphasising the value of ideas building upon ideas, showing how the sum of ideas becomes larger than its single parts (Kvellestad et al., 2021) Working interactively in a collective creative process with other humans, may challenge fears and the need for control. Embroidery can thus

serve as a gateway to understanding the intra-action with non-human actants through a creative process, in which a sensory, tactile practice involves materials, tools, techniques and scientific concepts.

Since training in crafts and craftsmanship may be a direct answer to principle 48 of the Incheon Declaration's call for 'developing high-level cognitive and non-cognitive/transferable skills', we wish to continue our research by further exploring the creative intra-action within embroidery between the human and non-human (Matless & Revill, 1995). We wish to further explore how embroidery can be used as a 'craftivism tool' that may engage in quiet activism. We believe it is important to incorporate transdisciplinary collaboration, including the intra-action between the human and non-human in higher education, especially in student teacher training. These future teachers have a vast scope for impact as they educate the generations of tomorrow.



*Figure 9.* 'When the sea-level rises in Venice'. Applying dark humour in visioning a dark future. Student-work. Photo: Randi Veiteberg Kvellestad

### **About the authors**

Janne Robberstad is associate professor in arts and crafts and a PhD student researching eco-creativity at the Western Norway University of Applied Sciences. She is the production manager of the Global Science Opera and has coordinated several Erasmus projects. She also works as a visual artist and an eco-scenographer and is a member of the Association of Norwegian Visual Artists.

Randi Veiteberg Kvellestad is associate professor in design, art, and craft at OsloMet – Oslo Metropolitan University. She has worked as a textile artist within embroidery since 1999 and is a member of the Norwegian textile artists (NTK). Kvellestad is concerned with linking teacher education, interdisciplinary activity, and research. She has written academic articles about these themes.

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