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Citation: Horvath, Anca-Simona, Laura Beloff, Lykke Brogaard Bertel, Judit Boros, Lorena Cebolla Sanahuja, Pia Fricker, Foad Hamidi, et al. "Editorial: Weaving Hybrid Futures: Sustainability in Higher Education with PBL Through Art, Science, and Robotics." *Journal of Problem Based Learning in Higher Education* 11, no. 2 (October 10, 2023): I–VII. <https://doi.org/10.54337/ojs.jpblhe.v11i2.7981>.

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**Weaving Hybrid Futures: Sustainability in Higher Education with PBL Through  
Art, Science, and Robotics**

*Special Issue*

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**EDITORIAL**

Sustainability is currently one of the most important topics in higher education and curriculum development. As a connected and interdependent global community, we are facing increasingly complex and multidimensional socio-political, economic, and environmental challenges. It is clear that trans-disciplinary efforts are necessary to tackle sustainability. Integrating sustainability in educational curricula involves cultivating a way of thinking that is holistic and collaborative so that we can adequately prepare students to work across disciplines, sectors, institutions, and geographies. Problem-based

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learning, a student-centered learning approach that focuses on real-life problems and where students typically work in groups (Servant-Miklos et al., (2023)), was shown to be a good method for teaching students to engage with complex topics such as sustainability. Defining sustainability is a double act of communication across disciplines and planning for and imagining the future, which requires creativity and, at times, speculation. This act is made more difficult by the fact that there is a lack of consensus surrounding sustainability and through what means and metrics sustainability should be assessed (Horsbøl, 2023; Smith, 2019). How can we use often conflicting conceptions to imagine and design sustainable futures? How can transdisciplinarity inform education and equip future students with a sustainability mindset to face the challenges of their time? These are the core research questions that inform this special issue on Weaving Hybrid Futures: Sustainability in Higher Education with PBL Through Art, Science, and Robotics.

## Background

The **ABRA project**<sup>1</sup> (Artificial Biology, Robotics, and Art) is a three-year Erasmus project that initiated and informs the context of this special issue. The project aims to cultivate transdisciplinary educational pathways through pilot teaching and learning programs with students and educators to help tackle the wicked problem of sustainability in higher education.

Throughout the past three years, ABRA has developed and led workshops with a dedicated group of students and educators from diverse backgrounds and disciplines from Europe, North and South America. Our aim has been to strengthen connections and build new bridges across the fields of artificial biology, robotics, and art. We focused on the topic of sustainability and capacity building for educators and students so that through new educational initiatives, we might develop tools and strategies to meaningfully address the impacts of environmental degradation and climate change through transdisciplinary inquiry. Although we come from diverse disciplines spanning biology, design, robotics, architecture, computer science, engineering, and the arts, we are connected through our mutual recognition that the world's most pressing problems are not going to be solved by experts from a single discipline alone, but will require people from many fields and sectors coming together to develop and implement new solutions and practices. This special issue, co-edited by the ABRA consortium and the *Journal of PBL in Higher Education*, is an opportunity to highlight some key outcomes from the project while also broadening the discourse to include other perspectives within higher education that have leveraged PBL to promote transdisciplinary teaching and education for sustainability.

Each of the contributions in this collection emphasizes the connections between sustainability and creativity, innovation and collaboration in research, and education within PBL. These connections are cultivated through dedicated initiatives, teaching and

training activities, theoretical understanding, and research that promote transdisciplinary thinking and practice. Educational systems will not transform overnight; centuries of mono-disciplinary degree programs and specializations have made it difficult for arts, humanities, and social science students to interact with science and engineering students. Creating learning environments where students work collaboratively across cultures and disciplines will take time and require new methods and practices. Furthermore, developing transdisciplinary curricula towards sustainability is made more difficult by the fact that defining sustainability is itself a complicated task. There is no definition of sustainability that works reliably across all fields of study. As many have observed, despite the increased focus on sustainability in the last decade, there are still basic challenges in defining what exactly sustainability is, as well as how best to address it or communicate its relevance (Horvath et al., 2023; Eskjær & Horsbøl, 2023; Horsbøl, 2023). Sustainability is a slippery and frequently paradoxical concept: social and economic sustainability can be at odds with economic sustainability and growth (Smith, 2019), and it can be difficult to reach a consensus about what decision might constitute the “correct” or most “green” in a given scenario (Horsbøl, 2023).

Definitions of sustainability should remain open and fluid, evolving at pace with new knowledge as fields of study interact and as contradictions and tensions become clear. Refining and re-defining sustainability while imagining sustainable futures will require a collective ability to imagine them creatively and through dialogue and experimentation.

The article *STEAM Matters for Sustainability: 10 Years of Art and Technology Student Research on Sustainability Using Problem-based Learning* [1] surveys ten years of student projects from a transdisciplinary undergraduate education program in Art and Technology. The authors focus on student projects that specifically address sustainability within an art-based research framework, identifying important themes within sustainability, research directions within a PBL context, and the artistic and academic methods the students employed. In their analysis, the authors identify five primary themes of sustainability that the artworks deal with: (1) pollution, (2) nature, (3) health, (4) capitalism, and (5) reduced inequalities. Within these topics, six research aims sought to either: (a) raise awareness about sustainability-related issues, (b) promote behavioral change in audiences, (c) challenge assumptions and opinions or provoke, (d) propose solutions, (e) speculate about possible futures, or (f) provide self-understanding. Importantly, sustainability was conceptualized by students as either a matter of (i) disconnect: between people and nature, between people and others and between people and abstract scientific communication, (ii) imagination, or the ability to imagine futures (or lack thereof), or (iii) conflict and/or paradox. The article highlights how artistic methods and practices can help make concrete the often abstract notion of sustainability, and illustrates how art methods can help make topics in sustainability accessible to diverse student populations and the general public.

The article *Becoming a Creative Genius: How a Creative Learning Environment Can Facilitate Transdisciplinary Engagement and Creative Mindset in a Life-Long Learning Perspective* [2] evaluates another transdisciplinary program at Aalborg University, entitled Creative Genius, an elective course focusing on creativity and interdisciplinary PBL with more than 200 students from fifty-six disciplines completing the program between 2013-2018. Based on interviews with graduates from the program, the article explores whether a PBL environment that focuses on creativity facilitates transdisciplinary engagement and creative competencies, and considers to what extent this manifests into transdisciplinary career paths and creative mindsets in a life-long learning perspective. Further, the findings indicate that a pedagogical approach which focuses on the embodiment of creative competencies helps prepare students to transition to professional settings, and equips them to engage in transdisciplinary and complex problem-solving in industry and society. The paper proposes a “double helix” model for creative transdisciplinary thinking, illustrating the intertwining of vertical and horizontal knowledge and emphasizing the significance of horizontal thinking, open-mindedness, and co-creation in problem-solving. Further, the authors suggest the need for PBL environments to cultivate creative self-efficacy and foster connections between various forms of knowledge for effective, transdisciplinary PBL.

Mattila et al.’s *The Interplay of Engineering Skills, Aesthetic Creativity and Ethical Judgment in the Creation of Sustainable Urban Transformations: Aristotelean Perspectives on PBL* [3] examines a PBL project module on “Sustainable Urban Transformation” within the Urban Design Master program at Aalborg University combining urban design and hydrology engineering. During the module, lectures and study circles that touch on various dimensions of sustainability, especially *vis-a-vis* climate change are introduced and students are given the freedom to choose how to balance between design and engineering approaches when giving a physical form for sustainability in their urban design interventions. The authors discuss the development of student skills scaffolded on the Aristotelian concepts of *techné* (understood as engineering), *poiesis* (interpreted as aesthetic form-giving), and *phronesis* (conceived as the making of ethical judgments) and argue that the last two concepts are especially important for issues and topics within design education. Analysing a sample of student projects, the authors examine how sustainability is made concrete, and how the students negotiate and find a balance between engineering skills, aesthetic creativity, and ethical judgment in their urban design work. These designs, however, should always be conceptualized as flexible over time, rather than fixed. Therefore, educators should encourage students to understand designs as *poietic* narratives.

We are interested in the ways that PBL can help centre questions of equity, justice, and power in sustainability and design curricula. Identifying the unspoken values and assumptions of conventional sustainability research and education programs can be

challenging. We recognize that educators play a key role in transforming educational and design practices that render marginalized communities invisible to prepare students for more just and transparent action. By giving access to and gathering perspectives from diverse stakeholders, PBL can help frame investigations on issues that are important to marginalized communities. McDonald et al.'s *Elicitation and Empathy with AI-enhanced Adaptive Assistive Technologies (AATs): Towards Sustainable Inclusive Design Method Education* [4] articulates this role by considering how to approach incorporating non-normative methods in design thinking to better meet the needs of people with disabilities. Recognizing the ethical challenges and sensitivity of working with people with disabilities in design education and wishing to avoid unnecessary burdens on users, the authors pilot-tested a participatory elicitation toolkit for generating empathy and self-reflection in technology for design students when developing new adaptive tools for users living with disabilities. The tool attempts to incorporate intersectional thinking in privacy elicitation while enabling sustainable and inclusive design practice in higher education.

Fricker et al.'s *Interconnected Agencies for Sustainable Futures: A Discourse on the Notion of Adaptation and Space* [5] invites a broader discussion on possible trajectories for sustainable futures by intersecting different practices and discourses on the concepts of *adaptation* on the one hand, and *space* on the other. The authors note that increasingly, tools and methods of science and technology are adopted and introduced into creative work within art, design, and architecture, although there is little traffic in the other direction. The article considers why this might be and presents four different disciplinary perspectives, which contribute to current discussions on sustainable futures. Further, the article describes the concept of *adaptation* as the process by which systems or individuals adjust to changing circumstances in order to optimize their performance and propose that *adaptation*, viewed through this perspective, can be a useful lens when designing PBL activities for students.

*Embedding Digital Data Storytelling in Introductory Data Science Course: An Inter-Institutional Transdisciplinary Pilot Study*, [6] presents a semester-long pilot study where a framework dubbed *Digital Storytelling* was presented in an introductory data science course at a four-year Minority Serving Institution, in collaboration with students studying non-STEM disciplines at a partner community college. The authors found that *Digital Storytelling* helped raise student awareness of sustainability issues and increased confidence in cross-disciplinary communication competency while deepening their understanding of data science concepts. The article reflects on the role of transdisciplinary communication as an important competency for increasing diversity in the data science workforce.

The contributions in this special issue highlight how creativity, like sustainability, is not domain-specific; it cuts across all research areas and sectors. The need for human

imagination and creative thinking in problem-solving has never been more apparent or more necessary than right now. Those educated with transdisciplinary skills are prepared for a dynamic future that will require flexible thinking, fluency of ideas, active and life-long learning, and collaborative skills.

Institutions of higher education increasingly prioritize curricula that train and prepare the next generation of students to work across disciplines in order to be able to tackle sustainability. However, our understanding of sustainability is evolving along with what it means for our respective fields. Refining and redefining conceptions of sustainability starts with conversations across disciplines and with re-thinking our current disciplinary system. This transformation requires more than technical solutions and environmentally sensitized practices; rather, it calls for innovative and just methods for collective and creative collaboration between scientists, engineers, designers and artists, policymakers, and educators to ensure that sustainability is addressed from multiple angles and across disciplines.

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**The issue articles:**

1. Horvath et al. (2023). *STEAM Matters for Sustainability: 10 Years of Art and Technology Student Research on Sustainability Using Problem-based Learning.*
2. Hansen et al. (2023). *Becoming a Creative Genius: How a Creative Learning Environment Can Facilitate Transdisciplinary Engagement and Creative Mindset in a Life-Long Learning Perspective.*
3. Mattila et al. (2023). *The Interplay of Engineering Skills, Aesthetic Creativity and Ethical Judgment in the Creation of Sustainable Urban Transformations: Aristotelean Perspectives on PBL.*
4. McDonald et al. (2023). *Elicitation and Empathy with AI-enhanced Adaptive Assistive Technologies (AATs): Towards Sustainable Inclusive Design Method Education.*
5. Fricker et al. (2023). *Interconnected Agencies for Sustainable Futures: A Discourse on the Notion of Adaptation and Space.*
6. Chen et al. (2023). *Embedding Digital Data Storytelling in Introductory Data Science Course: An Inter-Institutional Transdisciplinary Pilot Study.*

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<sup>1</sup> <https://www.abra-hub.net/> The project was funded by Erasmus+, the European Union's program to support education, training, youth, and sport in Europe.