Circular Movements of Healing with Maths, Arts and Craft: *Reimagining disciplinary transversals for learning*

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Recognizing the learning potential in maths, arts and craft when students, student teachers and teacher educators dare to transverse disciplinary boundaries we have come together to discuss what does it mean to work pedagogically, didactically and affectively at a slower pace creating new transdisciplinary spaces for being and becoming. Based on our previous work concerning theoretical and empirical investigations concerning the role of the body, embodiment, movement, materiality, senses along with sad and joyful affects we focus on how 'circular movements of healing with maths, arts and craft' allow us to reimagine disciplinary transversals for learning that combat fear, indifference and alienation. We discuss these issues through specific themes permeating our projects that address the intergenerational re-storying of mathematics through labyrinths, the mathematical sculpting in fabric, the challenges of embodying geometry with spiral sculptures, the learning experience of risk and serendipity in ceramic sculpting, the commoning of math/artifacts and the decolonial act of walking the capoeira circle counterclockwise.

Keywords: *reimagining institutional learning, embodiment, affect, making with maths, arts and craft, disciplinary transversals*

Introduction

Despite increased awareness for the potential onto-epistemic, aesthetic and creative linkages across mathematics, arts and craft, especially when bodily activity and embodied learning is being embraced for knowledge creation, efforts to enact transdisciplinarity in diverse context(s) of teaching and learning reveal the complexity of transversing disciplinary

boundaries. Specifically, as students, teachers or teacher educators attempt to cross disciplines in the formal setting of a classroom, auditorium or museum and in the informal space of the playground, the street, the garden or the rural landscape, they often find themselves trapped within essentialist and instrumental logic(s) of learning. There may be a felt reality of obstacles toward undoing such logics and trusting the necessary move to unknown or uncertain ways of knowing. This can easily result in sad affects (e.g. fear for failure to learn, despair for not seeing connections, anxiety or uneasiness to trust the body). How do we recognize such sad affects and how do we heal their deadening effects? Moreover, how do we work pedagogically at a slower pace toward clearing the path for students and student teachers, so that they themselves can experience the joy in creating their own relational spaces where mathematics, arts and craft become entangled in meaningful ways?

To address this question, we find value in the MACAS symposium call for "circles of resonance in mathematics". And in this spirit, we discuss the theme "circular movements of healing with mathematics, arts and craft" bringing together mathematicians, maths educators, artists and designers. Based on previous work concerning theoretical and empirical investigations between mathematics, arts and crafts where mathematics is seen as a bridging discipline (Michelsen et al., 2022) but also on important work concerning the role of the body, embodiment, movement, senses, affect and affective bodying (de Freitas and Sinclair, 2014, Chronaki, 2019, Gerofsky, 2024; Nemirovsky, 2024) we came together sharing experiences that can, potentially, work for transversing disciplinary boundaries. We have done so by attending to diverse circular movements of healing as a return to a particular movement where the full body, the hand, the eye and the senses resonate for remaking mathematics through the materiality offered by arts or craft and for slowing down the process so that to feel and think linkages across subject areas. Specifically, the sections below describe several projects where such circular movements of healing can be tapped.

The project *Restorying mathematics with an intergenerational community through the art of Labyrinths* is discussed in the first section by Susan Gerofsky. This project is focused on a remote rural community with a collective interest in making and understanding labyrinths. Through the embodied experience of this creative mathematical labyrinth exploration, community members with stressful prior experiences in mathematics started building a collective mathematical/artistic space of knowing that might heal prior sad affects. Ricardo Nemirovsky, in the second section, presents the project *Mathematical sculpting in fabric* that takes place in museum workshops with young children or adult science educators, and

focuses on how exploring the 3D Gaussian curvatures in a series of sculptures as an embodied activity across digital and hands-on making allows to participants to sense and make sense of novel, unexpected patterns. Next, in the third section, Anna Chronaki and Ulrika Ryan *Embodying geometry in the Spiral Playground of the art museum* discuss the affective experience of student teachers in a mathematics teacher education course on geometry asked to explore bodily the spiral structures in a local arts museum garden (i.e. use their bodies to feel, sense, climb and hands to draw or sketch the varied spirals). They focus on the spiral narrative of one student-teacher who tried to articulate the learning potential in terms of gains and failures. Maria Letsiou, in the fourth section, *Ceramic sculpture as practice-based research: Risks, serendipity, and learning across disciplines*, discusses her own bodily interaction as an artist with the complex materiality of clay sculptures through creating haptic circular forms with the material in hand and argues that attending to the process itself provides inspiration so that to appreciate complexity, uncertainty and creativity. The fifth section by Anna Chronaki and Eirini Lazaridou, *Commoning mathematics through crafting artifacts as matters of care*, narrates a pedagogic project with young children focusing on making mathematics and artifacts as a didactic practice for commoning knowledge (i.e. caring for the process and caring for sharing elements that open learning spaces). Nicholas Baroncelli Torretta in the sixth section, *The Capoeira circle as a space for decolonial and undoing dialogues,* works with the concepts of "walking counterclockwise" in the Capoeira circle and "flowing circularity" as decolonising methods not only for learning to use one's own body, but also for asking what needs to be undone, repaired, healed in the disciplinary practices of arts and design. And in the final section, Per-Anders Hillgren reflects across the above projects and shares key themes supporting contemporary pedagogic and didactic strivings traversing disciplinary boundaries in contexts of formal and informal teaching and learning.

Restorying mathematics with an intergenerational community through the art of Labyrinths: *Susan Gerofsky*

For many adults in Canada (and elsewhere), the word "mathematics" raises fears and recalls bad experiences, or even trauma, from their school years. The word "mathematics" may recall their (often unsuccessful) work to do precise, rapid numerical calculations and measurements toward finding elusive correct answers or carrying out complicated procedures that may seem meaningless. The shame of getting the numbers wrong at the end of seemingly impossible tasks stays with a great many people into adulthood, and they are all too willing to drop mathematics as soon as they are allowed to. Feelings of fear and shame have become an

ingrained part of mainstream culture and are communicated in both overt and subtle ways to younger generations, in a self-perpetuating cultural loop. Even a child who is enthusiastic about mathematics may get the message from their community that this is an odd and perhaps misguided pursuit, because so many adults perceive mathematics through stories of failure. On the other hand, mathematicians and mathematics educators see mathematics quite differently: not as a series of mechanical, meaningless precision calculations and measurement divorced from context, but as an intriguing and beautiful exploration of the patterns of patterns of patterns. Mathematics is a significant part of our human heritage spanning across human cultures and, hence, there is potential for everyone to find fascinating discoveries in mathematical patterning and a joy in the inherent beauty of these patterns. Having many people in a society blocked from an important area of human flourishing and endeavour is a loss to the whole society –a loss of insight, inventiveness, learning and joy. Without the active participation of adults and elders alongside children and young people, it seems there is little opportunity for meaningful restorying of mathematics at the community level, and entrenched stories of mathematics as a place of failure are likely to persist.

"Restorying Mathematics" is a collaborative project by Susan Gerofsky and her colleague Cynthia Nicol working with intergenerational communities in rural and urban settings, to open the possibility of confidence and enjoyment in a "seriously playful" approach to mathematical patterning. They strive toward creating the circumstances that help people begin to tell themselves new, more positive and engaging stories of their relationship with mathematics through the arts. In the first phase of the Restorying Mathematics project with the remote rural community in British Columbia, an interactive meeting was organised with the community where ideas were shared amongst participants for a collective exploration between mathematics and the arts. It came as a surprise to find that there was great interest from most of the community in a topic that they were new at that time*:* "labyrinths and their mathematical connections!" They went away from the meeting and researched the very intriguing connections between labyrinths, their worldwide history, and their structure based on geometric "seeds", then brought these insights back to the community through a series of exploratory workshops at varied spaces such as the Seniors' Lunch or the preschool context expanding to several all-ages workshops with the whole intergenerational community. Each workshop was accompanied by group and individual research conversations and interviews in a variety of media. Every experience of making, varying, designing, walking and dancing the labyrinths led to new, collectively constructed understandings about the mathematical nature of labyrinths. For example, faced with the conundrum of how to describe a labyrinth to three-

and four-year-olds at the preschool, they realized that a labyrinth is "a way to take a long walk in a small space", a fractal structure akin to space-filling curves and Koch snowflakes, where a (potentially) infinitely long path is enclosed within finite boundaries. In the preschool, they began by having the kids in turns taking the longest walk they could on the storytelling carpet, then went outside and drew, walked and ran chalked labyrinths on the playground.

Figure 1. A child making circular lines for the labyrinth. Photo by Susan Gerofsky

In whole community workshops, many of the participants became fascinated with the design and constraints of classical labyrinths. Some are continuing (after the workshops) to design beautiful new varieties of labyrinths and of labyrinth designs, and to add new understandings to the study of labyrinths as mathematical structures. One of these new designs, grounded in the community, is slated to be built out as a labyrinthine sculpture garden at the new local Arts Centre. People of all ages brought their special perspectives and insights to help build a collective mathematical/artistic knowledge with the whole community, where the knowledge and experiences we hold as a group is much greater than that of any one participant. They have used filmmaking as one of core techniques for documenting and sharing these experiences and people's reflections on their math stories through the process of participating in these community math-art experiences. The culminating community labyrinth workshop in 2022 was documented in a film (available at vimeo.com/699551189) in which several participants talk about gradual shifts in their own ways of telling their math stories -a shift reflected in our further work with an urban community. The outcomes of this experience give hope to the idea that it may be possible to re-story our collective relationships with mathematics, across generations, through exploratory interactions with mathematical arts.

Mathematical sculpting in fabric: *Ricardo Nemirovsky*

In 2015 a research group led by Ricardo Nemirovsky at Manchester Metropolitan University started working with iron-on fusible interfacing, ironing cotton fabric on both sides of the interfacing. This material can then be cut with scissors, or with a laser cutter if precision is desired, and sewn. For example, a flat flower shape with ten radiating square petals, cut with a laser cutter, can be bent upwards, and the petals sewn together can create a 3D bowl. In general, any shape you can imagine can be obtained by cutting into the reinforced cloth and then joining the edges. This is clearly a very central process in architectural and fashion design. For example, when designing custom clothing that needs to follow the curvature of the body, we need to start with flat fabric and alter it through cutting and sewing -a very ancient approach to create 3D curvature that is related to Gaussian curvature. The way the fabric is cut translates into a 3D curvature and then the cut material is sewn with positive curvature, while added material sewn in yields a negative curvature. Specifically, when designing a shirt, the top of the shoulder has positive curvature, while the underarm has negative curvature, and needs an inset of cloth. It is not trivial to imagine how a 2D cut will form a 3D shape!

The educational project on sculpting was first initiated in 2015 was with 9- and 10-year-old children in an after-school program at the local art museum. The children first experimented with creating their own bowls and then, were able to explain how they developed the shapes they wanted by cutting and sewing. After they had hands-on experience in making bowls, they visited a display at the art museum of some beautiful Indigenous American basketry. They were able to discuss how the weavers create the shapes of their baskets showing a greatly increased appreciation of the complex design involved in traditional basketry. Following this workshop, the research group's most recent experience was with staff members at a large Science Museum in Warsaw, Poland. The science educators at the museum were trained in science, design, mathematics and engineering and as they were involved in the sculpting activity their participation was documented through video-recordings. The following quotes from the participants gives a sense of the depth of their involvement through their reflections on how the sculpting activity could provoke novel imagery paths even for professionals with a high degree of training in geometry. Specifically, a biologist who was engaged into designing a lamp as part of the workshop mentioned:

> *I was surprised that I could create quite a complex 3D object myself by designing it on a plain piece of paper. I want to do more projects and implement them. Great fun with mathematics and space using intuition. It was nice to sew and talk together.*

Both children (in the after-school program in the local art museum) and adults (staff in the science museum) commented on the socio-cognitive aspect of making things together, as they become collectively engaged in an ongoing conversation, and felt more relaxed in working in this setting of an open workshop. The staff member who was making the Blue Flower Bow said: *"I really enjoyed the design process and sewing. I'm sure that I will use it at home to hold keys".* And the maker of "Jewellery Plate", who produced a detailed sketch for the laser cutter, with holes planned to sew the final product together with string argued: *"Working on the task was very relaxing for me, I was happy to look at other people's projects. The task was integrating, relaxing, and empowering the participants".* At the same time, another participant tried something unusual in 2D, with a Sunburst pattern of radiating arms, all curved in the same clockwise direction. When she sewed the piece together, it achieved a certain torsion, and everyone was surprised and interested to see the spiralling shape that this kind of 2D pattern created when translated into a 3D sculptural form. Moreover, the making of the Unexpected Pattern, a bowl with lacy open sides, highlights the fact that sewing is very much part of the creative process' (see Figure 2). The maker cut the shape, but he saw that if he stitched in tightly, the whole piece would be quite small, so he extended the strings to make open sides by explaining:

> *My design was supposed to be practical, so I didn't want to do complicated shapes. However, it turned out that if I stitched the edges together tightly my design, which was supposed to be "a pot", would be very closed in the central point.*

In all, some of the sculptures were created collaboratively with each participant and member of the team creating a part as they pleased, and then working together to put the parts together, as with the Funny Monster sculpture. Others were created through a joint design where each person agreed to make a different component like the wings, the head or the beak of the Bird, in a coordinated design.

Figure 2. The Unexpected Pattern. Photo by Ricardo Nemirovski

One of the museum designers who had a great deal of experience with CAD software and 3D printing, comparing computer design to hands-on analogue making, on the centrality of hand making to imagine shapes in space, gave the following description:

> *So, I discovered a very interesting thing because almost every day I'm working with 3D projects* (…) *I'm drawing them and I'm printing them all the time in our laboratory. But the computer programs are working in a different way because I'm drawing 2D and I just, for example, take some material to the app and give them shapes. But, this workshop was very interesting for me because before I was more like playing, just like investigation. Like I will cut here, I will cut there and I will just see what will happen. This workshop makes me think more.* (….) *Not just do something and see what will happen, maybe just delay it and do it again, but it pushed me toward thinking deeper from the very beginning what is a curve, what shape will it give me. So, more tactical and, really, more professional thinking. It is not only "Let's just, let's do it and we'll see what will happen". Before I was working on something intuitive, but before it was like I was, when I was doing some 3D projects, maybe I was doing 10 of them and I was relating them because I didn't achieve* (or…) *I was not thinking what line will, what shape I will get.* (....) *Just I would like, oh, let's see, not this, we may be delayed. But right now, by delving into the mathematics, I can more imagine what shapes, how the shapes and how the lines will be, what curvatures I will get*.

In all, the workshop on curvatures at the science museum let him learn about the importance of slowing down the design process and thinking of how the curves and the shapes create new forms in certain angles that determine the shape of the whole object. This project argues for the importance of curvature inquiry through hands-on making as a precursor for deepening into the complexity of both the mathematical concepts and the shapes design. It becomes apparent that even when computers are being used to design and produce 3D objects, they should be used in combination with hand making.

Embodying geometry in the Spiral Playground of the art museum: *Anna Chronaki and Ulrika Ryan*

The Spiral Playground located at the garden of the Malmö Art Museum involves 3D sculptures designed and built by artist Beatrice Hansson aiming to engage children and visitors with free playful activity in the outdoor space of the museum. During the pandemic and as part of a geometry course at the teacher education program at Malmö University, a day-workshop was planned for embodying geometry with the spiral sculptures (see Figure 3). The student teachers, who had been much deprived from face-to-face interaction due to

covid-related restrictions for indoor activity, they could meet outdoor and participate in a workshop where geometry (i.e. Euclidean, topological, projective and analytical geometry) could be explored through a direct bodily connection with the art sculptures in the spiral playground and do specific tasks (e.g. sensing, touching, climbing, photographing, drawing, sketching). Some of student-teachers' work (i.e. pictures of their bodily activity, sketches, geometry tasks) has been uploaded on a Padlet used to archive their work and to act as a visual mediator for discussing and reflecting on aspects of this outdoor workshop later. Despite our high expectations that student-teachers could turn enthusiastically in this type of embodied work not all of them were able to fully participate. The embodied engagement with spiral sculptures necessities that a person can come out of one's comfort zone toward using actively the body and the senses without fear of exposure and failure but also encourages to come together with others and to become (again) playful like children, a number of students were hesitant and reluctant to participate with their own body and could not engage easily with these "new" tasks. Their main concern was doubting the resonance of such embodied and playful activity with the core mathematics curriculum in their teacher education course. Thus, Ulrika and Anna turned to inquire about the student-teachers experience by discussing the relevance of embodying geometry in the spiral playground with one of them (Sebastian, a pseudonym). The open discussion with Sebastian (who is a young adult of 25 years of age from the south of Sweden) was chartographed as a spiral that denotes how the discursive elements (i.e. clarity and purpose, physicality and play, mathematical accessibility, social dynamics, learning potential) in his narrative move into a circular movement striving to articulate the Spiral playground experience (see Figure 3).

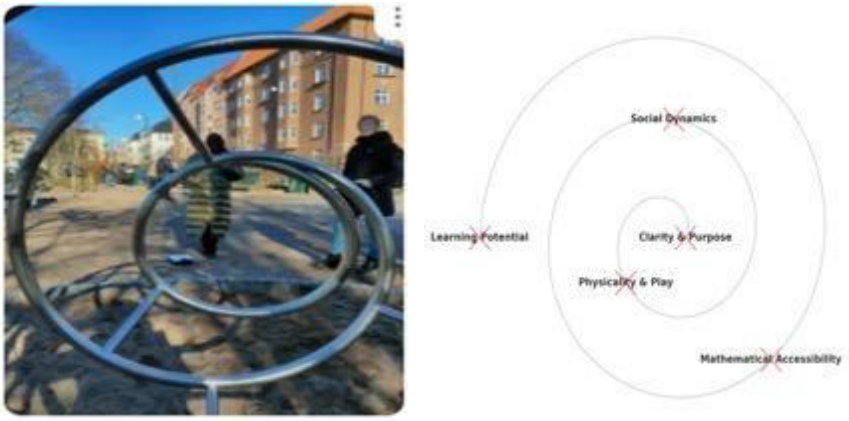

Figure 3. The spiral sculpture in the Arts Museum garden and Sebastian's spiral narrative. Photo by Ulrika Ryan and Figure sketched by Anna Chronaki.

A closer look reveals a tension across these discursive elements concerning the potential of arts-integrated, embodied mathematics learning and pinpoints the barriers posed by goals that were not made explicit, social hesitations, and lack of tangible mathematical connections. While the experience broadened Sebastian's perspective (along with his fellow student teachers as, sometimes, he wanted to speak on their behalf) and sparked some valuable teaching ideas, the absence of a familiar context in their teacher education program left him and others with a lingering sense of incompletion. However, the specific themes that have been located in this spiral narrative are summarised as: clarity and purpose (concerning how mathematics translates from the art work to the curriculum), physicality and play (concerning the difficulty to engage playfully and bodily with artwork), social dynamics (concerning the group interaction and its effects on the product), mathematical accessibility (concerning the problem of accessing the mathematics embedded in artwork) and learning potential (concerning, mainly introspectively, the expansion of deep math learning and new avenues for relating to mathematical activity). Specifically, Sebastian's learning potential was expressed through quotes such as:

> *It opened my eyes to math in the real world. I find it interesting to reflect on how geometry connects to the human body and the objects around us. Comparing things to your own body length... can be interesting. You remember things differently when you feel and experience them. When I was writing the text later, I was walking my mother-in-law's dog and looked at manhole covers—squares and circles—and thought about how I could use that in teaching.*

Taking the above into account, one may consider that if such embodied activity with art-sculptures are to be integrated in a geometry course for teacher education, more attention, time and space must be given so that not only to support making connections (as convergences and divergences) with the current math curriculum, but also to attend for the necessary pedagogical and didactic spacetime that allows one to work with onto-epistemic shifts. At the same time, the embodied activity must be seen as a polyphonic event that allows multiple bodies and minds to enter the scene making multiple connections across mathematics, bodies and discursive elements. Furthermore, we must note that the teacher-student cohorts at Malmö university comprise, for Swedish standards, an unusually large proportion of students from non-academic backgrounds and from second generation migrant populations. To enhance equitable learning opportunities Malmö university among other things, enacts, by and large, a so-called constructive alignment pedagogic program. This means that students expect that course objectives are explicitly related to each course

activity and are clearly linked to each examination task. While this policy allows transparency and facilitates access to examination tasks, it might, sometimes, restrict appreciation of open collective learning activities that are more exploratory or playful and require students to create themselves a deep personal and collective sense of activities by becoming agentic knowing subjects. We speculate that for such activity to enable transversals across maths and arts one must create a circular movement of healing sad affects that addresses feelings of fear for failure not only with mathematics but also with the embodied work needed. Getting involved with mathematical ideas in artwork as an outdoor activity (i.e. to expand curricular maths) is not an individual enactment. It requires that the collective body of student-teachers, teacher educators and artists can come together and allow themselves to learn how to entrust their bodies, senses and words in an open and playful experience across mathematical concepts and artwork objects.

Ceramic sculpture as practice-based research: Risks, serendipity, and learning across disciplines: *Maria Letsiou*

Based on Marshall's (2014) perspective, transdisciplinary art integration refers to the deep merging of visual art with other fields—not as support or thematic connection, but as a meaningful process that generates new ways of thinking, knowing, and inquiring; an evolving form of learning that represents the highest level of integration. Thus, the transdisciplinary teaching approaches in the visual arts develop through a wide range of materialities and processes, each offering distinctive opportunities to explore concepts beyond the traditional boundaries of the discipline. These approaches often integrate practice-based research -a direction in artistic creation that transforms the art process into an immersive, inquiry-driven exploration. Practice-based research in the visual arts, as an arts-based research approach, foregrounds the distinctive methodological features of artistic processes within research. When examined alongside other arts-based methodologies, it becomes apparent that practice-based research privileges studio practice as a primary site for the generation and investigation of research questions. This stands in contrast to a/r/tography, which is theoretically constituted through the interlacing of text and artistic practices, as well as through the dynamic interrelation of the practitioner's identities as artist, researcher, and teacher (Leavy, 2020).

Within this framework, I examine the contribution of ceramic sculpture, both as a material and as an artistic medium, to transdisciplinary teaching that fosters meaningful engagement through making (see Figure 5). Ceramic sculpture provides a unique space where both artistic creation and artistic inquiry intersect. Working with clay is inherently hands-on,

material-driven, and unpredictable. The process involves navigating real risks, such as balancing weight and hollow spaces, managing textures, and responding to unexpected cracks or collapses. Clay's raw, unshaped nature liberates artistic practice: **"**it encourages play, experimentation, and risk-taking without the pressure to produce a "perfect" outcome**"**. Hollow spaces add both technical challenges and expressive potential. Shaping empty volume requires precision, yet simultaneously allows the material to "speak back," creating opportunities for serendipitous discoveries. These hollows can carry symbolic weight, suggesting absence, transformation, and internal growth. Moments of chance are rarely setbacks; instead, they often open new creative directions and reveal insights unattainable through deliberate planning alone. Integrating ceramic sculpture into transdisciplinary learning thus supports the development of positive attitudes toward creative risk-taking and the productive use of serendipity in both creation and research. Ceramic sculpture can serve as a method of inquiry—an approach to questioning the creative process, the creator, and the resulting artefact (Skains, 2024). Through practice-based research, the material qualities of clay become not only technical considerations but central components of inquiry. In this context, studio art practice becomes research, where questions emerge through making and can only be answered through making.

Figure 4. Ceramic sculpture as a method of inquiry. Photo by Maria Letsiou

Practice-based research in the visual arts embraces openness to serendipity. The researcher-artist remains attentive to all aspects of the process—including challenges—and reflects on them to recognize outcomes that could not have been anticipated. The artwork functions as both experiment and research data. A useful tool in this process is the research or artistic journal/sketchbook, where every subtle nuance and detail of the process is recorded so

that to uncover the potential of serendipitous insights. In transdisciplinary learning environments, both teaching and research benefit from the unexpected, emphasizing the need to remain attentive to all subtleties of the creative processes. This perspective resonates closely with Eisner's (2005) insights on what education can learn from the arts: much of art's value lies in noticing subtle differences, delicate variations, and the richness of perception -a lesson education can directly draw upon. By engaging with art in ways that honours these subtleties, learners and educators can cultivate a mindset that appreciates complexity, embraces uncertainty, and recognizes the creative potential inherent in chance. Experiences shaped through such practice can inspire learners to overcome hesitation, take initiative, make thoughtful choices, and grow, ultimately contributing to the transformation of their learning communities.

Commoning mathematics through crafting artifacts as matters of care: *Anna Chronaki and Eirini Lazaridou*

The project "Commoning mathematics through crafting artifacts as matters of care" was organised as a long-term workshop for creating a dialogic space across preschool where young children were working with mathematics as part of the question "what is an island" and the university where students in teacher education and in architecture could come together listening, liaising and experimenting with children's ideas. Central in this dialogic process was the commoning of mathematics (i.e. caring for the process itself and caring for sharing elements that open dialogic spaces) through crafting artifacts that aim to bridge knowledges across the disciplinary subjects of mathematics, pedagogy and architecture. But, is the commoning of mathematics important? With Bruno Latour (2004) one could argue that mathematics as an epistemic form of scientific knowledge production tends to remain a "matter of fact": *"the only neutral, reliable and objective way of describing, prescribing, modelling and, even, predicting reality"*. As such, the fate of a history of "western" mathematics as "common knowledge" in all levels of formal education, from preschool, to primary and from elementary to tertiary, is trapped, by and large, within harsh enclosures of national curricula, international assessments or high-stake exams in which mathematics follows the standards of arithmetic, geometry, data handling, measurement etc. Moreover, its creative potential is fuelled toward gatekeeping practices that exemplify the desire for accelerating personal and societal progress or the dream for unlimited growth as both economic development or knowledge accumulation. In this, one witnesses the continuing perpetuation of local epistemicides along with genocides and femicides, cognitive injustices and individual alienation (see Chronaki & Lazaridou, 2022). Taking these into account, a

process of commoning mathematics must be primarily concerned with the question of "how could we, together, encounter this deadening situation?", "how could we bring "life" back to the subject of mathematics?" and "how our agonistic strivings move toward aims for the commons?". A core answer to this is the onto-epistemic move from approaching mathematics as a "matter of fact" toward encountering maths as a matter of care. With Maria Puig de la Belacasa (2017, pp. 11) this is all about a feminist onto-epistemology of collective-making of pedagogic care where *"...the meanings and situated relevance of care cannot be taken for granted"*.

Figure 5. Crafting and sharing artifacts as "gifts" amongst children and students. Photos by Anna Chronaki and Eirini Lazaridou

The study denotes that the process of commoning mathematics as "matters of care" is being engulfed within dialogic moves of transdisciplinary work (i.e. assemblages of making math and craft) and cannot be taken for granted. Instead, it requires continuous attention. In this, the commoning of mathematics becomes possible only when hierarchical teaching structures are being countered, combated and transformed into a liminal space of creativity. A way to counter hierarchies is to move toward transversal modes of making where the artifact is valued as part of assembling collective thinking, feeling and learning with children, adults, materials, questions, problems and ideas across the disciplinary fields of education (e.g. childhood, pedagogic and didactic design) and architecture (e.g. material design, artwork, visualisation). Specifically, since the project is grounded in the collaborative making of artifacts amongst preschool children, student-teachers and student-architects, it was thought and felt necessary to unfold with care the pedagogic and didactic elements involved. The analysis revealed that unfolding with care can be experienced through multiple dialogic transversal moves: *first*, transversing the preschool and university contexts and cutting through disciplinary boundaries in education, mathematics and architecture, *second*,

transversing across several pedagogic experimentations where artifacts were co-crafted as "gifts" amongst children, and *third*, amongst the preschool children and the class teacher who as they receive the "gifts" they turn into pedagogic and didactic experimentations exploring with spatial forms and novel ways of numbering. A padlet was utilised as a digital means to archive aspects of this collective transdisciplinary work but also to share and discuss in retrospect specific didactic and pedagogic elements amongst children, students and researchers. These elements concern the commoning of mathematics as part of a transformative collective growth of ideas, material crafts, and participation rituals (e.g. voting processes amongst children, sharing in-between children, student-teachers and student-architects, reasoning, numbering, visualising) functioning as a shared cartography. In this way, the island's abstract dramatization of "non-place" began to acquire soil, breath and flow where maths and craft could co-exist amongst children and students (see Figure 5).

The care/ful documentation of these interrelated processes denotes the presence of mathematics as number, geometry or topology being embedded in several moments of the collaborative process of crafting as reimagining in context of novel ways in communicating, sketching, cutting, writing, narrating, feeling, expressing, measuring, locating, constructing, playing, acting etc. It, further, notes that experiencing the process of commoning mathematics as "matters of care" requires time and space that, often, in the fields of education and architecture become not only underestimated, but, also, underpaid and undervalued. In this project, care permeates all forms of co-production and co-reproduction at every stage of creation and making, through diverse forms of, often, hierarchical relations. It, thus, needs to involve a care/ful inquiry of ways including spaces and times where one can reimagine, relearn and renegotiate how we relate to one another and to the wider world. Moreover, it needs to involve the turn from solitary to collective ways of producing knowledge and materials as we begin to acknowledge the spectrum of affects activated within these experiences.

The Capoeira circle as a space for decoloniality and undoing dialogues: *Nicholas B. Torretta*

The Capoeira circle unpacks aspects that interest Nicholas toward reorienting the design research practice so that to be guided by circularity through the ethos of social justice and decolonisation. Capoeira is an Afro-indigenous Brazilian martial art born during the colonial period in Brazil to fight against colonization. To be practiced under colonial administration, Capoeira was disguised as a dance because it was forbidden by law in Brazil, being legalized only in the 30s and then in 2014 it got the recognition as Intangible Cultural Heritage of

Humanity by UNESCO (Rêgo, 1968; Cruz, 2006; Cunha, 2013). Here, Nicholas will briefly explain the Capoeira circle and unpack some aspects of circularity in Capoeira based on the traditional practice of Capoeira now often called “Capoeira Angola” or “Capoeira Antiga” in which he has been involved in practicing and teaching. What follows is a circular text that revolves around core aspects of Capoeira asking how they can reorient design research. Each round of unpacking Capoeira finishes by posing questions to hopefully encourage reflection on our professional and academic practices.

Figure 6. Capoeira roda in Santos, Brasil. August 2025. Photo by Nicholas B. Torretta

Capoeira is a practice that happens in a circle and includes varied circular aspects in its performativity (see for instance https://www.youtube.com/watch?v=f2vmtT2iU1w). The circular aspect of Capoeira comes from diverse Indigenous and African traditions that got intertwined in colonial Brazil. The circle where Capoeira happens is constituted by four different parts: The first part is a percussion orchestra (called bateria) consisting of 8 people playing 5 different instruments (3 berimbaus, 2 pandeiros, one atabaque drum, one reco-reco and one agogô). The *bateria* is considered sacred and is the heart of the Capoeira circle. The second part of the circle is then formed by people who are waiting to get into the circle to play the martial art/dance. Next is the third part which consists of the core pair of players; two people who are inside the circle having the fight/dance interaction. And the fourth part is the music that is led by the bateria, with one person leading the singing which is, in sequence, answered by the people completing the circle. The rhythm and lyrics of the song guides and shapes the game between the two people inside the circle.

Since Capoeira was developed by the enslaved people to practice fighting, the intention of the game in the circle is not to beat each other, but rather to improve together their capacities through a process of respectfully challenging each other. Overall, they were not practicing toward destroying the colonial system, since they were a weaker part of society, but rather to

fight to escape to the forest so that to start anew free societies. There is no winner in a traditional Capoeira game. Here we can draw two learnings from Capoeira that are worth reflecting on and that Nicholas has been using to guide design research: to create spaces for respectfully challenging; and secondly, to not fight for winning, but to fight for finding spaces to create something different. How can such processes of coming together become spaces for respectfully challenging each other? And how can we shape our intentions of social and environmental justice towards the goal of finding spaces for creating different ways of being instead of taking over problematic structures?

Nevertheless, in a game, the two people constantly try to take the other down or to hit with the head. This happens because the intention of the enslaved Capoeira practitioner was to learn how to take the colonial police down to get space and time to run away from captivity. However, in a game within the circle, if someone manages to take the other down, it is considered a sort of closure while the goal of the circle is to keep the conversational game, to keep challenging each other until the music asks for it to stop. Therefore, when such moments occur, the players in the circle walk counterclockwise within it. This practice stems from Afro-Indigenous traditions of walking counterclockwise to rewind time and to seek connection and guidance from the ancestors. This represents an undoing of the closure, and an intention to "re-continue" the game with more bodily connection and wisdom. Here we can highlight two aspects: the process of undoing closures, and the act of seeking connection to the past and to ancestral knowledge. It is important to notice that in a Capoeira cultural realm, "ancestral" is not only those who came before us but also the nature, other beings and the energies that guide our life. When it comes to our professional and academic practices, we can ask: What needs to be undone? When in our projects and processes could we have undoing moments to open for other "re-continuings"? What are the other elements that we can connect to, such as local nature and local knowledge, to inform our practices? And as an overall final question: How can we shape our projects, processes and practices from linear to circular? That is, to see and organise them as learning spaces rather than trajectories, so that we can welcome and foster the aspects of mutual improvement through respectfully challenging, reconnection to place, openings for other ways of doing, and moments of undoing closures to allow plural "re-continuations"?

Discussing themes across the projects: *Per-Anders Hillgren with all authors*

Reading across all projects as described above, Per-Anders noted several themes permeating our concerns for transdisciplinary work in maths, arts and craft. These themes denote the possibility of reimagining our institutions (schools, museums, departments, universities)

through reconsidering our ontological and epistemological landscapes, delving into the processes of creating circles of resonance as a couplet of alienation/resonance and accounting critically on multiple societal and political issues involved in circles of healing. Below, these themes are being commended by all project authors of this collective offering useful lines for reimagining our institutional practices.

Concerning the first theme of "re-imagining our institutions" the specific question posed is: *Could one radically re-imagine a mathematics department that is built around openness regarding epistemological and ontological approaches?* In other words, could we rethink the production of mathematical knowledge in the context of our institutional programs by, for example, start working bodily, bringing generations together, taking children's ideas seriously, making artwork, dance and music central to maths learning and, even, creating space and time where the healing bodies and minds becomes a prominent part of curricular activity? Revisiting the projects reported here, one notes how they all argue for the importance to turn toward a process of slow science instead of accepting progress and growth without questioning. Their shared underlying view is that as efficiency driven education accelerates, it also reaches its limits. The values of slow practice in arts and design are exemplified in several of the projects (e.g. making labyrinths, sculpting 3D objects, creating ceramic sculpture, crafting artifacts, walking counterclockwise the Capoeira circle) that identify the importance of an onto-epistemology grounded in embodied, material experience, cultivating relational competencies for new generations. In maths education, the teacher student's engagement with embodied, arts-based, and playful geometry at the Spiral Playground foregrounds the need for a radical reimagining of the mathematics department. Such reimagining may need to critically address how traditional mathematical epistemology and ontology are deeply anchored in notions of certainty and precision. Departing from these onto-epistemological foundations, one may evoke unsettling, even uncanny, affective responses that one needs to attend and deal with care. Expanding the above a further question placed is: *If you would dare being radical in your imagination: How could such a math department operate? What would be its key-elements? What practices, people, disciplines, material resources, or places would be activated in this institution?*

Responding to these questions from the arts and design perspective might be valuable for mathematicians and math educators to rethink their onto-epistemic practices in novel ways. As such, from a visual arts perspective, a radical approach to learning (including math learning) recognizes the significance of embodied learning and more-than-human relations that emerge between body, material, and environment. Within a university context, this

implies creating spaces where engagement with material functions as a visualization of thinking and as a process of slowing down that allows redefining our relationship with the world. Moreover, guided by the traditional practice of Capoeira to rethink the trajectory of design research it becomes obvious how we learn from/with all disciplines including from/with traditional practices and from/with any kind of embodied knowledges we might have. The example of Capoeira can be seen not only as a perspective, but it can be put forward as an invitation for everyone to bring their own bodily knowledges, be it from traditional practices or not, to reshape our professions, work rituals, lives and institutions in any discipline.

As far as the second theme of "the ontological and epistemological landscapes in and around math" is concerned, it becomes apparent that the prevailing ontological prejudice about what is mathematics brings forward certain notions such as "the beauty of clarity" in an equation or the potential to control with rigour, to enact an instrumental manipulation and also to claim for universal truths, precision and abstract clear steps in any operation. At the same time, many big thinkers claim that our present societal challenges require approaches that are the opposite of these. Rather than clarity, control and certainty, they state that we need to be able to embrace complexity, mess, uncertainty or to *"stay with the trouble"* as Donna Haraway (2016) frames it. Rather than focusing on universal truths, attention is brought to situatedness and pluriversality. These thoughts bring forward the question: *How could we understand our research practices in relation to multiplicity and the pluriverse?* Again, the projects presented here seem to resist restrictive definitions of what is maths, arts, design, craft etc. enforcing individuals to shield themselves behind layers of an assumed certainty. Instead, they espouse arts-based, practice-based and decolonial methodologies that prioritize process over outcome, cultivate authentic risk-taking, refuse to remain safe within certainties and expand the boundaries of what a practice with maths, arts and craft can become beyond preconceived assumptions.

Concerning, the third theme *"circles of resonance as alienation-resonance"* allying with the conference theme on "Circles of Resonance" makes us think of the German philosopher Hartmut Rosa (2010) who claims that we have become alienated from the world just because we are trying to "master" it. According to him our Western society tries to expand its reach, conquer, rule, control, calculate, manipulate and optimize resources and make the world instrumentally accessible, but this also makes our relations to the world mute! As a contrast Rosa (2019) later brings forward the notion of "resonance" and describes it as events where we feel a vibrating string between ourselves and the world, where we are allowed to be

touched or moved by people, plants, mountains, music, arts, stories, basically events where we come alive. However, Hartmut Rosa says that resonance cannot be controlled or instrumentally accumulated. Common prejudices about math places the disciplinary subject mostly in the first strand of alienation (which hopefully is wrong). Thus, the question for us all remains: *How do we see our own practices (with a focus on maths) in relation to Hartmut Rosa's understanding of resonance and alienation?* In response to this question, one can think how in the project of commoning mathematics the flow of activities around an imagined island created a circle of alienation and resonance: a gradual alienation from the "real world" led children, students and researchers to resonate with the imagery of an island as commonplace. In parallel, another circle of alienation and resonance was created when the teacher had to temporarily step away from established didactic or pedagogic roles and expectations caring for the flow of activity. Whilst, in practice, it is challenging for the teacher to release control of learning (and especially mathematics learning) so that to, truly, become guided by children's desires and ideas, the workshop's orchestration through several interconnected dialogic moves has worked toward countering authority and hierarchies amongst teacher and children. This was possible when a slower pace of work was espoused allowing multiple mathematical expressions and capacities to be unfolded and shared aesthetically and with care. To speak of this experience only in terms of the resulting crafts as a product of the workshop is misleading. On the contrary, discussing the experience as part of commoning mathematics one can emphasize dynamic relationships inextricably connected to the world of preschool, teacher education and architecture centred on the exchange and negotiation of creative ideas.

As many of us have recently got increasingly interested in the notion of slow science, and with inspiration from Isabelle Stengers (2018) book "Another Science is Possible: A Manifesto for Slow Science", we have begun discussing temporality, the rhythm and pace of academic culture and existential and emotional aspects of our research life. Thus, the added question: *What role could one think of temporality, rhythm and pace can have in making arts, craft or math?* In ceramic sculpture, slow practice is not just about time but about a critical stance toward the fast and consumptive pace of contemporary culture. The rhythm of working with clay—waiting, drying, firing—cultivates a material dialogue with care and patience turning slowness into an ethical and creative attitude. In this sense, temporality becomes a form of craftivism, inviting us to rethink value and progress through a respectful coexistence with materials. Moreover, the flow of didactic and pedagogic activity in the commoning mathematics project has evolved with a rhythm that alternates not in acceleration but in

deceleration (i.e. slowing down the speed of making artifacts through the making of maths). The idea of the circle of resonance and alienation, as discussed above, help us to see learning, creativity, and mathematics unfolding through movement, rhythm, and relations. Activities, paths, places, crafts and stories are not separate steps, but part of a living cycle where ideas, experiences, and knowledge are continuously shaped, shared, and renewed.

The fourth theme refers to the need for accounting the "societal and political issues" in education and points out that many of our contemporary societal challenges are associated with an instrumental use of graphs and calculations of different kinds. The embodied practices embraced by several projects seem to provide a powerful way to get a more profound understanding of challenges and processes in our world and this realisation foregrounds some pertinent questions: *How do you see the potential in artistic/embodied methods to bring forward, trouble, and elaborate on mathematical calculations, graphs etc. regarding e.g. climate change, planetary boundaries, economic growth, inequalities and injustice? Could these artistic/embodied methods help us to get these calculations or graphs into our bones? To help us carry them with us more fully and committed?*

Trying to see these questions from the perspectives of visual arts and art education, it is noted how data art visualization has been introduced to research in visual arts and art education offering subjective and interpretative views on the quantitative data used to address social, political, and environmental issues (Bertling et al., 2021; Dean & Bertling, 2020; Galbraith et al., 2024). Such artistic interpretation critically reflects on the underlying conditions of quantitative data that are being obscured by official reports, particularly those linked to power relations, profit, and extractive interests. As an artistic and embodied method, data art visualisation may enable emotional engagement with data, making complex realities more perceptible and leaving a significant imprint on our critical awareness.

Further, it seems that embodied artistic practices in math can support (as the projects have shown) diverse understandings through different scales (looking from above, being immersed from within etc). Several researchers argue that we also need to grasp the planetary scales and claim that e.g. the notion of the Anthropocene is too big and abstract. Therefore, we must discuss another question*: How could embodied and artistic methods potentially also help us to better understand the scale of the planet?* One may note here how embodied and artistic methods can help us understand planetary scale by translating environmental knowledge into sensory and affective experience. Artistic data visualization and practice-based research in visual arts make ecological issues perceptible through material engagement and visual interpretation, fostering empathy and ecological awareness rather than conveying abstract

facts alone (Dean & Bertling, 2020). Moreover, the Capoeira circle is known in the capoeira community as the "school of life", a place where we learn how to deal with situations in life as a respectful conversation. The circle in this case is thus a smaller (and denser) form of the world outside. Bringing this idea into design research and education, lectures and participatory processes have become collective spaces for learning the world while learning a subject. Setting up such circles have included moments of "being on the circle", where we stand together as individuals, observing and creating the space, as well as moments of "being in the circle" where we are in conversation, trying out some ideas, finding ways to connect, challenge and improve each other's perspectives.

As a way of concluding, and in relation to the above themes, the theme of "circular movements of healing", addressing directly the focus of the MACAS symposium brings upfront what the researcher Juliana Restrepo (2025) coined as timespaces for collective healing. This included embracing vulnerability and working with the concept of sentipensar "feeling-thinking" (from the Colombian sociologist Orlando Fals-Borda), basically to think with the heart and feel with the brain. The interest for sentipensar has grown recently as an increasing crowd of scholars argues that traditional technical rationality is not enough if we want to understand the world, ourselves and our role in the world. Thus, we must continue reflecting on questions such as: *What kind of practices could potentially provide circular movements of healing? Sentipensar or something totally different? And how do you think that your own practices inspired by art potentially could provide circular movements of healing?*

In this, the act of walking backwards in the Capoeira circle is a practice of healing, of undoing an undesired outcome. As already mentioned, this act is an undoing combined with a journey to reconnect with greater forces of nature, place, ancestral and the past. We turn toward undoing by trying to come back to the conversation with greater wisdom and humbleness and by rethinking three interrelated questions: *What do we need/want to undo in our professions, lives, institutions and practices to heal? How can we create practices of immediately undoing undesirable outcomes in all these realms? And what are the other aspects we can/need to connect to (such place, past, nature, ancestral knowledge, traditional practices and his/her/stories) to continue our endeavours with greater wisdom, respect and humbleness?*

Acknowledgment

The project "Commoning mathematics through crafting artifacts as matters of care" has been part of the European funded 2020 Horizon SMOOTH: Educational Commons for Active Inclusion under grant agreement 101004491.

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