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TRaD 2022

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Edited by

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Transdisciplinary education and innovation through STEAM

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Abstract

While the concept of transdisciplinarity has been widely discussed in research, there are still challenges for its translation into practice. In this paper we elaborate on the concept of STEAM (Science, Technology, Engineering, Arts and Mathematics) as a nexus for transdisciplinary practices in research, teaching and project design. We introduce the STEAM Innovation and Curriculum project and analyse a set of cases identifying different approaches to transdisciplinary practice in higher education (HE) which include framing, inspiring, exploring, challenge addressing and innovating. Each of the approaches is connected to a set of strategies together with some examples. We reflect on the commonalities between the different STEAM approaches since they can offer opportunities for facilitating effective transdisciplinary practices in research and HE leading to innovation.

Keywords

Transdisciplinarity; STEAM; Higher Education (HE); HE curriculum; HE policies; STEAM methods; STEAM approaches, Innovation

1. Introduction

Attention to transdisciplinarity is not new with several international conferences and key work produced in the past five decades. It is, however, a concept that has caused confusion about what it actually means - including, how it differs from interdisciplinarity and multidisciplinary - and has posed challenges in its translation into practice. We align our definition of transdisciplinarity to that proposed by Erich Jantsch (1972; Augsburg, 2014) and applied in published work since (e.g. Tress et al., 2005; Nicolescu, 2004). Therefore, for us transdisciplinarity includes a realistic setting, acknowledgement of complexity and working across, between and beyond disciplinary boundaries.

It differs from interdisciplinarity, which integrates different disciplinary knowledge systems to create new methodological approaches, by going beyond breaking down disciplinary barriers through reaching out to external knowledge (such as policy-making and practice knowledge, or local and indigenous knowledge). As Darbellay (2015: 165) observes, “undisciplined knowledge” involves rethinking disciplinary identities and presents a different thought style. Figure 1 illustrates the differences and characterises the inherent principles for transdisciplinarity drawing on insights gained from across the literature and own research experience.

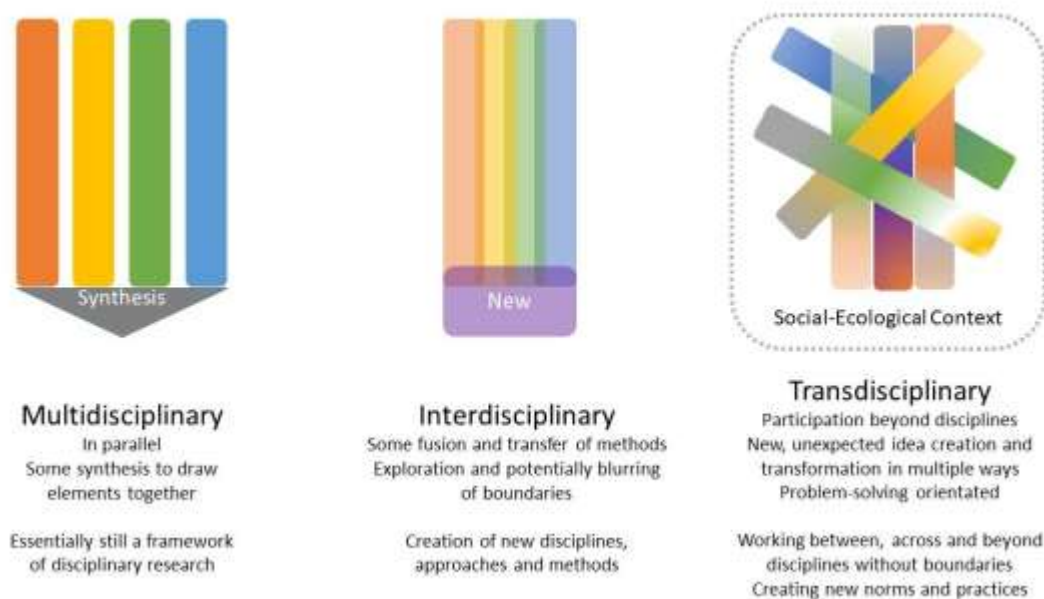


Figure 1: Explaining the differences between Multi-, Inter- and Transdisciplinarity

Looking at the context and characteristics of transdisciplinarity, similarities become obvious with ‘STEAM’, an agenda that arose from attempts to inject ‘Arts’ (A) into Science, Technology, Engineering and Maths (STEM); or more broadly to adopt creative Arts and/or Design based approaches to other academic fields. STEAM approaches allow the framing and analysing complex current challenges in critical and cross-cutting, holistic ways, stimulating innovative thinking and solutions through co-production and reflection (Catterall, 2017; Colucci-Gray et al., 2019). Further, methods have found traction in primary and secondary education, but are relatively new to tertiary (or higher) education. However, they have been gathering momentum for opening up research and (extra-) curricular pedagogy, stimulating social learning and innovation through collaboration with industry, practitioners and/or community involvement (Carter et al., 2021).

Recent work, conducted as part of the STEAM Innovation and Curriculum (STEAM INC) project to help clarify and develop guidance for STEAM approaches and methods in higher education (HE), suggests that STEAM is an opportune setting to facilitate transdisciplinarity. The sharing of common principles, as for example captured in the Charter for Transdisciplinarity (de Freitas et al., 1994) or Nicolescu’s (2014) Methodology of Transdisciplinarity is evident. Key themes for STEAM and transdisciplinarity are further unpacked and discussed in the following sections, following an overview of the STEAM Innovation and Curriculum project and its key outputs.

2. STEAM innovation and curriculum

2.1. Project overview and outputs

STEAM Innovation and Curriculum (STEAM INC) is an Erasmus+ funded collaboration between seven European partner organisations who have a common interest in STEAM approaches and methods (Table 1).

Table 1
The STEAM INC project partners

Institution	Country	Specific role
Birmingham City University	England, U.K.	Project lead; Objective 1 lead
Central Saint Martins College, University of the Arts London	England, U.K.	Objective 2 lead
Science Gallery Dublin, Trinity College Dublin	Ireland	Objective 3 lead
Aalto University	Finland	
Amsterdam University	The Netherlands	
Dresden Technical University	Germany	
Ars Electronica	Austria	

STEAM INC started in October 2019 and finishes in January 2023. It has three major objectives:

1. Identify points of intersection across current European HE STEAM approaches and develop a collaborative definition of HE STEAM.
2. Produce methodologies for the implementation of STEAM thinking in HE education, policy and engagement.
3. Create an evaluation framework for measuring the effectiveness of STEAM processes in HE institutions and HE partner organisations.

To realise its objectives, STEAM INC has held partner meetings, workshops, training events and conferences. Apart from the very first partner meeting in December 2019 in Amsterdam, all activities have been held online due to the COVID19 pandemic, often using collaborative software such as Miro. Techniques employed in sessions include templates, peer review, reflection and ‘hacking’ (deconstructing something and then taking elements/inspiration from across other sources to reconstruct it in a different way).

Selected activities, key to the deliberations presented in this paper, are described in the following. Where the activity is complete, a link to the relevant output is indicated, if applicable. The work is also described in greater detail by Carter et al. (2021).

To achieve the project objectives, it was vital that there was a mutually agreed understanding of what STEAM means in the partnership. This was the focus of a workshop held during the first partner meeting in Amsterdam in 2019 and has since been revisited and further reflected upon.

Each partner presented a definition of STEAM that reflected their understanding and experience. This was followed by group work that assembled key and recurring words that were then evaluated and prioritised. Finally, an agreed definition emerged that encapsulated the collective understanding of what is contained in a STEAM approach. This comprised a set of baseline attributes for a STEAM practitioner or process (expressed for the HE context but more widely applicable) which was embedded into STEAM INC’s working definition:

- a culture (or cultures) that puts the Arts and Sciences on an equal footing;
- operating within a paradigm that is process-driven, student-centred, holistic and provides permission to fail alongside being comfortable with uncertain end-results;
- being collaborative, diverse and delivered through safe spaces;
- establishing a mindset of radical openness, flexibility, reflection, experimentation and curiosity;
- generating qualities that promote learning, cooperation and multi-modality;
- developing competencies of critical thinking, creativity and communication whilst investigating how these can be applied to generate solutions”.
- developing competencies of critical thinking, creativity and communication whilst investigating how these can be applied to generate solutions.

Work on the handbook began in March 2020, when each partner presented two STEAM approaches at an online training event. While limited by being set in a Higher Education context,

choices were flexible to represent examples from curriculum development, external engagement and policy (internal or external).

The event included a period of reflection where attendees considered the commonalities and differences of the approaches as well as key features. The resulting themes were then further refined by the lead partner. This work was complemented by the development of the handbook (Burns et al., 2021), which includes brief descriptions of the approaches², detailed advice for implementing STEAM approaches in Higher Education and reflection regarding the tensions and ambiguities arising through the project and STEAM approaches as a whole. It is this work that has primarily informed the findings of this paper.

To fulfil the second project objective the partnership has developed new STEAM methods. This has entailed presentations of existing methods, that were then critiqued and dismantled. The new methods are either an improved version of an existing method, a hybrid of several methods, or something completely new, inspired by working through the hacking process. This is nearing completion with the methods available on the project website at <https://www.steaminnovation.org/resources>.

Finally, to realise the third objective, the partnership is developing a new toolkit to evaluate the effectiveness of transdisciplinary cooperation across STEAM disciplines. This aims to measure the value of unconventional methods arising from STEAM activities as well as assessing their significance in the development of curriculum, engagement, and policy.

All together, the project outputs provide a picture of current STEAM practice in HE as well as providing a practical toolkit which will enable and engender expansion of the field.

2.2. Selection of cases

The cases included in the STEAM INC project consist of initiatives developed by the project partners focused on supporting and promoting inter-/transdisciplinary research and/or learning in HE. While some of the initiatives might be considered as public engagement, so addressing a public beyond academia, they maintain strong links with universities. In this section, we introduce the cases and provide a brief outline of each.

- **Aalto Biofilia** is a biology lab in an arts school. This learning environment supports exploring life sciences in arts contexts as well as providing a research space for artists, researchers and students in the Aalto School of Arts, Design and Architecture.
- **Aalto University Wide Arts Studies** is an elective courses programme on art and design-based practices and processes targeting students from all faculties.
- **Birmingham City University's STEAMhouse** provides an innovation and business development centre fostering collaborations around STEAM. The centre brings together artists, engineers, entrepreneurs, companies, and public sector organisations in events and training oriented at idea generation, as well as product and service development.
- **Birmingham City University** - Jo Berry's research involved explorations between art and science and employed 'play' to generate new methods and insights in scientific data applications.
- **Central Saint Martins MA Art and Science** is a Master's Degree programme exploring contemporary and historical relations between art and science, working in non-hierarchical transdisciplinary and collaborative ways. As part of the Masters programme relations with external actors and institutions from different fields have been forged and resulted in a range of public-facing events and off-campus activities.
- **Science Gallery Dublin (SGD)³ at Trinity College Dublin** was a cultural and educational space and part of the Science Gallery Network. SGD was focused on triggering conversations about science and art, targeting young adults.

² The STEAM approaches are also explained in greater detail on the project website: <https://www.steaminnovation.org/resources>.

³ Sadly, funding for the Science Gallery Dublin stopped in 2022.

- **Science Gallery Dublin - “Idea Translation Lab”** was an elective module for undergraduate students from diverse faculties. In the course, students engaged in collaborative projects focused on societal challenges.
- **Dresden University of Technology - “Interdisciplinary summer project”** is an Industrial Design Engineering course. Participants are students from design, engineering and technology studies. During the project, they work together on challenges provided by companies, as well as research and cultural institutions.
- **Dresden University of Technology - Module on Bionics** is a cross-disciplinary course introducing Bachelor students to core aspects of Bionics from the perspective of Biology, Mathematics and Engineering.
- **University of Amsterdam - Bachelor and a Master programmes on Information Studies** combines STEM fields with Arts to broaden students' perspectives around information systems, encouraging them to consider the human and social needs before developing any technological solution.
- **University of Amsterdam - Humans, Science and Technology** is an academic programme preparing students to address societal complex challenges. The programme is a joint endeavour of the faculties of social sciences, humanities, and science.
- **Ars Electronica - STARTS programme** supports innovative projects at the nexus of science, technology, and the arts by creating a platform for collaboration between artists and industry.

3. Results and discussion

A thematic analysis of the cases selected by the STEAM INC partners has been performed to identify different approaches to transdisciplinary design and research in policy, engagement, and education in higher education. Five themes emerged as central to all approaches: framing, inspiring, exploring, challenge-addressing (or a social-ecological or social-technical context), and innovating. While all the themes have been found present in all the cases, we consider the differentiation between themes a valuable contribution since it helps to understand where the emphasis is placed. Next, we elaborate on each of the themes, presenting the key strategies that characterise the approach, together with some examples from the cases.

Framing refers to STEAM approaches aiming to create and foster a transdisciplinary thinking mindset. The focus is on opening up perspectives and embracing new ways of looking at things so that current social-ecological challenges can be better understood and explored. This then helps create greater awareness of the opportunities and limitations of different methods and ways of thinking. In STEAM INC, the cases that were linked to framing included programmes, such as the University of Amsterdam’s new Master’s in Humans, Science and Technology. Some of the strategies used to support transdisciplinary thinking focused on using different modes of analysis pertaining to different disciplines/perspectives and triggering out-of-the-box thinking to explore divergent views. From an institutional perspective, enabling and fostering close collaboration with different departments and faculties, as well as including various stakeholders, who might be external to the institution (such as alumni) was key for broadening understanding and ensuring the programme was rooted in transdisciplinary practice.

While all the cases used inter-/transdisciplinarity to spark new ways of thinking and tackling current societal needs and challenges, in some of the cases a clear endeavour for inspiring was evident. For instance, in the module on bionics offered at Technical University Dresden, the effort focused on inspiring the next generation of professionals to use creative approaches for bridging different areas of knowledge. Demonstration and modelling were an important component of this module, in which students were introduced to fundamental aspects of Biology, Mathematics and Engineering and encouraged to connect these different areas of knowledge through projects with external partners and design solutions. In other cases, such as the Science Gallery Dublin - Trinity College Dublin, the mission was to inspire the general public. The Science Gallery Dublin’s motto “connect, participate, surprise” captured the main strategies used to inspire their audiences, through

offering a social space to spark conversations and trigger curiosity about current issues, from a transdisciplinary point of view.

The creation of knowledge-sharing opportunities between experts from different fields was another strategy to inspire and foster transdisciplinary collaborations. For instance, at Birmingham City University, Jo Berry's artistic work using advanced imaging and microscopy to create links between arts and sciences exemplified how artists' residencies, in which artists collaborate with scientists, can lead to novel ideas and open up transdisciplinary perspectives and ways of researching/working. This work also found that it takes time to create a 'common' language and shared/better understanding of concepts and meanings amongst the collaborators.

Transdisciplinary work can be regarded as an **exploratory** quest for producing new concepts, tools and ways of doing to help formulate or develop solutions towards social-ecological challenges. Thus, cultivating ways to conduct explorations in a transdisciplinary way is considered critical. In our analysis, some of the strategies commonly used to support transdisciplinary explorations consisted of introducing methods from one field into another, but also through embracing creative methodologies to make links between the arts and sciences. Aalto University's initiatives such as 'Biofilia' and the university-wide 'Arts Studies' are examples of the various ways in which transdisciplinary explorations can be embedded in HE.

In BCU's STEAMhouse and TU Dresden's 'Interdisciplinary Summer Project' a link with industry and/or other external stakeholders created the opportunity to **address** real-world **challenges** through fast-paced exploration and creative processes drawing on transdisciplinary knowledge and team-working. Such collaborative approaches, in which participants are encouraged to work on projects with societal actors or industry, was another strategy to support transdisciplinary explorations and addressing complex social-ecological challenges. Similarly, Central Saint Martins's MA Art and Science programme puts a strong emphasis on relation-building (within, between and beyond). This is an integral part of the programme's transdisciplinary approach to STEAM, maintaining a strong link between academia and practice, with a focus on current day challenges or emerging issues.

A common reasoning regarding the value of transdisciplinarity relates to being better equipped for addressing and **innovating** solutions for current challenges. The STEAM INC project showcased many project-based approaches to nurture collaborations between academics, students, and external actors to academia. These collaborations were perceived as key for addressing problems in a transdisciplinary fashion. In innovation-oriented initiatives such as Birmingham City University STEAMHouse, design thinking strategies have been introduced to the academic and professional community to spark innovations. In other cases, such as in the Arts Electronica STARTS programme, the creation of a platform for collaboration between art and industry was a key instrument for sustaining transdisciplinary innovations.

While the emphasis among the approaches outlined in this section might vary, many of them build on strategies focused on supporting collaborations with diverse knowledge holders, actors and communities, as well as expanding the methods repertoire borrowing from other fields of knowledge and creating fused or novel approaches and methods. Another important aspect is the role of design. In the cases analysed in the STEAM INC project, design (or a design thinking approach) has frequently been used as a glue to link different fields of knowledge, ideating, and developing solutions to address a current challenge. We consider it important to highlight these commonalities since it can offer avenues to implement transdisciplinarity in research and create innovation projects using STEAM approaches and methods.

4. Conclusions

The current drive to develop and apply STEAM approaches in education and analysing specific approaches and learning in the STEAM INC project, showcased a range of insights about how STEAM approaches can effectively facilitate transdisciplinary working. STEAM and transdisciplinarity share many principles and highlight how STEAM has inter-/transdisciplinarity at its core. The five themes identified in our analysis - framing, inspiring, exploring, addressing challenges, and innovating - help characterise vital ingredients for successful transdisciplinary projects and teams. Importantly, the role of the Arts and the influence of design thinking (and

adopting a user-centric lens) can help overcome disciplinary barriers and narrow mindsets. They have emerged as catalysts for wider/novel framing of issues, inspiration, exploration, and innovation and as a ‘glue’ in transdisciplinary projects and teams for developing ‘solutions’ to help address complex challenges. Furthermore, the Arts, and artistic approaches, are a critical component in their own right alongside other disciplines (Carter et al., 2021) and deserve due attention as part of transdisciplinary working/projects.

STEAM approaches (as outlined in section 2.2 and Carter et al., 2021; and the STEAM INC Handbook / Burns et al., 2021) and methods belonging to different disciplines (e.g. hacking from IT/computing) can be applied or reconfigured in new ways to help innovate and meld ways of conceiving, analysing issues and/or designing and creating solutions. STEAM approaches can be challenging by placing participants out of their comfort zone and approaching an issue from diverse perspectives and in novel ways. In the education sector the link with practice and policy (beyond academic) and moving from inter- to transdisciplinary working seems an important step for empowering students and staff to help tackle social-ecological challenges and become more grounded, multi-skilled and creative in their inquiry and production of outputs.

We concur with Hans Dieleman (2015) who links “reflective action and artful doing” and emphasises “spaces of experimentation and imagination” (p.68) to characterise transdisciplinarity which “should be considered as both a transformative process as well as an epistemological, ontological and methodological endeavor” (p.69).

References

- Augsburg, T. (2014). Becoming transdisciplinary: The emergence of the transdisciplinary individual. *World Futures*, 70(3-4): 233-247, DOI: 10.1080/02604027.2014.934639
- Burns, K., Cahill-Jones, T., Carter, C., Stint, C. and Veart, L. (eds, main authors) (2021) *STEAM Innovation and Curriculum Handbook*. Birmingham: Birmingham City University. https://www.steaminnovation.org/uploads/STEAM_INC_Handbook_2021.pdf.
- Carter, C., Barnett, H., Burns, K., Cohen, N., Durall, E., Lordick, D., Nack, F., Newman, A. and Ussher, S. (2021). Defining STEAM approaches for Higher Education. *European Journal of STEM Education* (Special Issue STEM & Arts Education) 6(1): 13. Open access at <https://doi.org/10.20897/ejsteme/11354>.
- Catterall, L. G. (2017). A Brief History of STEM and STEAM from an Inadvertent Insider. *The STEAM Journal*, 3(1): Article 5. DOI: 10.5642/steam.20170301.05 Available at: <http://scholarship.claremont.edu/steam/vol3/iss1/>
- Colucci-Gray, L., Burnard, P., Cooke, C., Davies, R., Trowsdale, J., and Gray, D. (2017). *Reviewing the Potential and Challenges of Developing STEAM Education through Creative Pedagogies for 21st Learning: How can school curricula be broadened towards a more responsive, dynamic, and inclusive form of education?* London, U.K.: British Educational Research Association.
- Darbellay, F. (2015). Rethinking inter- and transdisciplinarity: Undisciplined knowledge and the emergence of a new thought style. *Futures* 65: 163-174.
- de Freitas, L., Morin, E. and Nicolescu, B. (1994). *The Charter of Transdisciplinarity* (Trans. K.-C. Voss). <http://ciret-transdisciplinarity.org/chart.php#en>.
- Dieleman, H. (2013). From Transdisciplinary Theory to Transdisciplinary Practice: Artful Doing in Spaces on Imagination and Experimentation. In B. Nicolescu and A. Ertas (Eds) *Transdisciplinary Theory & Practice*, Chapter 5, pp67-85. The Academy of Transdisciplinary Learning & Advanced Studies (The ATLAS).
- Jantsch, E. (1972). Towards interdisciplinarity and transdisciplinarity in education and innovation. In: L. Apostel, G. Berger, A. Briggs, and G. Michaud (eds) *Interdisciplinarity: Problems of teaching and research in universities*, 97-121. Paris: Organization for Economic Cooperation and Development.

Nicolescu, B. (2014). Methodology of transdisciplinarity. *World Futures* 70(3-4): 186-199.

Tress, G., Tress, B. and Fry, G. (2005). Clarifying integrative research concepts in landscape ecology. *Landscape Ecology* 20(4): 479-493.



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