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Sustainable Food Systems: Embedding Education for Sustainable Development (ESD) in a Food Science Module

Kieran Higgins[1], Alison Calvert[1], Alysha Thompson[1] and Tracy Galvin[2]

Abstract

This paper explores the design and implementation of an Education for Sustainable Development (ESD)-informed food science module, following the authors' participation in the Learning Design and ESD Bootcamp. The module aims to challenge and transform students' beliefs, values, and assumptions about real-world issues in the agri-food industry through active learning in an outward-facing curriculum that makes use of place-based learning, problem-based learning and peer and collaborative learning. Assessment was designed to be as authentic as possible, mirroring real-world tasks and challenges. Preliminary feedback indicates that the module was well received by students and contributed to their understanding of the challenges and opportunities associated with sustainable food production, processing, and consumption, as well as their ability to critically evaluate and propose solutions to real-world problems in the agri-food industry. However, the authors also encountered challenges in student engagement, resistance from teaching staff and institutional barriers that made constrained design and made implementation difficult. Overall, this paper highlights the importance of ESD in curricula generally and food science in particular. The success of the module so far demonstrates the value of active and authentic learning experiences in developing students' understanding of sustainability in the agri-food industry as well as promoting critical thinking and problem-solving skills. The challenges faced during the development and implementation process offer insights into the importance of leadership as well as targeted support for staff involved in curriculum development and delivery.

Keywords

education for sustainable development, learning design, sustainability, sustainable food systems, place-based learning, problem-based learning, peer-learning, authentic assessment

[1] School of Biological Sciences, Queen's University Belfast, UK

[2] Academic Development and Student Learning, Glasgow Caledonian University, UK

Corresponding Author:

Dr Kieran Higgins, School of Biological Sciences, Queen's University Belfast, 19 Chlorine Gardens, Belfast, BT9 7DL, United Kingdom

Email: k.higgins@qub.ac.uk

Resumen

Este artículo explora el diseño e implementación de un módulo de ciencia de alimentos dentro del marco de la Educación para el Desarrollo Sostenible (EDS), siguiendo la participación de los autores en el Bootcamp de Diseño de Aprendizaje y EDS. El módulo tiene como objetivo desafiar y transformar las creencias, valores y suposiciones de los estudiantes sobre problemas del mundo real en la industria agroalimentaria a través del aprendizaje activo en un currículo abierto que utiliza el aprendizaje basado en el lugar, el aprendizaje basado en problemas y el aprendizaje colaborativo. La evaluación se diseñó para ser lo más auténtica posible, reflejando tareas y desafíos del mundo real. Los comentarios preliminares indican que el módulo fue bien recibido por los estudiantes y contribuyó a su comprensión de los desafíos y oportunidades asociados con la producción, procesamiento y consumo de alimentos sostenibles, así como su capacidad para evaluar críticamente y proponer soluciones a problemas del mundo real en la industria agroalimentaria. Sin embargo, los autores también encontraron desafíos en la participación de los estudiantes, la resistencia del personal docente y las barreras institucionales que dificultaron el diseño y la implementación. En general, este artículo destaca la importancia de la EDS en los planes de estudio en general y en la ciencia de los alimentos en particular. El éxito del módulo hasta ahora demuestra el valor de las experiencias de aprendizaje activas y auténticas en el desarrollo de la comprensión de los estudiantes sobre la sostenibilidad en la industria agroalimentaria, así como en la promoción del pensamiento crítico y las habilidades para resolver problemas. Los desafíos enfrentados durante el proceso de desarrollo e implementación ofrecen ideas sobre la importancia del liderazgo, así como el apoyo específico para el personal involucrado en el desarrollo y la entrega del currículo.

Palabras clave

educación para el desarrollo sostenible, diseño de aprendizaje, sostenibilidad, sistemas alimentarios sostenibles, aprendizaje basado en el lugar, aprendizaje basado en problemas, aprendizaje por pares, evaluación auténtica

Background

Education for Sustainable Development (ESD) is a comprehensive approach to teaching and learning that promotes the principles of sustainability through high-quality education that nurtures the knowledge, skills, and attributes that enable individuals to lead environmentally, socially, and economically responsible lives. This approach involves five interrelated learning domains, namely learning to know, be, live together, do, and transform oneself and society (UNESCO, 2017). ESD equips learners with the knowledge, competencies, and skills required to act as responsible and effective citizens, capable of safeguarding the environment, promoting social equity, and contributing to economic well-being, bridging the gap between academic knowledge and the Sustainable Development Goals (SDGs), enabling learners to become agents of positive change and builders of sustainable futures (UNESCO, 2019).

During 2021, a programme review of the BSc Food Science at Queen's University Belfast was undertaken. A collaborative approach involving a range of stakeholders identified a lack of graduate knowledge and skills in sustainability. The review also coincided with the publication of the Independent Strategic Review of the Northern Ireland Agri-Food sector (Kendall, 2021, p. 8) which identified that "sustainability will become agri-food's licence to

trade", reinforcing the conclusion that sustainability should be central to the redesigned programme. At the same time, we were fortunate to have the opportunity to take part in the Learning Design and ESD Bootcamp (ALDESD, 2023; Calvert et al., 2022; Toro-Troconis et al., 2023; UNESCO IESALC, 2022). The team comprised two academics, an academic developer and a PhD student who was also a graduate of the BSc Food Science, bringing a varied range of expertise across sustainability, ESD, food science, learning design and more, as well valuable insights from the learner perspective.

It was decided that creating a new module through the lens of ESD would provide both a foundational and a transformative experience for learners, whilst ensuring future graduates have the necessary skills, knowledge and understanding to become true change-makers and sustainability champions in the local and international agri-food industry. Consequently, Sustainable Food Systems was created.

About Sustainable Food Systems

Sustainable Food Systems module is designed for first year (QCF Level 4) BSc Food Science & Nutrition learners. The aim of the module is to introduce learners to the building blocks of a sustainable food system through the lenses of the UN Sustainable Development Goals (SDGs) and the One Health model (WHO, 2021). The key concepts to be introduced to learners include: the food systems of key food commodities, food waste and by-products of food processing and manufacturing, carbon neutrality, the role of consumer choices and their impact on sustainability, legislative and policy contexts, and becoming an ethical food industry professional. Practically, there was a focus on data collection, analysis, and interpretation.

Table 1. Module information

Creators	Kieran Higgins, Alison Calvert, Alysha Thompson and Tracy Galvin
Institution, Country	Queen's University Belfast, UK
Course and Discipline	BSc (Hons) Food Science & Nutrition
Module name	Sustainable Food Systems
Level (year) of learners	Level 4 (first year undergraduate)
Learning hours / Credit value	200 learning hours / 20 credits (UK, 10 European Credit Transfer System)

Structurally, it has a credit value of 20 Credit Accumulation and Transfer Scheme (CATS) points, which is deemed equivalent to 200 learning hours over 12 weeks. Direct contact time is 3 hours per week, apart from a full-day field trip, leaving 164 hours to be spent in self-directed learning and preparing assessment. Figure 1 shows a breakdown of the module within the framework of the CoDesignS ESD Toolkit Planner (Ahmad et al., 2023; CoDesignS ESD, 2023).

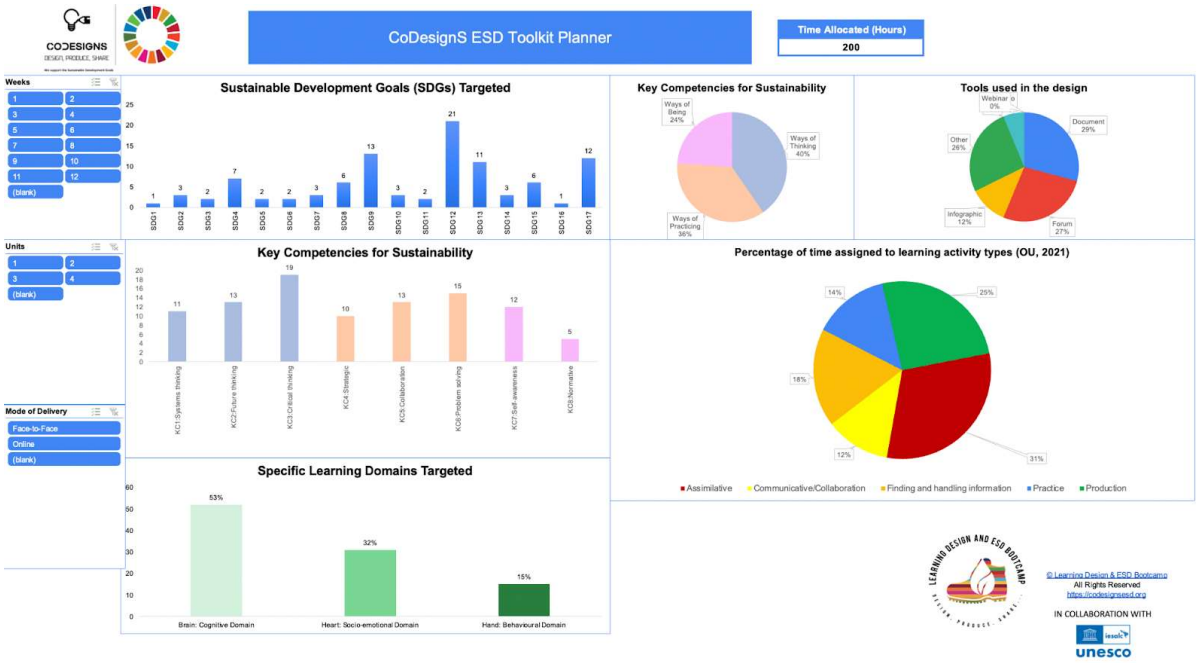

Figure 1. Sustainable Foods Systems Visualised in Toolkit Planner (ALDESD, 2023)

The authors firmly believe that curriculum co-creation and a students-as-partners mindset are vital to creating a learning environment that is truly inclusive and learner-centred. By working with learners in this way, learners can feel more valued and respected, leading to a more positive and productive learning experience that allows them to take ownership of their education and become active participants in their learning journey (Mercer-Mapstone, 2017). As a result, we consulted with current students, alumni, colleagues, employers, placement providers and other agri-food stakeholders to solicit viewpoints on what should feature in this module's content.

Central also to this module was employability. The need for employment-ready graduates is growing as recruiters shift from degree-based to skills-based selection processes (Jack, 2022). As employers place more emphasis on softer skills such as teamwork and communication, institutions need to reflect on their curriculum and assessment (Callaghan, 2022), so as to integrate such skills (Fuller et al., 2022). Among these skills, problem solving and digital literacy, were recently identified as the most important factors for employers, ranking above subject specialisation and academic excellence (Times Higher Education, 2022). Bearing this in mind, the module team were determined to integrate opportunities to develop employability skills throughout the module. Listening to our employers during the co-design process, they too echoed the importance of not just sustainability being a crucial skill for food industry employees but also problem-solving and being comfortable with data and similar digital processes and outputs.

Module Content

The module has four learning outcomes:

- Define food systems and understand their position within a global food context.

- Identify and discuss the challenges associated with the sustainable production, processing, and manufacturing of a range of food commodities and describe relevant approaches to mitigate impact.
- Understand the impact of consumer choices on sustainable food systems.
- Demonstrate an understanding of new data collection, analysis, and interpretation methods and how these can be used to monitor and improve sustainability.

To achieve the learning outcomes of the Sustainable Food Systems module, an interdisciplinary range of relevant theories and taught content was included:

- The structure, actors, and relationships within global food systems, including concepts such as food security, food sovereignty, and food justice; and the different types of food systems that exist.
- The environmental, social, and economic challenges associated with sustainable food production, as well as relevant approaches to mitigating these such as sustainable agriculture, circular economy, and food waste reduction.
- The role of consumer choice, such as the influence of culture, social norms, and dietary preferences on food sustainability, and the impacts of different types of diets on health and the environment, with attention given to how sustainability can be promoted via labelling and certification schemes.
- How data is collected, analysed, and used to make decisions within the food sector, with attention given to sustainability enhancing approaches smart farming, industrial monitoring, carbon footprinting, blockchain and artificial intelligence.

Initially, it was thought SDG2: Zero Hunger & SDG4: Quality Education would be the key Goals to be focused on, but as we proceeded to map the contact hours against the SDGs, SDG12: Responsible Production & Consumption, SDG9: Industry, Innovation & Infrastructure, and SDG17: Partnerships for the Goals instead all emerged as prominent contributors to the module, occupying a significant amount of the contact hours allocated.

Teaching & Learning Strategies

The approach to the design of Sustainable Food Systems was firmly rooted in transformative pedagogies, which are instructional approaches that aim to challenge and transform students' beliefs, values, and assumptions through the lens of critical reflection and dialogue, which should empower students to take action to challenge social injustices (Tasler & Dale, 2021). This is a particularly relevant approach for Education for Sustainable Development (Giangrande et al., 2019). Situating ESD competencies centrally to curricula can lead to learners questioning their ways of thinking, ways of practicing and ways of being, which is central to a transformative learning experience (QAA & Advance HE, 2021). According to Gramatakos and Lavau (2018), herein lies a potential challenge for HEIs in “supporting transformative sustainability learning, in that institutional, formal modes of teaching may struggle to connect with the “life world” of individual students within a classroom setting” (p.381).

In order to be fully transformative, we wanted to ensure that our curriculum was outward-facing, meaning that it highly connected learning to real-world issues and challenges (Fung, 2017). We relied heavily not only on the team’s academic knowledge but the suggestions of employers and alumni to identify topics of critical concern to the agri-food industry at local, national, and international scale. Rather than being passive learners,

students were given opportunities, both guided and self-directed, to reflect upon important issues that have no defined solutions, and this provided them an opportunity to develop key competencies, enabling them to become autonomous learners. These learner-centred approaches are supported by Leicht et al., (2018) for graduates to be action-orientated change agents.

It was decided that this would be best achieved through active learning, an instructional approach that emphasises student participation and engagement in the learning process, utilising activities that require them to think, discuss, and apply concepts. This approach promotes deeper understanding, retention of knowledge, and the development of critical thinking (Rieckman, 2018) and problem-solving skills (Wiek et al., 2015). Once devised, these activities were categorised using the Open University (OU) Learning Design Activity Types which are Assimilative, Communicative, Finding and Handling Information, Productive, Practice and Assessment (Open University, 2021). We aimed to have a greater number of Productive activities since that is often considered the best way of enhancing learning but given that this is a first-year class, the high level of Assimilative activities were important for building foundational knowledge.

We had several cross-cutting approaches that ran-alongside the various OU Learning Design Activity Types. The first of these was Problem-Based Learning (PBL), which reflect the outward-facing approach in that students work together to gather information, analyse situations, and propose solutions to real-world problems (Cardon et al., 2022). This helps develop many of the ESD competencies, particularly problem-solving (Karan & Brown, 2022). One such PBL session gave students the opportunity to address real-world challenges concerning animal feed, cattle management, fertilizer, and fuel. The session was facilitated by a Sustainability Manager from the dairy industry who brought a unique insight into finding innovative and creative solutions to complex and challenging problems in food science.

Our second cross-cutting approach was place-based learning, an approach that strives to connect learning to the external contexts in which they are actioned, using physical places and local communities as learning resources (Johnson et al., 2022). To integrate place-based learning into Sustainable Food Systems, we undertook a field trip where we followed a food commodity throughout its lifecycle in the food system, beginning first at a dairy farm, then a dairy goods production plant, concluding in a tour of a foodbank and social supermarket. These experiences can provide more “amenable conditions for extending beyond cognitive learning than can be offered by formal education, which has physical, temporal, social and pedagogical constraints” (Gramatakos & Lavau, 2018, p.388).

Our third cross-cutting approach was the use of peer and collaborative learning, in which students are given opportunities to teach to and learn from one another while working together to complete tasks and projects (Davidson & Major, 2014). This not only improves engagement and makes for deeper understanding, retention of knowledge, and the development of critical thinking (Rieckman, 2018) but helps to build collaborative competency (Wiek et al., 2015). Students worked regularly in groups, including both in-class discussion and activities, as well as completing one of their assessments in groups.

Assessment

In addition to our teaching being active and outward-facing, we also wanted to ensure that our assessment was as authentic as possible. Unlike traditional forms of assessment, which often involve essays or exams, authentic assessments are designed to mirror real-world tasks and challenges, with the responses allowing students to demonstrate their knowledge and abilities in a way that can be more motivating and meaningful for them (Villarroela et al., 2017).

There were three pieces of assessment on this module. The first was a report, worth 25% of the module. Students took on the perspective of the Service Development Manager for an organisation called Fareshare, a leading UK food redistribution charity which aims to tackle food waste and alleviate food poverty (FareShare, 2023). Fareshare kindly provided us with real anonymised data from their operations last year, and in the report, students were required to produce three tables or graphs showing insight into the patterns within the data that might affect their operations. This was highly authentic, as it represented a real task that students might have to do as professionals using real-world data, and Fareshare may actually make use of some of the more unique findings. Next year we plan to make it more authentic by asking students to instead produce a PowerBI Dashboard, which is what Fareshare actually use for their management reporting.

The second piece of assessment was a reflective report worth 15%, in which students produced a carbon footprint analysis of their personal eating habits, as well as reflecting on their choices. This was authentic in the sense that authentic assessments have the potential to support learners to “deeply engage with sustainability goals, foster skills crucial for sustainability-related careers and create change in their communities” (Asgarova & Macaskill, 2021, p.29).

The final piece of assessment was a group poster, accompanied by an oral presentation, which accounted for 60% of the final mark. This required students to review the food system for a given commodity, identify its specific sustainability challenges and propose innovative solutions. While many food industry professionals do not create posters as matters of course, problem-solving, especially for sustainability, is a regular occurrence. Producing posters is an academic skill not found elsewhere on the programme, and important for those who wish to go onto further study.

Reflections & Next Steps

There were several lessons learnt from our time in the Bootcamp and subsequent implementation. Collectively as a team, we have thoroughly enjoyed the process of working in a team with such a varied range of disciplines, expertise, and passion to create something truly unique for our students. The collaboration amongst the Bootcamp team has not only changed our own academic practices but has potential to yield far-reaching change at our own institution(s) and beyond.

Successes

During the Bootcamp, Sustainable Food Systems was still in the planning phase. As of January 2023, the first iteration of teaching is complete and will be formally evaluated through the institutional teaching and module evaluation processes by the end of the academic year. Additionally, learners were asked to self-rate their competencies and knowledge of relevant issues at the start and end of the module.

A mid-semester check-in provided an opportunity for learners to give in-session feedback on the module. Place-based learning was found to be extremely engaging by 88% of the students, with 88% finding the guest speakers to be engaging or extremely engaging. Problem solving and critical thinking workshops were noted to be 'very engaging' and 'informative and relevant' by students who also self-rated these skills as having improved by 77% and 53% respectively.

Challenges

Learner engagement in the module was critical for success in this initiative but was also a key challenge. Sustainability is a complex and multifaceted concept that can be difficult for first-year learners to understand, who may view sustainability as an abstract concept with little relevance to their day-to-day lives or even their future employment, much like any concept taught initially (Arthur, 2009). A significant challenge has been conveying content in a simple but also applicable way, as well as demonstrating the personal and professional relevance. Our place-based and community-based learning approach was invaluable for this, with students remarking they were 'very inspiring' and that 'the field trip was an invaluable learning experience as it helped everything from class click into place'. However, 12% of students wanted more traditional lectures and shorter classes, showing that there can be resistance and fatigue with the active learning needed for ESD.

At the meso-level, embedding ESD into the curriculum involves changing established practices and ways of thinking. As expected, resistance to change from fellow staff was experienced during this process, potentially due to sustainability education not being within their area of expertise, or relevance to their work. Further, time and resource constraints made it difficult to allocate and dedicate the necessary time to implement plans.

More broadly, we encountered institutional barriers around timetabling and room layout (Calvert et al., 2022), as well as in procedures such as quality assurance. For example, changes to the assessment profile need to be made nearly two years in advance, so if decided to make assessments more authentic by eliminating reports, that decision would need to be made now.

Next Steps

At module-level, the aim is to develop an instrument for assessing the key competencies in ESD that could be used to measure learner growth. Opportunities will be sought in the second-year curriculum for social learning that would allow learners who have completed this module to return to support their first-year peers, perhaps in the form of a vertically-integrated project or collaborative seminar.

The intention is to invite learners who have completed the module to engage in the next round of co-design for the following year of delivery. We also want to find ways in which learners who are about to embark on the module can engage meaningfully in co-design in a way that does not put pressure on staff time and resources. Institutionally, we are developing an accredited staff development course on ESD.

Conclusions

Participation in the Bootcamp was a valuable experience and challenged the team's understanding of and approach to ESD. Our recommendation is to approach this process with an open, growth-orientated mindset and be prepared to work consistently and outside your comfort zone. Scaling up this activity requires a commitment from

leadership that ESD will be part of institutional policies strategies, while staff need more than just time and resources in order to buy-in, particularly opportunities to build knowledge through recognised professional development opportunities and support from communities of practice at various scales. This is further emphasised by Strachan et al. (2022, pp. 3-4) who highlight that, instead of offering individual degree programmes or specialist courses on sustainable development and climate change:

> ESD should be ubiquitous and woven into the fabric of our formal, informal, and subliminal curriculum (existing and new), our teaching practices, course approval, quality assurance and review processes and our institutional governance structures to create the enabling environment that can empower teaching staff, with suitable CPD training and support, to actively engage with ESD.

The Bootcamp has shown us that embedding ESD will always be an ongoing process, and one that should be central to all institutional processes, it can also be simultaneously challenging and fun, yet ultimately necessary if we are to pave the way for a more sustainable and equitable future for generations to come.

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