Organizing Children and Youth Mathematical Art Exhibits and Interpreting MathArt-works through a Collaborative, Transdisciplinary Practice

Kristóf Fenyvesi[1], Christopher S. Brownell[2], Pamela Burnard[3], Pallawi Sinha[4], Carine Steyn[5], Werner Olivier[6], Zsolt Lavicza[7], Saara Lehto[8], Kirsi Peltonen[9]

[1]University of Jyväskylä, Jyväskylä, Finland; fenyvesi.kristof@gmail.com
[2]Fresno Pacific University, Fresno, USA; chris.brownell@fresno.edu
[3]University of Cambridge, Cambridge, UK; pab61@cam.ac.uk
[4]Independent researcher; pallawix@gmail.com
[5,6]Nelson Mandela University, Port Elizabeth, South Africa; catherina.steyn@mandela.ac.za; werner.olivier2@mandela.ac.za
[7]Johannes Kepler University, Linz Austria; lavicza@gmail.com
[8]University of Helsinki, Helsinki, Finland; saara.lehto@helsinki.fi
[9]Aalto University, Helsinki, Finland; kirsi.peltonen@aalto.fi

Abstract

This workshop will build upon a process developed by some of the authors for interpreting the mathematical and artistic knowledge demonstrated in MathArt-works created by children and youth. The participants will be separated into small groups and be given a MathArt-work to interpret. Each group will develop their own "Rhizomatic" representation of their interpretation which will be shared with the whole group during a "Gallery Walk" exhibition. Finally, all participants will discuss the creation of a network of practitioners interested in organizing children and youth mathematical art exhibits.

Introduction

The Children and Youth Mathematical Art Exhibits were initiated by John A. Hiigli (1943-2017), painter and educator, founder of the Jardin Children's Art Galerie in New York [5, 6] and Kristóf Fenyvesi, educational researcher. Since 2012, the Bridges Conference has provided space for these exhibits as part of the Family Day/Public Day programs (www.familyday.hu) and several other exhibits have been organized in collaboration with members of the Experience Workshop STEAM Network (www.experienceworkshop.org) in various countries (Figure 1). Since their inception, the goals of these exhibits have included supporting both the participants and the audience to actively explore new sources of mathematics and art education through transdisciplinary artworks created by children and youth to express various connections between mathematics and arts. The children and youth mathematical artworks, that we have termed "MathArt-works", have been collected over the years through open calls published online and various email lists that include mathematics and art teachers. Teachers, parents, and students from a growing number of countries worldwide make submissions to the Hiigli Collection of Children and Youth Mathematical Art, which has led to an archive of several hundred pieces. The archive serves both research purposes and as a source of organizing thematic exhibits. The exhibits are intended to motivate and engage children and teachers in transdisciplinary mathematics and art learning activities as part of educational MathArt events. Based on this concept, several local children and youth MathArt exhibits have been initiated around the world, and the MathArt-works have been collected and shown at international exhibitions. Recently, in South Africa, Nelson Mandela University's Govan Mbeki Mathematics Development Centre (GMMDC) successfully launched a national educational development program based on this concept (see: http://www.MathArt.co.za/#).

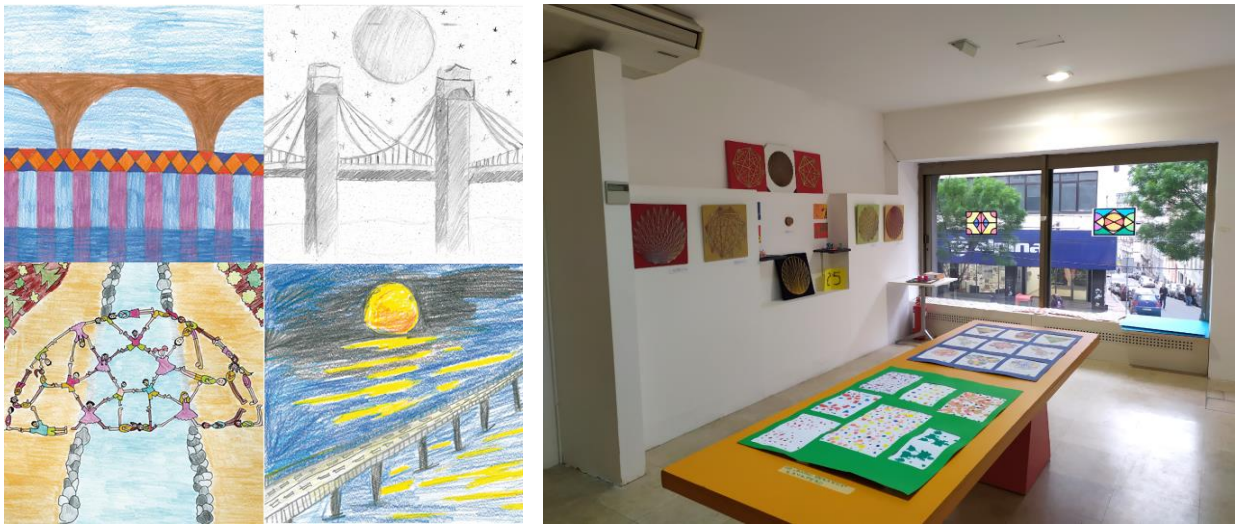

Figure 1: *Left: Submissions for the "Bridges of the World" call for the Children and Youth Mathematical Art Exhibit in 2012, curated by John Hiigli and Kristóf Fenyvesi. Right: Project M_ART exhibition in Belgrade, curated by Tatjana Stanković and Nataša Lazarov (ETŠ School "Nikola Tesla", Pančevo, Serbia). The exhibit featured artworks from children of more than twenty schools from Serbia, Romania, and Croatia. The exhibit toured in Serbia and its material has been part of the digital exhibition on show in the John Hiigli Children and Youth Mathematical Art Exhibit at SPLACE Gallery in Bridges 2019 Linz.*

In this workshop participants will learn techniques for collecting MathArt-works from children and youth, how to organize a MathArt exhibit in their own school or locality, and methods for interpreting MathArt-works. The interpretation methods are based on earlier research [1, 3] that has not yet been introduced as a systematic educational practice. Furthermore, participants will engage in discussions around the practical aspects of creating a student MathArt Exhibit locally and how to submit student works to the Hiigli collection. Growing the Hiigli Collection as well as achieving the goal of improving attitudes towards, and engagement with, both mathematics and art are collateral benefits to the workshop. Empowering the participants to organize and conduct their Children and Youth Math Art Exhibition and then submitting selections to the collection and employing the analytic method demonstrated as an educational practice will be our focus.

A Description of Children and Youth Mathematical Art Exhibits

All artists aged 4-18 years who live within the designated community are invited to create a drawing or painting for submission to a Children and Youth Mathematical Art Exhibit. The artwork can be based upon the young artists' work at school or at home and can be an artistic rendering of their favorite MathArt idea or concept: structure, pattern, symmetry, synergy, subdivision, transformation, playful learning, etc. Successful exhibitions in the past were based on calls related to topics like "Mathematics and Art Connections in Nature", "Mathematics and Art Connections in My Life", "Mathematics and Art Connections in the Universe", "MathArt Connections in Architecture: Bridges of the World" (Figures 1, 2, 3).

For practical purposes related to the exhibition of the physical artworks, the submitted artwork is expected to be two-dimensional. Photographs of the original work, along with the artist connected

description are submitted. Depending on the age and interests of the participants and the organizers, the artists are invited to write a few passages to interpret their own artworks. For children in upper elementary and secondary grades, a few targeted prompts or questions would follow the free textual introduction of the artworks, such as:

- Explain what mathematics you used in your artwork.
- How did you creatively connect mathematics and arts with the topic of the exhibit? Explain your answer as clearly as you can.
- Do you think creativity and arts could be used to teach mathematics? Explain your answer.
- Do you think mathematics could be used to teach arts? Explain and make clear your thinking on this question.

The photograph of the artwork and the attached verbal interpretation are the items that are then considered "data" for scientific analysis if there is an interest in research. Parents', teachers' and children's consent is obtained upon submission, in accordance with the ethical and data protection guidelines. The team of organizers, researchers and teachers then conducts a first pass through the collection to make initial interpretations based upon their own aesthetic, mathematical, and artistic insights. These initial interpretations and selections are then brought to the whole group for discussion and winnowing to a manageable size. This process is done in verbal communication and is followed by a process of synthesis that brings into a cohesive whole the thoughts of the team. This then becomes the cognitive source-code for the "rhizomatic" analysis, as it is introduced below.

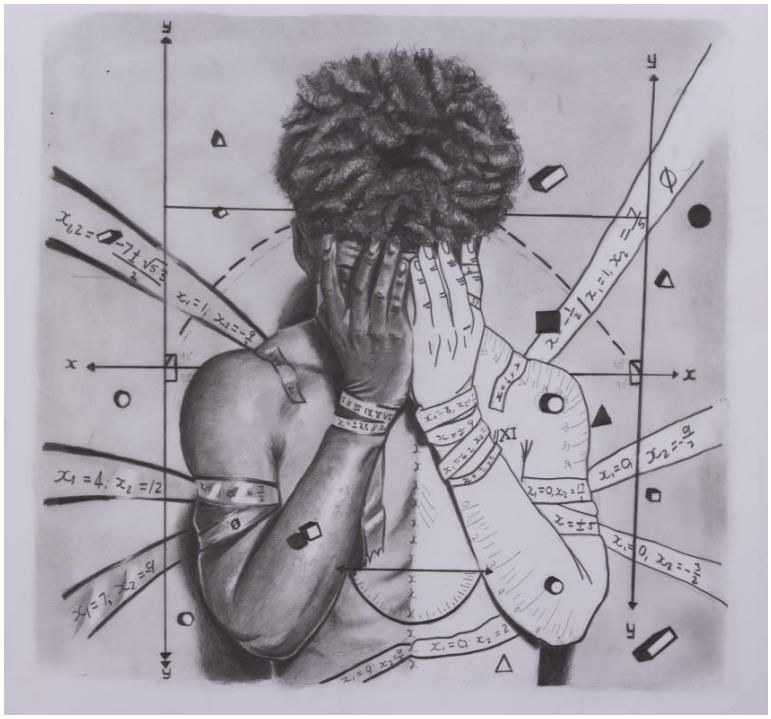

Figure 2: "*The Stressed Vitruvian Man", a submission for the first Children and Youth Mathematical Art Exhibit in South Africa, curated by Werner Olivier and Carine Steyn.*

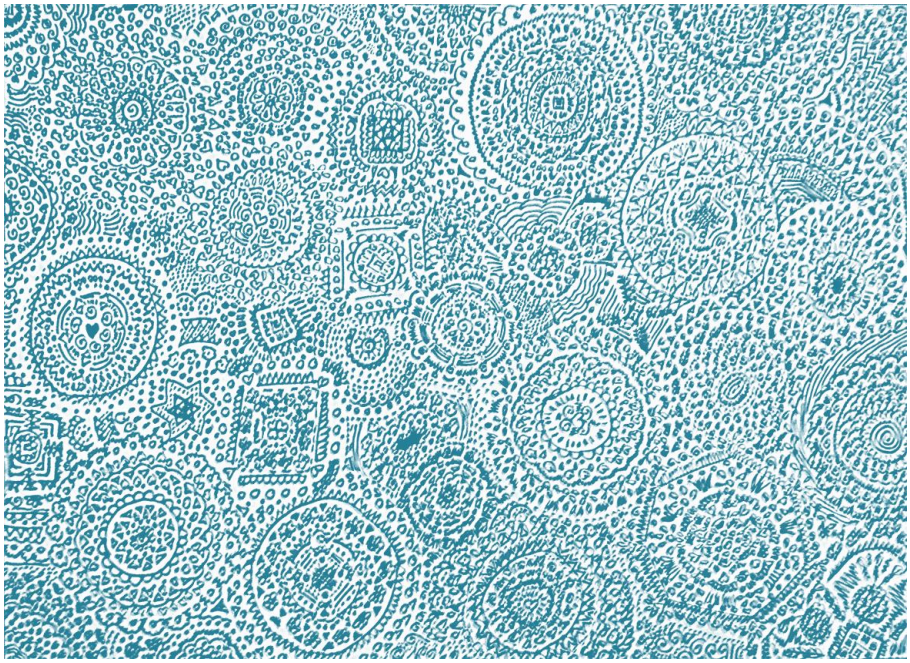

Figure 3: *A submission for The Birth of the Universe Student Math Art Exhibit & Sphere Workshop, curated by Anita Ádám at the György Hevesy Elementary School in Hungary.*

In some countries, the Children and Youth Mathematical Art Exhibits have been organized as MathArt Competitions as well. Here, the competitive nature of the event provides a different motivation and may yield a higher participation rate. In any case, the goal of the preparation is to connect to a MathArt workshop to support the potential participants, both teachers and students, to interweave the MathArt topics and smoothly enter the program. One example of a call for submissions was the GMMDC-South Africa MathArt Competition. The focus of the competition was to stimulate learners and teachers to look at mathematics and arts differently. By connecting arts and mathematics, the organizers want to promote mathematics and art education, but also develop creative thinking and innovation. The submission could make use of drawing, painting, collage, and mixed media. A paragraph of 100-200 words had to be submitted with the artworks in which the learner described the link between their artwork and math they focused on in the creation of their MathArt-work. GMMDC-South Africa developed a presentation on various internationally known approaches to link mathematics and art in education and host STEAM workshops with learners in local provincial regions in an attempt to stimulate their interest. The positive outcomes of this innovative project emphasized the need for low-threshold, inexpensive, and equal access STEAM programs to release creativity and bring recognition to students and teachers in under-resourced schools.

An Overview of Rhizomatic Analysis

In *A Thousand Plateaus* (1987), Deleuze and Guattari employ the biological concept of a rhizome (say, a ginger tuber) that burgeons in unstructured and unfathomable directions to introduce a "rhizomatic inquiry" [2]. The construct of connections is relayed in the form of "assemblages" that form "plateaus", described as "any multiplicity connected to other multiplicities by superficial underground stems in such a way as to form or extend a rhizome**"** [2, p. 24]. Within such a framework the studied artworks became mappings of ideas, contexts, reflections, and lines of flight that move beyond binaries; rupturing hierarchies and structures. It relies on mapping connections and disconnections between and across multiple pathways to avoid normative discourses and "ideal types".

While similar in appearance this must not be confused with mind-mapping, which relies on individual memory or personal journeys related to concepts, events, or systems. Unlike the former, the collaborative rhizomatic mapping offers a multiplicity of interconnections.

We found similar structures emerging in our analysis of learners' MathArt-works, particularly in regard to making connections between different ideas, concepts, contexts, and dialectic moments across different disciplines, geographies and histories. These connections enabled a more fluid exploration of the multiplicities in thinking about and **"**doing**"** mathematics and art literacies as **"**ways of being**,"** emerging from the specific and broader socio-cultural, economic, and political conditions of the learners. It allowed us to **"**read**"** factors such as culture, political histories, embodiment, or transgressions of gendering, which may not necessarily be quantifiable but highly relevant, valid and accountable for self/meaning-making. Here, we present a brief example of **"**doing**"** a rhizomatic analysis. To do so, we employ the MathArt-work (Fig**ure** 2) and accompanying statement created by a 16-year-old South African male learner in grade 11 of a private school that supports less privileged students. The Artist Statement provided by the learner as a commentary accompanying his MathArt-work reads as follows:

> *This implies how Mathematics is involved in our daily lives. It gives the impression of how intact Maths is and effective Maths is. Upon the decision of choosing this specific image, I made it clear that Mathematics could have positive or negative impacts. A few examples of how we experience Math daily are measurements of our clothing; which is why in my artwork you will see the right side has measurements that are in centimetres which are used to measure clothes. Clothes require accurate calculations together with the fact that our bodies are asymmetrical; which you see the left side does not look like the right side. We need our measurements to make sure we get the right fittings. My artwork illustrates the simplicity which is how the effect of maths has been ignored and neglected. My illustration also shows the reality of Mathematics, that even though it is interesting and effective, Mathematics could prove to be stressing especially for teenagers who have other interests. The artwork has the main figure who is stressed. I've indicated that his head is slightly bowed to show the negative impact. The hands which cover the face are an indication of frustration. This has brought about the reality which I didn't intend to hide. The answers to the equations represent that there is always a solution. This is a form of encouragement to the mathematical society. I placed the equations on different places to show that there are different ways to get the answer. On the same note, I've shown that if done frequently Math could cause a negative toil inside every part of the brain. The two sides have different shading as an indication of the positive (simple art, no shading) and negative (complicated side with shading) influence of the subject on a person. I call it The Stressed Vitruvian Man; it would be the modern version of Da Vinci's artwork. I admire the artist a lot and I feel we might have the same ideals on art. The lines on the background are from the Vitruvian Man with his arms open and legs spread out.*

This young man's drawing is a self-portrait where he cannot separate the learner from what is learned as a way of being in the world. He focuses on his body, his hands and hair to frame what he thinks of, and how he experiences mathematics. We connect with a young man and his experience of mathematics which is inscribed on his body. This seems dependent, in this time and space, on giving expression to a form of knowing and his experience of the subject. He is thinking with and through mathematics and art; making new patterns of thought (superpositions), employing power-producing binaries (mind/body; black/white; asymmetry/right fittings; mathematics/art) and revealing what these disciplines do, how they overlap, change and become connected in the MathArt-works.

Like Leonardo's *Vitruvian Man*, there is a great deal of detail concerning the proportions and the regulation of the body through its spatial-material organization as mathematical shapes float in space as if

to ask: “what is mathematics?”, “when is mathematics?”, “why does mathematics matter?” We connect with a young man. We see maths doing something to him, stressing him out, closing him down. Math and art are entangled with/in/on his body, clothes, gestures, emotions in the production of his “Vitruvian man”. With his head hidden between his hands, and just a tiny peep-hole to see through, his body is as divided as his encounter with mathematics, materializing in binarized shading (simplicity of art/ complexity of math). Math is experienced, math is performed here. He seems to be asking why is learning mathematics so hard. We see how learning is produced through participation in the “MathArt-work” operating on the learner and the learner operating on math through multiple connections (physical, material, and discursive). What else is going on here? Appreciating a growing body, a polarization of learner’s emotional wellbeing, and the troubling of intellectual needs are the effects of mathematics. Is this inconsequential? Or could this be an expression of deep understandings about the need for enacting and embodying mathematics learning to make the familiar strange inside the art “work”? Is the challenge here with the traditional conceptions of education matters, urging to see the world through another’s eyes and understand how it looks? Is he envisaging what might be possible (social imagination) in his awareness of how mathematics and artwork connect, overlap, interfere and change in their intra-action to create an interference; what we call “learning”? Is it the pivotal role that embedding the Arts in learning experience can enhance students’ imaginative and creative capacities while improving and fostering such understanding? The critical issues here are that there are no inherent and clear borders between matter and discourse, being and knowing, and being and doing. This makes knowing of mathematics and art just as much a matter of the body and the material as it is a matter of the mind and the intellectual, all of which cannot be separated.

Figure 4: *The Rhizomatic complexity of themes and relationships arising from the transdisciplinary interpretation of “The Stressed Vitruvian Man” in Figure 2.*

The rhizome offers an alternative (to conventional model drawing) tracing of the interconnectedness and complexity of what is present and experienced when learners share the boundaries of disciplines. Figure 4

provides a visual interpretation of the transdisciplinary configurations as expressed by the learner in his MathArt-work (Figure 2) and further explained in his accompanying statement.

By tracing and connecting lines that move between, interconnect and shape the MathArt-work, we gain new ways of understanding the learners experience (and processes) of making MathArt-work. We gain insights into the invention and exchange of transdisciplinary creativity, between the non-human and the human, between mathematical and arts knowledges and how material agency and affect shape work in ways that are explicit. We also see how learners make clear connections between being and becoming an artist and a mathematician and the embodiment of stress and anxiety that seems to be about the happening of the ethico-political present. This rhizomatic analysis (Figure 4) enables us to see "what is" and "what else" is going on and can be made visible through the enactment of MathArt-Work. This type of approach has been called "the rhizomatics of practice as research" [4].

The Bridges 2020 MathArt Workshop's Structure

The expectation with this workshop is that we are laying a foundation for future school projects and also scientific research to meet, to build upon and encourage teachers, parents, and educators to create similar enactments and opportunities to trace the phenomenon of children and young people's engagement with MathArt-works. Using a rhizomatic interpretation we are able to map the emotional (affective) and cognitive relationships to their knowledge and skills. The workshop will be subdivided into five segments.

Introduction and Overview (5 minutes)

We will outline the approach of the John Hiigli Children and Youth Mathematical Art Exhibits and the related South African MathArt Competitions along with the outline of this workshop.

Introducing the Rhizomatic Approach for analysis (10 minutes)

To introduce the Rhizomatic Approach [1, 3] a brief overview of the Children and Youth MathArt Exhibits will be discussed. This will be followed by a description of the process which also resulted in the "Rhizomatic" tracing of the phenomenon featured in Figure 4.

Small Transdisciplinary Workgroups (30 minutes)

The participants will be formed into Small Transdisciplinary Workgroups based on their scientific and artistic experience and interest; each group will consist of 3-5 members and each member is expected to bring a different focus and lens in the math/science and art context.

Each group will randomly pick a single child or youth art-piece and its artist statement from a selection of children works of the Hiigli Collection of Children and Youth Mathematical Art archives. When identifying mathematical and artistic concepts and representations both in the MathArt-works and in their interpretations provided by the artists, attention needs to be also given to the artists' perceptions and communication of cultural, social, historical, personal, and emotional dimensions. The task of the participants is to build up their own collaborative, transdisciplinary interpretation in the form of a "rhizome" (see Figure 4 for an example) focusing on the images and connected paragraphs. Each small workgroup's task is to develop a framework for the interpretation of learner perspectives in dialogue with each other. This way, both the MathArt-works and connected paragraphs provide datasets, which can be approached thematically and interpretively, focusing on identifying and understanding the mathematical-artistic knowledge nexus along with learners' emotions related to mathematics and arts.

Sharing Results (20 minutes)

The small groups will post their choices, linked paragraphs, and group rhizomes around the workshop space. Then a whole group Gallery Walk will be conducted. During the Gallery Walk, individuals will be encouraged to interact with others regarding the analysis of each, and form their own analysis of each work. The purpose of this is to practice the MathArt Method of inquiry [1, 3]. Recalling that the goals for all mathematical learning experiences in classrooms include, "helping students become pattern-sniffers, experimenters, describers, tinkerers, inventors, visualizers, and conjecturers," [7, p. 63.] the emphasis will be turned towards these habits of mind that the MathArt-works put on display.

It is expected that a great many conversations around individual MathArt-works will be engendered during this time. The workshop leaders will monitor and provide in situ prompts to small gatherings of participants at the various works on display.

Vision casting for Large Transdisciplinary Workgroups (20 minutes)

After creating the ad-hoc exhibit in the workshop space, we will discuss several cases where MathArtworks have influenced educational practices or led to a new MathArt workshops being offered for children. Based on these examples all participants get a takeaway task: to collect children and youth MathArt-works and organize exhibits in their schools and, based on the exhibit, create local pedagogical development plans for the betterment of the mathematics and arts education in their school or informal learning place.

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