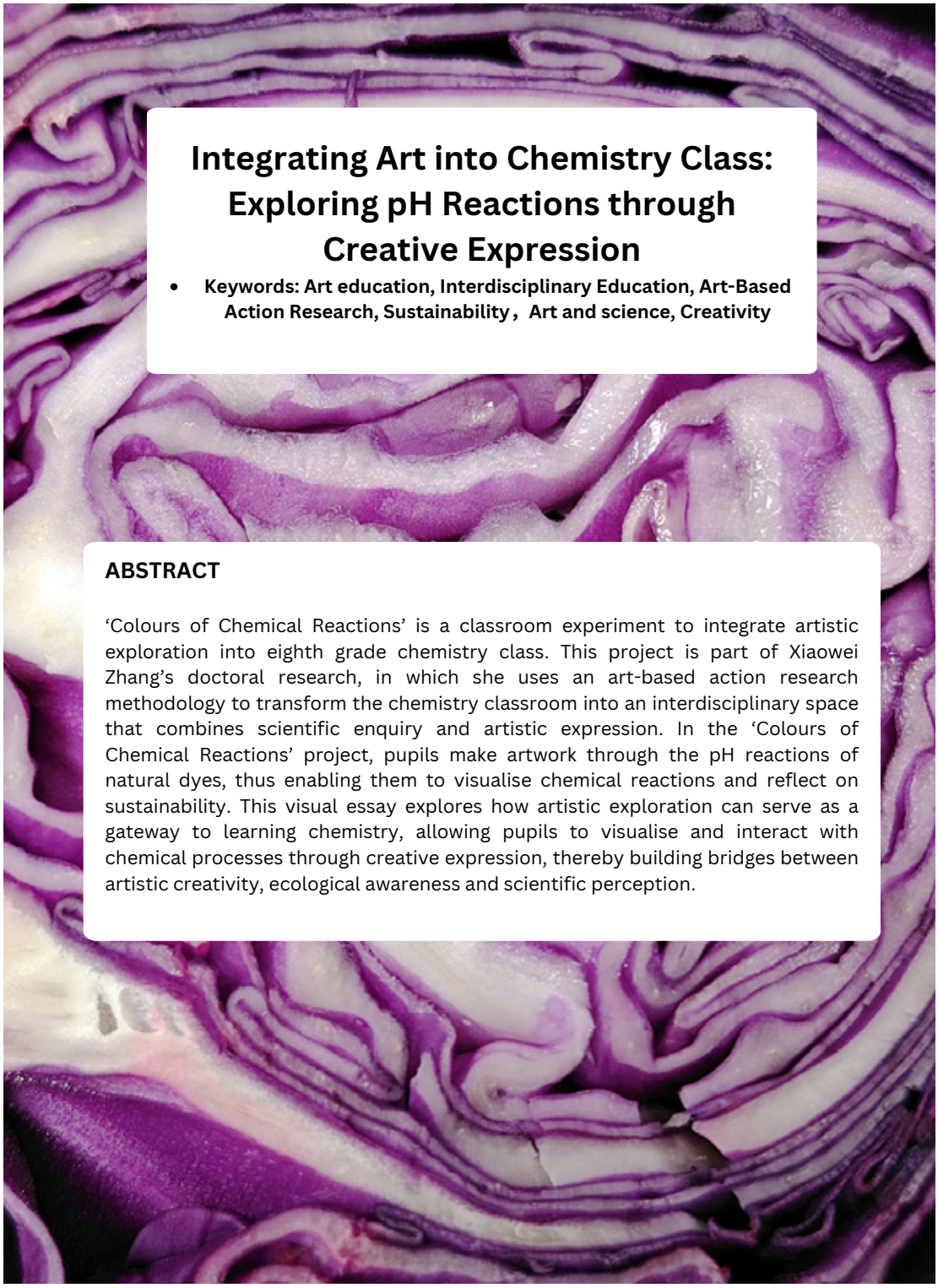
Article IV

Zhang, X., & Hiltunen, M. (2025). Integrating art into chemistry class: Exploring pH reactions through creative expression. *International Journal of Education through Art,* 21(3), 483–493. https://doi.org/10.1386/eta_00213_3

Article IV is reproduced with the kind permission of their copyright holder. It is included in this doctoral dissertation in accordance with the author rights granted under the publishing agreement with Intellect Ltd. The version presented here is the Accepted Manuscript (AM).



Integrating Art into Chemistry Class: Exploring pH Reactions through Creative Expression

- **Keywords: Art education, Interdisciplinary Education, Art-Based Action Research, Sustainability , Art and science, Creativity**

ABSTRACT

‘Colours of Chemical Reactions’ is a classroom experiment to integrate artistic exploration into eighth grade chemistry class. This project is part of Xiaowei Zhang’s doctoral research, in which she uses an art-based action research methodology to transform the chemistry classroom into an interdisciplinary space that combines scientific enquiry and artistic expression. In the ‘Colours of Chemical Reactions’ project, pupils make artwork through the pH reactions of natural dyes, thus enabling them to visualise chemical reactions and reflect on sustainability. This visual essay explores how artistic exploration can serve as a gateway to learning chemistry, allowing pupils to visualise and interact with chemical processes through creative expression, thereby building bridges between artistic creativity, ecological awareness and scientific perception.

INTRODUCTION

Disciplinary boundaries are often seen as an unbridgeable, which affects the development of creativity and the ability to solve complex problems. In recent years, the integration of art and science has promoted a deeper understanding of scientific concepts and enhanced the application of knowledge through artistic expression (Straksiene et al. 2022). However, science education usually focuses on conceptual explanations and experimental validation (Markula & Aksela 2022), whereas arts education is often marginalised as skills training in middle school curricula (Lilliedahl 2022). This can limit the development of pupils' creative thinking.

This project is part of a doctoral research project which uses an art-based action research approach (Jokela et al. 2019) to examine interdisciplinary teaching across four educational levels in Finland, involving 185 participants from primary school to university. This essay focuses on the second cycle of the study, carried out with nine eighth-grade pupils and one chemistry teacher. Located in Finnish Lapland, the project was co-designed with the teacher and supported by the University's Science Education Center, Ujunnu. Over a two-month period, pupils explored acid–base reactions using natural dyes, integrating artistic expression into scientific inquiry. The researcher encouraged pupils to consider sustainability as a theme, which they interpreted through their own artistic approaches. During the process, the pupils had a lively discussion with the teachers. Together, they considered the ecology of materials and the impact of their use on the environment.



Figure 1: Exploring Chemical Reactions with Natural Dyes, 2025. Photograph by Xiaowei Zhang.

In this essay we ask: How can the integration of art and science in chemistry education enhance pupils' understanding of ecological sustainability and scientific concepts through artistic exploration?The study findings reported here indicate ways in which participants reflected on the interplay between colour, ecology, and sustainability while creating their own artworks.

INTERDISCIPLINARY CLASSROOM: FROM CHEMICAL REACTIONS TO ART

Upon entering the classroom, the eight-grade pupils put on lab coats. They were surrounded by scientific instruments and natural materials, including droppers, beakers, lemons, vinegar, cabbage, beetroot, and more.

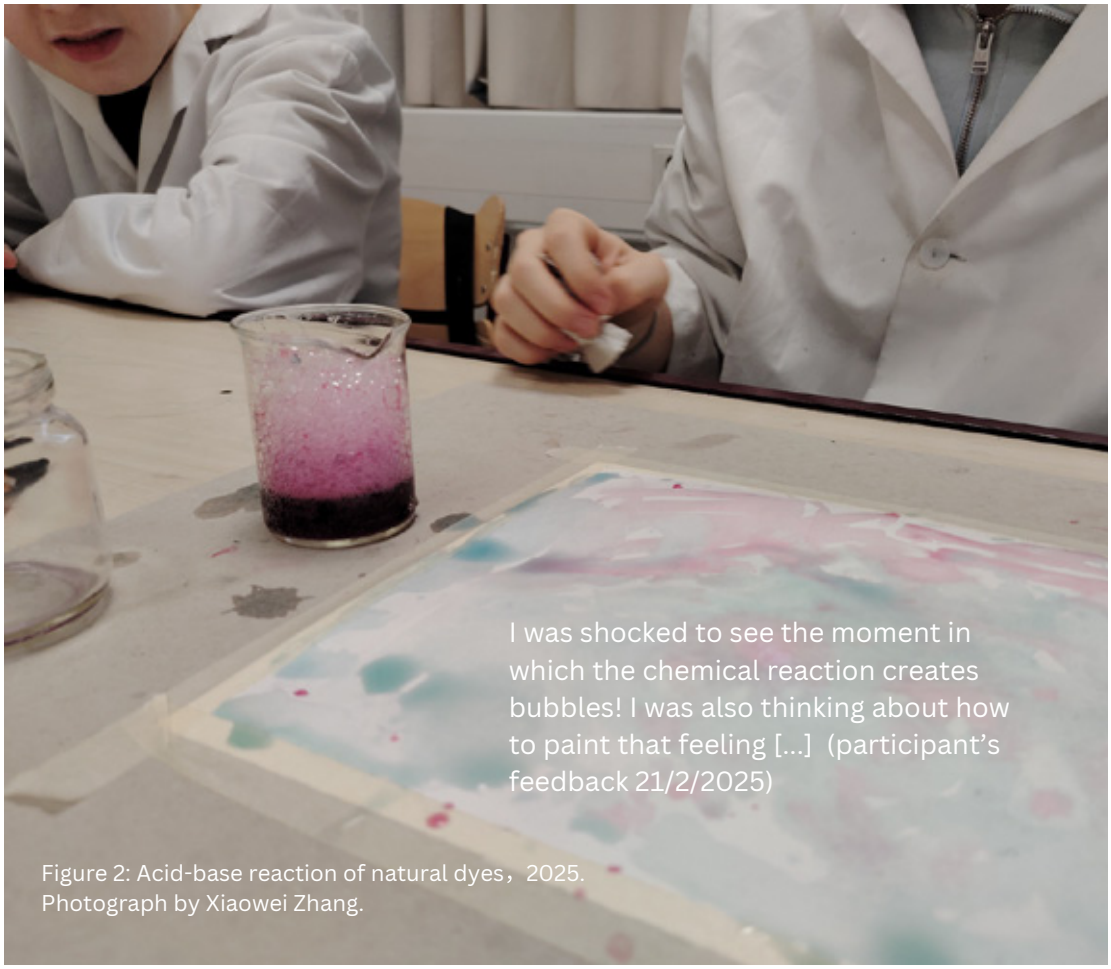


Figure 2: Acid-base reaction of natural dyes，2025.
Photograph by Xiaowei Zhang.

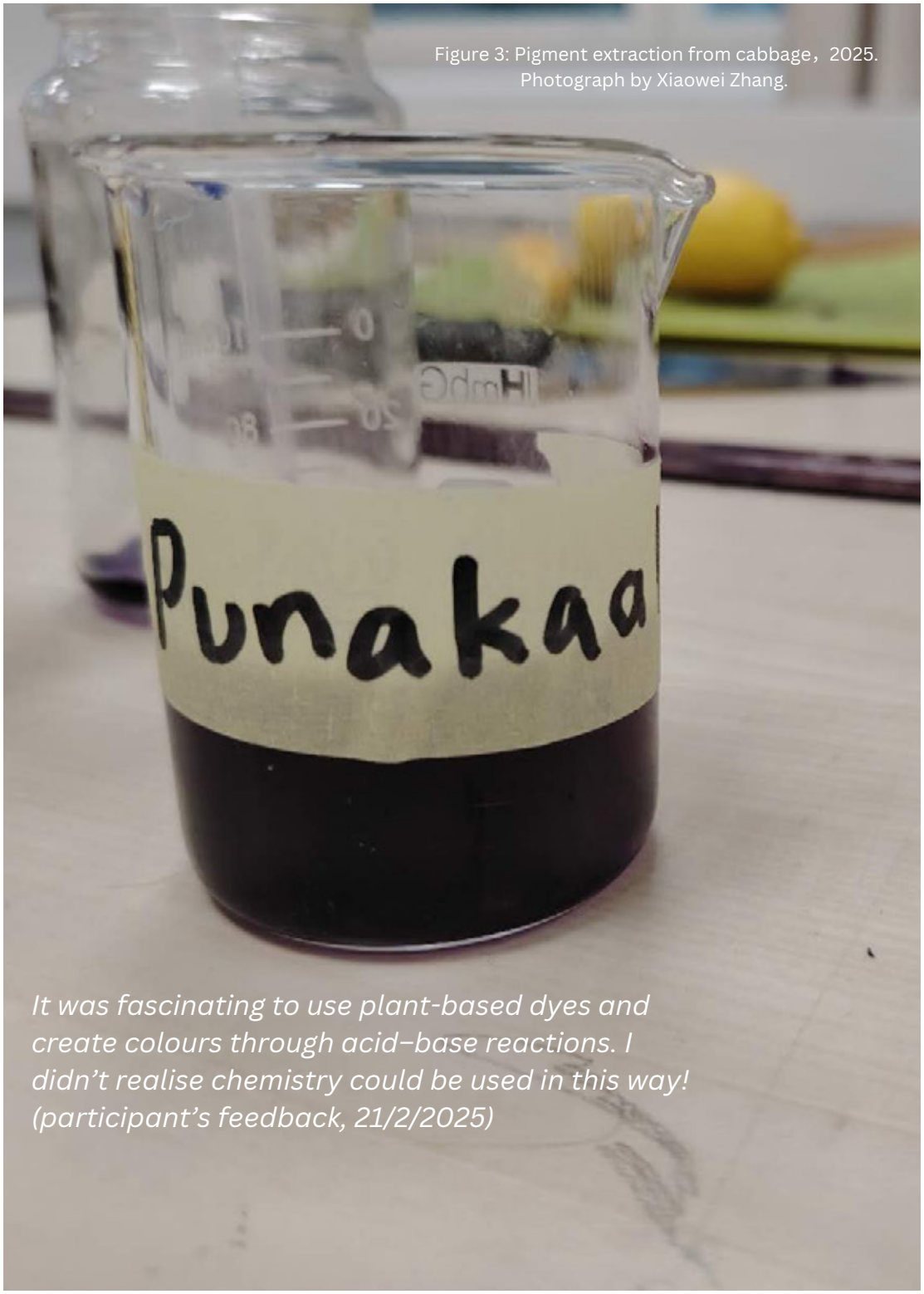


Figure 3: Pigment extraction from cabbage，2025. Photograph by Xiaowei Zhang.

It was fascinating to use plant-based dyes and create colours through acid–base reactions. I didn't realise chemistry could be used in this way! (participant's feedback, 21/2/2025)

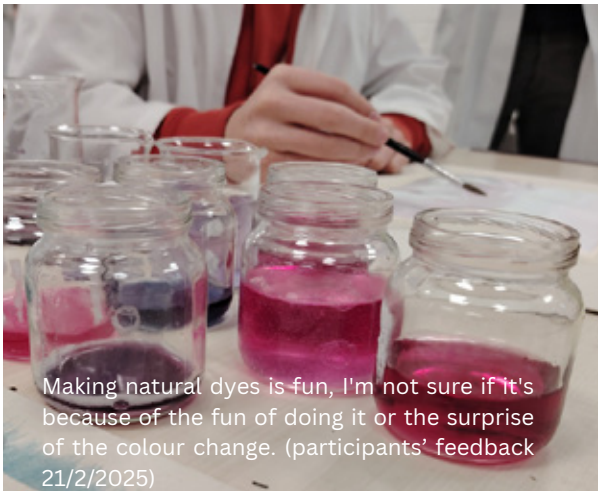


With curiosity, pupils moved from recording observations to creating works of art, using a variety of pH reagents to manipulate colour variations and create visual layers in their compositions. They constantly adjusted their strategies between experimentation and creation, testing the effects of different reagents on the colours, analysing the way the colours spread and trying to create patterns on the paper.

Figure 4–7: Explore different materials, 2025. Photograph by Xiaowei Zhang.



Pupils carefully controlled the concentration of acid and base solutions to experiment with different effects of natural dyes on paper. One pupil tried different ways of dripping liquids so that the colours formed naturally diffused patterns. The formation of these patterns was influenced by chemical factors and physical diffusion principles. Another pupil combined the results of their experiments with personal narratives to create an artwork. One pupil said he drew a map and named it ‘Shape of Sustainability’, symbolising the conflict between pollution and ecological balance through the contrasting colours of acid and base changes.



Making natural dyes is fun, I'm not sure if it's because of the fun of doing it or the surprise of the colour change. (participants’ feedback 21/2/2025)



Figure 8–11:Making Natural Dyes, 2025. Photograph by Xiaowei Zhang.





Figure 12-19: 'Oh, we can do art in this way! ' The process of creating ChemArt, 2025. Photograph by Xiaowei Zhang.

SUMMARY

The interdisciplinary integration of teaching and learning strategies is effective in enhancing pupils' creativity (Bertling & Galbraith 2024). By exploring chemical phenomena through artistic means, pupils created paintings with a thematic focus on ecological sustainability. These artworks visualise the colour response to pH changes and incorporate pupils' reflections on the sustainability of materials and the relationship between humans and nature. In the process, the artwork became an expression of sustainable practice. By working as both scientists and artists, pupils explored how natural pH indicators function and how these materials can be used sustainably in creative processes, linking scientific understanding with environmental responsibility. These findings echo Marqués-Ibáñez's (2023) ideas about the importance of sustainability awareness in education, highlighting the value of interdisciplinary teaching in ecological education.

It's really fun to make art with natural dyes and test tubes, and it offers a more environmentally responsible alternative to conventional chemical paints. (participant's feedback 21/2/2025)









Figure 20-23: Towards the final artworks, 2025. Photograph by Xiaowei Zhang.

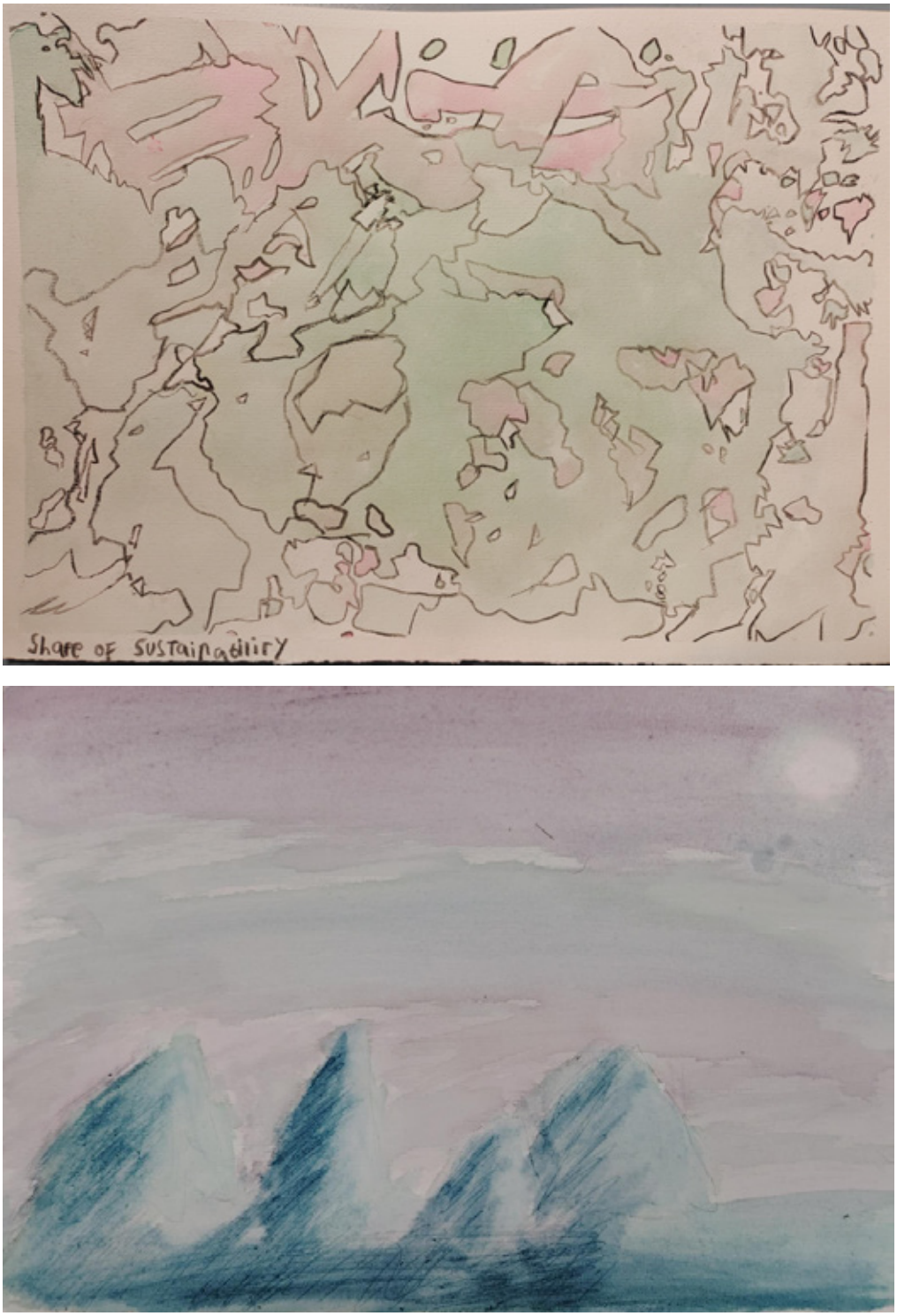


Figure 24-25: ChemArts, 2025. Photograph by Xiaowei Zhang.

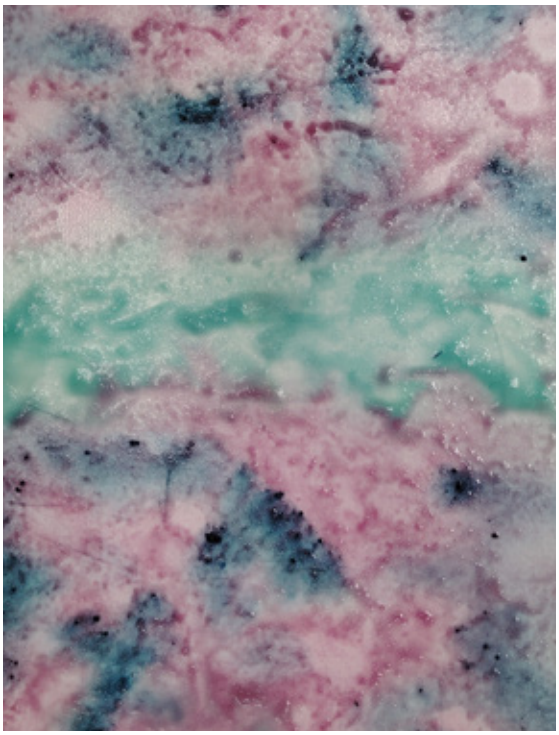




Figure 26-27: ChemArts, 2025. Photograph by Xiaowei Zhang.

ACKNOWLEDGEMENTS

This collaboration involves the University's Science Education Center uJunnu, Luma center Lapland, Rantavitikka school in Rovaniemi, University of Lapland.

REFERENCES

Bertling, Joy and Galbraith, Amanda (2024), 'Teachers' data-based storytelling in a STEAM professional development programme', International Journal of education through art, 20(3), 367–378. https://doi.org/10.1386/eta_00174_7

Jokela, Timo, Hiltunen, Mirja and Huhmarniemi, Maria (2019), 'Art-based action research: participatory art education research for the North. In A. Sinner, R. L. Irwin and J, Adams (Eds.), Provoking the field: International perspectives on visual arts PhDs in education (pp. 45–56). Intellect.

Lilliedahl, Jonathan (2022), 'Why the arts are not considered core knowledge in secondary education: A Bernsteinian analysis', Journal of Curriculum Studies, 54(2), 165–178. https://doi.org/10.1080/00220272.2021.1925971

Markula, Anette and Aksela, Maija (2022), 'The key characteristics of project-based learning: How teachers implement projects in K-12 science education', Disciplinary and Interdisciplinary Science Education Research, 4(1), 1–17. https://doi.org/10.1186/s43031-021-00042-x

Marqués Ibáñez, Ana, María (2023), 'Art education through the sustainable design of learning spaces', International Journal of Education Through Art, 19(1), 113–133. https://doi.org/10.1386/eta_00122_1

Strakšienė, Giedre, Ben-Horin, Oded, Espeland, Magne and Robberstad, Janne (2022), 'Towards a rationale for science-art integration as a transdisciplinary signature pedagogy', Cogent Education, 9(1), 1–15. https://doi.org/10.1080/2331186X.2022.2087459