

# Education for Sustainable Development through Maker Education: Visions, Concepts And Experiences

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**Abstract:** This paper presents first results from an European Erasmus+ project that integrates ecological Making with interdisciplinary, CLIL-based STEAM education to address eco-anxiety and empower students to participate in negotiating livable futures for all. Drawing on Education for Sustainable Development (ESD), Maker Education, and Content and Language Integrated Learning (CLIL), the project fosters transformative, intercultural learning environments. Using Mobile Maker Boxes (MMBs), students and teachers engage in hands-on problem-solving around sustainability challenges. This paper outlines the project's aims, theoretical framework, methodology, and early insights from an international co-design workshop involving teachers and researchers from five countries. The findings suggest that interdisciplinary, collaborative making—whether physical, digital, or conceptual—enhances student agency, emotional engagement, foreign language and intercultural competence, and Futures Literacy. A Design-Based Research (DBR) methodology supports iterative development, preparing the project for classroom implementation.

**Keywords:** Ecological Making; Intercultural Cooperation; STEAM Education; CLIL; Education for Sustainable Development (ESD); Maker Education; Futures Literacy.

## 1. Introduction

Today's youth face a growing sense of disempowerment in the face of complex global crises, particularly climate change, which is increasingly linked to eco-anxiety (Hickman et al., 2021). Traditional education systems often emphasize cognitive knowledge acquisition over emotional engagement, failing to inspire the critical and affective capabilities needed for transformative societal change (Ulmanen et al., 2016).

The EMIC-STEAM project responds to this gap through a novel pedagogical framework that integrates Education for Sustainable Development (ESD), interdisciplinary Maker Education, and Content and Language Integrated Learning (CLIL) to foster interdisciplinary, intercultural, and emotionally resonant learning in grades 7 to 10. Thus, students elaborate creative projects on social-ecological challenges in Mobile Interdisciplinary Maker Boxes (MMB) and discuss their ideas in international cooperations. Thus, they develop Futures Literacy as well as intercultural and foreign language competence. The project particularly targets girls, who statistically show greater environmental concern but remain underrepresented in STEM pathways (Benavent et al., 2020; So et al., 2022). A central tool in this endeavor are the MMBs: thematic, portable kits enabling schools to implement ecological Making projects, even with limited resources.

The present paper aims to: (i) Articulate the theoretical and methodological foundations of EMIC-STEAM; (ii) present early findings from a transnational co-design workshop carried out with researchers and teachers; (iii) demonstrate how interdisciplinary, CLIL-enhanced Maker Education can address both cognitive and affective learning outcomes related to sustainability.

The short-paper is structured as follows: Section 2 describes the workshop design and pedagogical innovation; Section 3 discusses national adaptations and Making practices; Section 4 explores broader implications; Section 5 concludes with next steps and future directions.

## 2. Theoretical Framework

This study draws from four main strands of educational approaches:

- Education for Sustainable Development (ESD): Emphasizes the cultivation of transformative capabilities—critical thinking, anticipatory capacity, and agency—in addressing real-world problems (e.g. Pettig & Ohl, 2023).
- Maker Education: Positions students as creators rather than consumers, combining hands-on engagement with problem-solving and digital literacy (Martin, 2015). Ecological making, a core focus of this project, adds sustainability as a pedagogical priority.
- CLIL (Content and Language Integrated Learning): Supports simultaneous acquisition of subject knowledge and foreign language skills, enabling students to communicate solutions in international settings (Coyle et al., 2010, Wunderlich, 2023), as well as reflecting on the cultural situatedness of problem definitions and solution finding.
- Futures Literacy: Encourages learners to explore and imagine alternative futures, thus empowering them to act meaningfully in the present (Miller, 2018).

Together, these frameworks inform an approach that is interdisciplinary, multilingual, culturally sensitive, and grounded in real-world relevance.

### 3. Methodology

The project employs a Design-Based Research (DBR) methodology (Barab & Squire, 2004; McKenney & Reeves, 2021). DBR supports iterative co-creation between researchers, teachers, and students. It allows for continuous reflection and refinement across multiple cycles of design, implementation, and evaluation. Data collection methods include: Observations and field notes from the design workshop; Teacher reflections; Prototypes and documentation created during and after the workshop.

A total of five countries—Germany, Austria, Sweden, Portugal, and Luxembourg—are involved, each represented by interdisciplinary teams from universities and schools. The diversity of these contexts enriches both the design process and the analysis.

### 4. Design Workshop and Pedagogical Innovation

The EMIC STEAM teaching design is developed in close collaboration between researchers and teachers in accordance with the DBR approach. Thus, a key milestone was an international design workshop that brought together teachers and researchers from all partner countries. The focus of the workshop was to present first design steps to the teachers, initial design concepts for the Mobile Maker Box and suitable topics had already been discussed with the teachers in the first six months of the project and developed into a comprehensive design based on their feedback.



**Figure 1: Participant choosing materials for the Making activity; Participant showcasing a handbag prototype (left).**

At the project meeting, the teachers worked with the MMB FAST FASHION and reflected on its suitability for their school contexts from a student and teacher perspective as part of question-led feedback discussions. The focal theme FAST FASHION was chosen for its global relevance and accessibility for learners. The workshop

comprised of three phases: (i) Introduction (awareness and contextualization); (ii) Making (design and prototyping), and (iii) Discussion (presentation and reflection) (Figure 1).

Participants engaged in a two-part Maker challenge:

- Analog Phase: Teams designed and built handbags from discarded materials. These were not only functional but metaphorical—sparking reflection on consumer culture and environmental impact (Figure 1 and 2).
- Digital Phase: Participants used TinkerCAD to conceptualize digital prototypes, thereby integrating coding, electronics, and 3D design with sustainability learning.



**Figure 2: Participants working in groups (left); and discussing the Making pedagogical approach.**

## 5. National Adaptations and Making Practices

During the final session, country teams translated the workshop experience into context-specific educational applications:

- Austria: Emphasized combining student-led and teacher-guided explorations, proposing hands-on activities like natural dyeing, clothing swaps, and podcast production.
- Portugal: Focused on personal consumption habits. Students would trace the life cycle of their own clothes, culminating in upcycled fashion shows and social media campaigns.
- Germany: Proposed a 10-hour Making phase featuring mobile apps. Emotional and reflective elements were prioritized to deepen engagement.
- Luxembourg: Suggested linking fashion to broader consumer habits. Ideas included art installations and redesigned school uniforms.
- Sweden: Planned a pilot project for ages 12-14 centered on jeans. It would include blog writing, video production, and cross-border dialogue in English via CLIL.

These diverse approaches highlighted the flexibility of the MMB model and its resonance across pedagogical and cultural contexts (Figure 3).



Figure 3: Participants discussing possible teaching approaches.

## 6. Emotional and Reflective Engagement

Emotional engagement emerged as a critical driver of student motivation and deeper learning. Participants reflected on how the tactile nature of making activities—combined with real-world relevance—elicited empathy, responsibility, and solidarity.

Reflective tools such as journals, exhibitions, and peer discussions were proposed to further scaffold emotional learning. Teachers noted that addressing sustainability requires more than facts—it requires affective investment, which our approach of ecological Making can facilitate by connecting the personal to the planetary.

The international and collaborative nature of the meeting also fostered intercultural competence and solidarity among educators, further strengthening the ESD foundation of the project. Discussions surfaced new thematic directions for future MMB development, including climate change, gender equality, media literacy, digital well-being, and post-COVID realities.

## 7. Implications for Practice

The workshop revealed several insights:

- **Interdisciplinary Flexibility:** Making activities can integrate arts, sciences, and humanities while promoting both conceptual and practical knowledge.
- **Language Learning through Purposeful Use:** Using English to discuss real sustainability challenges gave authentic purpose to language learning.
- **Infrastructure and Support:** MMBs enable even under-resourced schools to adopt Maker Education. However, logistical planning (e.g., dedicated time, access to materials) remains a key implementation challenge.
- **International Dialogue:** Teachers appreciated the value of international co-creation. It expanded their own perspectives and highlighted how intercultural learning can be embedded into sustainability education.

## 8. Conclusion and Future Directions

The EMIC-STEAM project demonstrates how CLIL-infused, interdisciplinary Maker Education can help reimagine education for sustainable development. The co-design workshop validated the project's pedagogical approach and highlighted the power of emotional and reflective engagement in learning.

Next steps include:

- Piloting MMBs in classrooms across partner countries.
- Collecting empirical data on student learning outcomes.
- Refining materials and strategies for broader dissemination.

- Developing an online platform for cross-cultural student collaboration.

Our interdisciplinary approach of ecological Maker Education with a focus on sustainability-related challenges is already proving to be a promising way to inspire young people to find ways forward in light of global challenges by enabling hopeful, holistic and hands-on learning processes.

## AI Declaration

AI tools were used to correct language issues

## Ethics Declaration

Ethical clearance was not required for the research activities described.

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