

Mapping the Bioeconomy Education Landscape in Ireland: A Spatial and Structural Analysis of Gaps and Skills Alignment

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Project: Mapping the Bioeconomy Education Landscape in Ireland: Identifying Gaps and Building Skills for a Circular Bioeconomy Transition

This research was conducted for **CBEC, the Circular Bioeconomy Education Centre**, a national initiative focused on bringing bioeconomy learning into schools, industry and lifelong education to build the skills and knowledge needed for a sustainable bioeconomy transition in Ireland. CBEC funded by Department of Agriculture, Food and the Marine works to establish a bio-based education, training and skills network, develop a national education and upskilling roadmap for the bioeconomy, identify current education and skills gaps, and support policy development in this area.

The study examines how bioeconomy and sustainability-related education initiatives are distributed across the Irish education landscape. Using a structured national database and ArcGIS-based spatial analysis, it mapped formal programmes, non-formal initiatives, curriculum-linked resources, teacher education pathways, workshops and sustainability-focused educational materials across multiple education levels.

Findings show that while sustainability and bioeconomy education in Ireland is growing, provision remains fragmented and uneven. Initiatives are concentrated in higher education, teacher-focused programmes, and urban or institutional centres, while early years engagement, regional diversity and explicit systems thinking integration remain limited.

The study highlights structural gaps between policy ambition and classroom implementation, contributing to debates on education for sustainable development, systems thinking and circular bioeconomy transitions. It also demonstrates how integrated educational mapping can support CBEC's wider aim of developing more coherent, inclusive and nationally embedded sustainability and bioeconomy education pathways in Ireland.

Methodological Approach

A structured dataset of 65 initiatives was compiled and categorised based on:

- Target audience (Early Years, Primary, Secondary, Tertiary, Teachers)
- Type of education (formal vs non-formal)
- Thematic focus and systems thinking integration

In addition to quantitative analysis, a spatial mapping approach using ArcGIS was employed to visualise the geographical distribution of initiatives across Ireland (see Figure 1).

Key Findings

1. Structural Imbalance Across Education Levels

The analysis reveals a highly uneven distribution of initiatives across education stages:

- Strong concentration in teacher-focused initiatives
- Moderate representation at secondary level
- Limited engagement at primary level
- Near absence of early years initiatives

This indicates that the system is top-heavy rather than pipeline-based, lacking continuity from early education through to higher education and workforce development.

2. Spatial Concentration and Regional Disparities

The ArcGIS spatial analysis (Figure 1) highlights clear geographic trends:

- Urban centres (e.g., Dublin) show multi-level engagement across audiences
- Rural regions exhibit limited and less diverse targeting
- Initiatives are not evenly distributed across education stages geographically

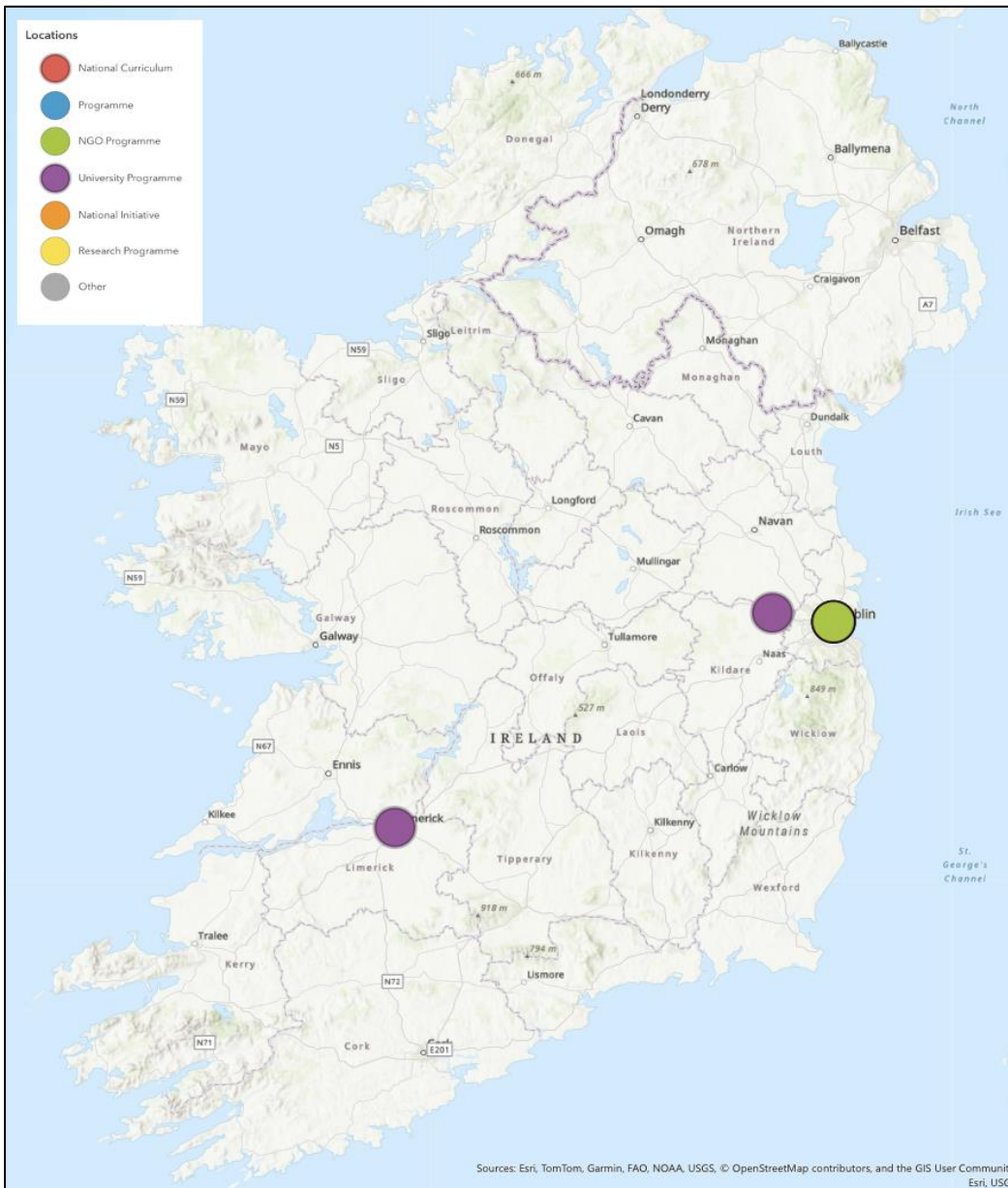


Figure 1. Bioeconomy Education Framework illustrating the relationship between key themes, bioeconomy principles, pedagogical approaches and intended educational outcomes within bioeconomy education.

Source: The framework was developed through work conducted by the BEST Network and the Circular Bioeconomy Education Centre (CBEC), and adapted by the authors from Empowering Education for Sustainable Development: A Submission from the BEST Network for Ireland's Third SDG National Implementation Plan - A Case for a Bioeconomy Approach (Nic an Bhaird et al., 2026).

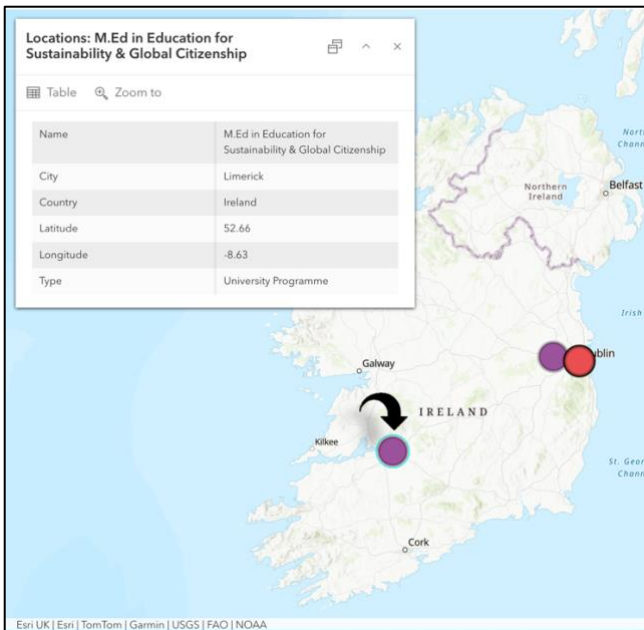


Figure 1a. Example of a university-level sustainability education programme identified within the mapped dataset: M.Ed in Education for Sustainability & Global Citizenship (Limerick).

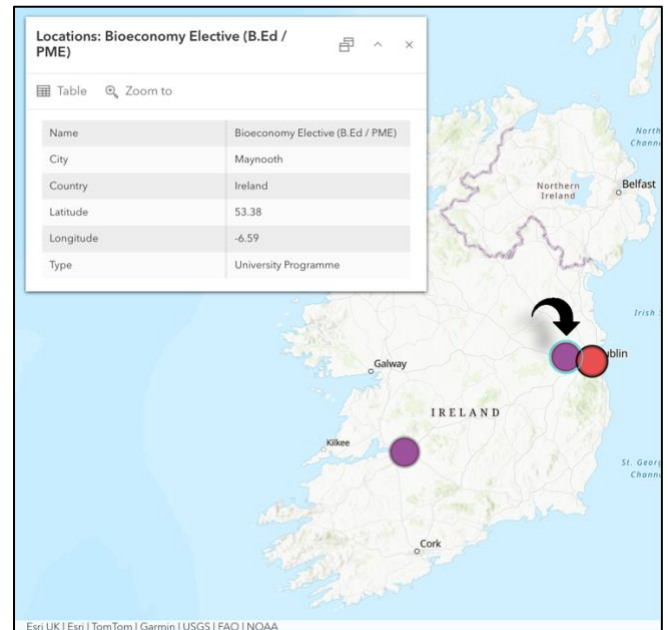


Figure 1b. Example of a teacher education bioeconomy initiative identified within the dataset: Bioeconomy Elective (B.Ed/PME) (Maynooth).

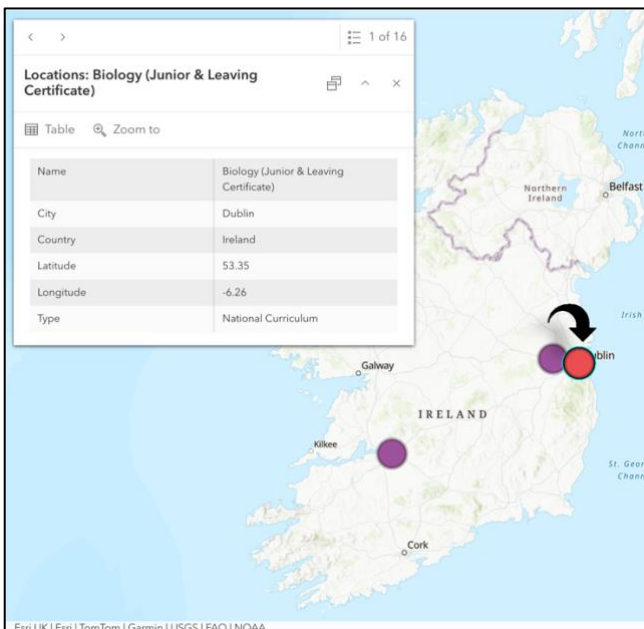


Figure 1c. Example of national curriculum-linked integration through Biology (Junior & Leaving Certificate), demonstrating how bioeconomy-related concepts are embedded within formal secondary education structures.

This suggests that access to bioeconomy education is spatially uneven, reinforcing existing regional disparities.

3. Weak Integration of Systems Thinking

Despite its central role in sustainability transitions:

- Only 2% of initiatives explicitly incorporate systems thinking
- The majority include it implicitly or not at all

This represents a critical gap, as systems thinking is essential for understanding interconnections across ecological, economic, and social systems.

Interpretation of Findings

The results indicate that the challenge is not a lack of initiatives, but a lack of systemic integration and alignment:

- Educational efforts remain fragmented across levels and sectors

- There is limited connection between policy ambitions and curriculum design
- Core competencies required for a circular bioeconomy are not structurally embedded

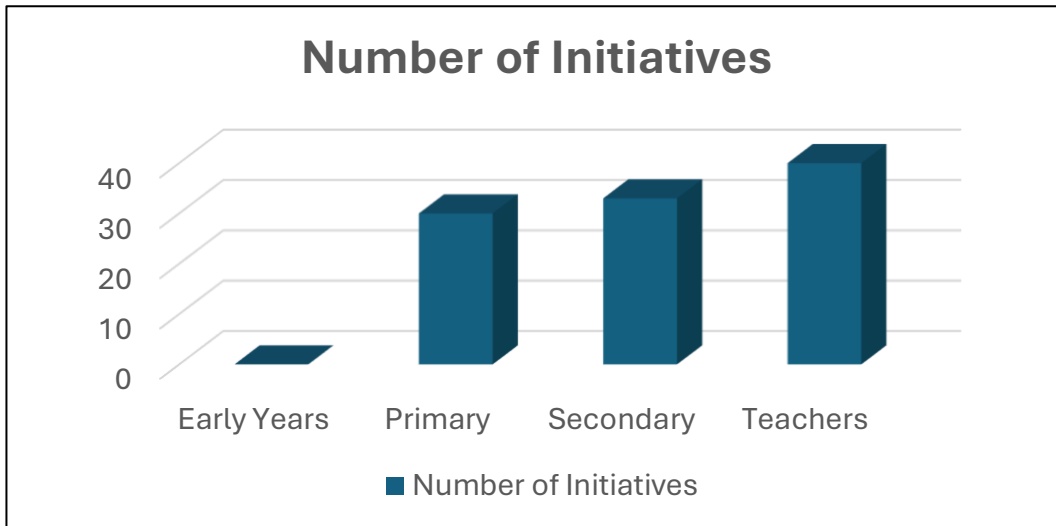


Figure 2. Distribution of bioeconomy education initiatives by target audience across the Irish education landscape. Data highlights strong concentration in teacher-focused initiatives and limited engagement at early years level.

Source: Authors' analysis based on the CBEC/BEST bioeconomy education database.

As illustrated in Figure 2, the current system reflects a fragmented landscape, whereas an effective transition requires a coherent, structured education pathway.

Implications for Policy and Practice

These findings highlight the need to shift from:

- Isolated initiatives → Integrated education pathways
- Teacher-heavy focus → Balanced multi-level engagement
- Implicit learning → Explicit systems thinking integration

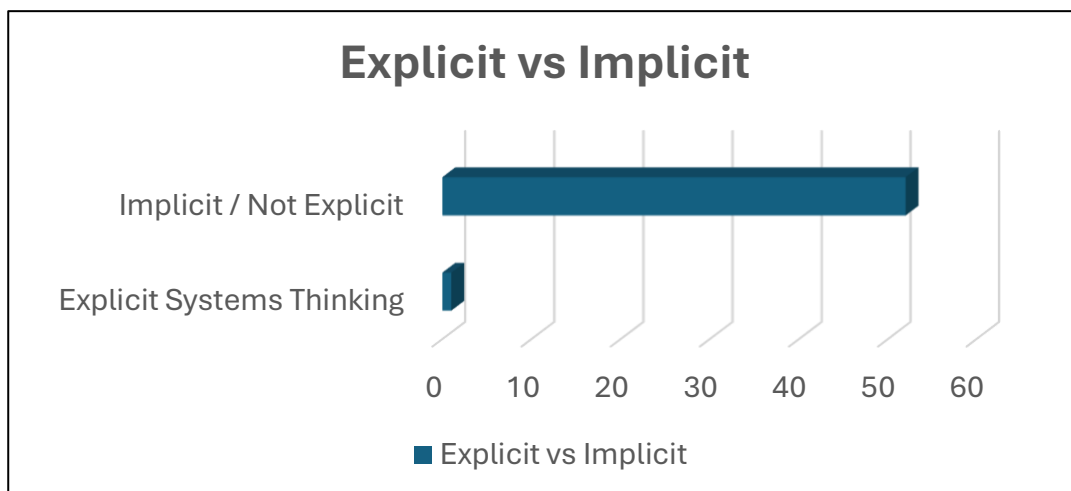


Figure 3. Distribution of bioeconomy education initiatives by target audience across the Irish education landscape. Data highlights strong concentration in teacher-focused initiatives and limited engagement at early years level.

Source: Authors' analysis based on the CBEC/BEST bioeconomy education database.

A more coordinated approach is required to ensure that learners develop the skills necessary to actively participate in the bioeconomy transition (figure 3).

Conclusion and Contribution

This study provides one of the first national-level mappings of bioeconomy education provision in Ireland, offering both:

- A structured evidence base for identifying gaps
- A spatial perspective on access and distribution

“The transition to a circular bioeconomy depends not only on innovation, but on how we structure and deliver education across all stages of learning.”
