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Can a Picture Paint a Thousand Words? Visualising Variety in Challenge-Based Learning

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Abstract

Challenge-Based Learning (CBL) is an educational approach that involves students engaging with peers, academics, and external stakeholders to collaboratively investigate and develop solutions to real-world challenges of urgency and significance. One of the strengths of CBL is that it is a flexible framework that can be adapted to suit the educational discipline and local context. As CBL becomes applied in more disciplines, there are opportunities to learn from those implementing it which can stimulate new ways of approaching certain aspects. Staff members developing and disseminating guidance to support CBL at one Irish university therefore initiated a project to co-develop a set of visually-oriented examples of different varieties of CBL in practice that could be shared with those new to the concept. In particular, the project aimed to highlight different scenarios of external stakeholder involvement within CBL projects. This case study describes the history and thinking behind the initiative and shares the six visuals representing CBL implementation in various contexts that emerged.

Key words: Challenge-Based Learning, Challenge Based Learning, Challenge-Based Education, CBL, Variety, Stakeholder

Introduction

Challenge-Based learning (CBL) has been described as a pedagogical approach that "actively engages students in a situation that is real, relevant and related to their environment, which

involves defining a challenge and implementing a solution" (Tecnológico de Monterrey, 2015, p. 2). It is increasingly gaining traction in higher education for its potential to support the development of the knowledge, skills and competencies needed to prepare students for today's complex world (Galdames-Calderón et al., 2024; Perna et al., 2023). Through working on open-ended, real-life challenges, CBL can stimulate students to take an active lead in their own learning, acquire and apply the knowledge necessary to respond to the challenge, and develop disciplinary and transversal skills throughout the process (Helker et al., 2025).

One commonly cited benefit of CBL is its potential flexibility and adaptability to different contexts. Once perceived as a predominantly STEM-oriented pedagogy (Sukackė et al., 2022), it is increasingly being viewed as an approach that can be used in a range of disciplines and can be adapted to the local context. CBL is being applied in teacher education (Yáñez De Aldecoa & Gómez-Trigueros, 2022), business entrepreneurship (Pérez-Sánchez et al., 2023), communications (Cruger, 2018), and nursing (Tang & Chow, 2020), to name just some examples. Variations are happening across CBL implementations, with adaptations dependent upon a range of factors such as the level of external stakeholder involvement, the extent to which multi- or inter-disciplinarity occurs, and the emphasis on the nature and purpose of assessment. Hybrid (online/in-person) forms of CBL and integration with other pedagogies and concepts are also evident (Gallagher & Savage, 2022).

Recent literature recognises this variety in CBL implementations and there are frameworks – such as the CBL Compass (van den Beemt et al., 2022) – that support a degree of flexibility about the characteristics of CBL. This recognition of implementation diversity likely reflects what is happening on the ground in various institutions and it provides potential practitioners

with an entry point to potentially start small with educational change. However, potentially numerous forms and variations of CBL can contribute to a 'definitional muddying' issue that makes it hard to research and understand what exactly CBL is (Gallagher and Savage 2020, p.11) especially for those who are new to the concept. Therefore it is importance that guidance is clear and accessible, while also offering examples of good practice that can potentially inspire others.

The following section will describe how staff collaborated to co-develop a range of visuals representing implementations of CBL that they have been leading within the Dublin City University (DCU) context. It will provide some brief history of CBL and its driving influences at the university and then explain how the visuals project emerged through the DCU CBL working group.

The DCU context

Challenge-Based Learning has been applied at DCU for several years but its adoption has accelerated significantly since 2019 through two key strategic projects: European Consortium of Innovative Universities (ECIU) and DCU Futures. The ECIU is an international consortium of 13 research-intensive universities, a network united by a common profile of shared beliefs, interests, and mutual trust (ECIU, n.d). DCU has been involved with ECIU since 2011 as part of a network of universities focused on innovation, entrepreneurship, and societal impact. ECIU has expanded its activities and remit in recent years, leading to the creation of the ECIU University, a more recent EU-funded Erasmus+ initiative (ECIU, 2022). Within this context, a challenge typically starts with a "Big Idea" in the area of the UN Sustainable Development Goal 11 "Sustainable cities and communities" with potential for societal impact (Stahlberg et al., 2022). At present, students from an ECIU University can participate in a challenge offered by any other member institution. The ambition of the ECIU

University is to enable learners, teachers, and researchers cooperate with cities and regions, businesses, and citizens to solve real-life challenges uniquely and flexibly founded in challenge-based education (Mayer et al., 2022).

In 2020, DCU was awarded approx €20 million as part of the Irish government's Human Capital Initiative (DCU, 2020). The 'DCU Futures' initiative aims to transform the educational experience of undergraduate students by reconceptualising the learning experience, developing authentic connections between the classroom and enterprise, and embedding digital literacies, disciplinary competencies and key transversal skills (DCU Futures, n.d). From this project, ten new innovative programs were launched in September 2021, with CBL as a central pillar of educational innovation throughout all programmes.

As part of the DCU Futures project, the university-wide DCU CBL working group was formed. Membership is drawn from each of the DCU faculties and the student union executive. The purpose of this working group is to champion and support adoption of the CBL pedagogy by developing a range of implementation guides and resources, informing strategic policy, and engaging with the scholarly literature on the pedagogical underpinnings of CBL. Together, these resources and activities are intended to support DCU programme teams to implement CBL within programmes across the university.

Developing and disseminating guidance about CBL is therefore core to the remit of the DCU CBL working group. At one of the bi-monthly meetings, during discussions about various ways in which CBL can potentially be implemented, the basis of an idea to develop a set of visuals representing different varieties from different disciplines emerged. The thinking was that rather than presenting time-poor colleagues with a lengthy text-based description of different varieties, it might be useful to share these ideas in a more visually-oriented at-a-glance format. In October 2024, therefore, the following invitation was issued:

> CBL Working group members are invited to consider developing a visual resource based on their own practice of CBL to help illustrate the various range of 'flavours' or adaptations of CBL in existence and provide a mix of insights on the different ways of involving stakeholders. (CBL Working Group Minutes)

Over the following months, various slides and drawings were received from contributors from the disciplines of public policy, business, teacher education, and staff development. Five staff members and one student contributed. The draft visuals were initially developed in various forms, specifically PowerPoint slides and hand-drawn portrayals of the process. These visuals were shared and discussed within the group in February 2025, following which one of the members with expertise in user interaction design and data visualisation offered to develop these visuals further. For each of the initial staff-provided drawings, a series of sketchings from pen-and-paper to PowerPoint to Photoshop was iteratively created while communicating with the staff who ran the modules for clarification and to insert further information where useful for visualisation. On the graphics, the stakeholders involved (student teams, external partners/client, etc.) interim outcomes, and deliverables were turned into icons, and the transactions/connections between them were drawn to collectively represent the process. Final sketches were then presented to the staff for further refinements and final approval.

The designs that emerged

The following six examples visually illustrate various implementations of CBL at DCU. The disciplinary/sub-disciplinary roots of each example are obviously different in each case, but all are applying CBL and adapting it creatively within their own contexts. All reflect the overarching CBL phases of Engage, Investigate and Act where **Engage i**s the commitment that students take on in facing a challenge, in defining the problem to be solved and in asking the right questions; **Investigate,** is where they find relevant information and analyse it; and **Act,** is where they design, implement and assess the solution (ECIU, 2021)

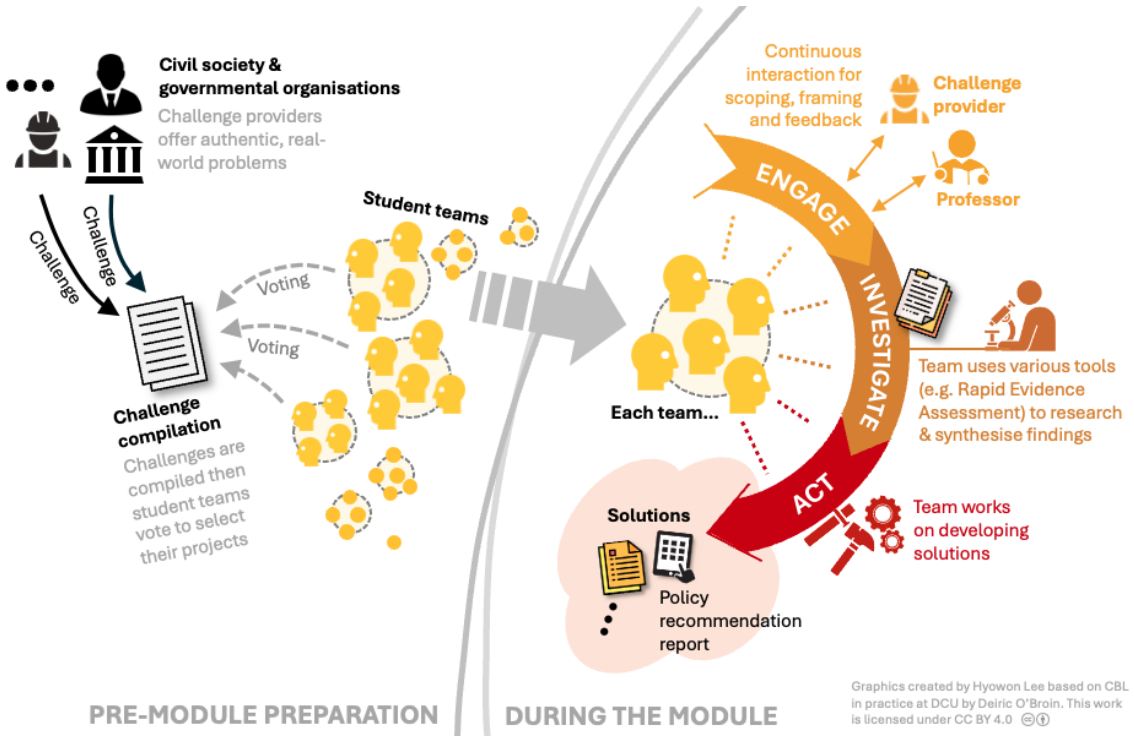
While all of these CBL experiences broadly share common factors, each implementation differs in various ways. Differences relate to how the challenges get sourced, the number of stakeholders/partners, the frequency of interaction between them, what particular angle the challenge gets framed by, and what tools or approaches are employed to develop solutions. One of the most striking differences across the examples is the differences in the level of involvement of the external stakeholder/challenge provider/client/mentor. For example, in the first two (public policy and digital business) the external stakeholder is heavily involved in proposing the societally-relevant challenge, influencing the scope, and contributing to multiple feedback points throughout the process over the semester. In the hackathon example, the external stakeholder plays more of a mentoring role, being involved/available to offer expertise as the process unfolds over the course of one day. In the sustainability and geography education example, the challenges were sourced from a specific biodiversity event and the students gathered data from local authority and NGO sources. In the accounting example, five DCU campus entities/partners/businesses acted as external stakeholders and provided feedback throughout the project. Finally, in the student perspective LIFE module

example, the managing director set a focused challenge to which the students responded with a report and storyboard prototype.

The graphics aim to visually capture both common and unique characteristics of CBL, offering an overview of what CBL modules/projects can look like and in what ways they are taught. Short explanatory text is included to accompany each graphic.

Example 1: Public Policy Challenges

Programme: MSc in Public Policy
Module: Policy Challenges
Module Co-ordinator: Prof. Deiric Ó Broin
School: School of Law & Government
Faculty: Humanities & Social Sciences

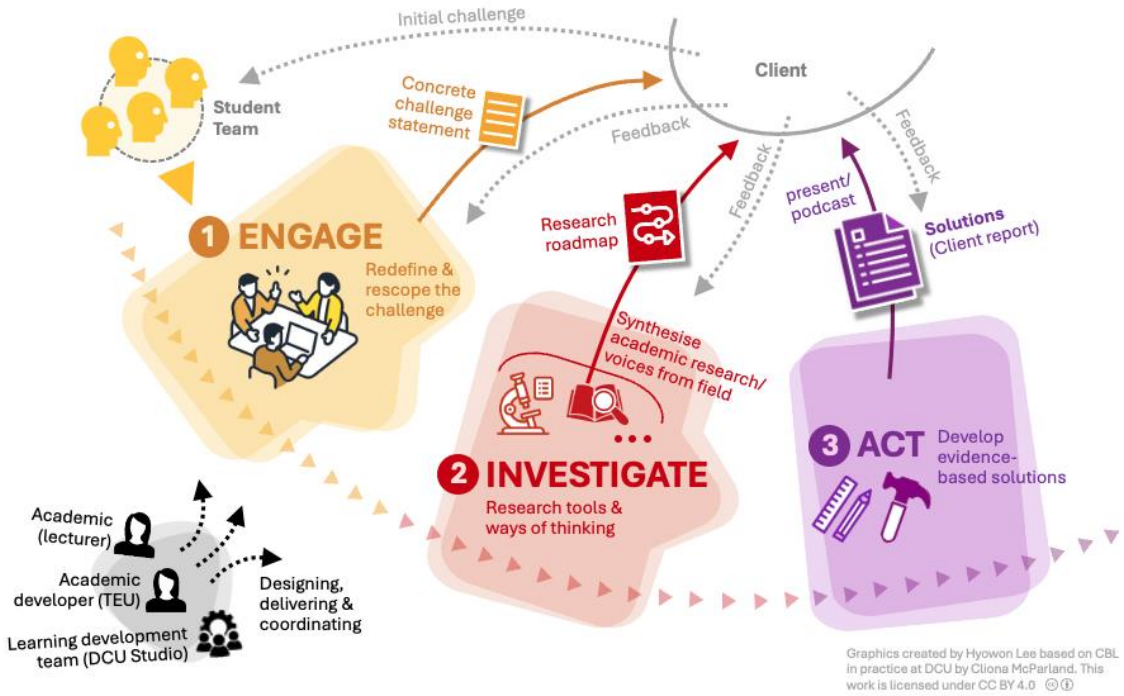


In this module, challenges are proposed by multiple potential challenge-providers who are civil society organisations and public bodies only (not private or professional bodies). Challenges must be 'real-world' authentic challenges addressing significant societal issues

(e.g economic decline of city centre; housing issues; renewable energy). Students select the challenge of most interest to them and work with the challenge-provider for potential source materials and data. Students also work with academics and the challenge-provider to refine the scope of the challenge. They are given a specific research tool (i.e Rapid Evidence Assessment Tool) to investigate the challenge while challenge-providers answer questions and provide feedback throughout. Students ultimately co-develop actionable solutions such as policy recommendations and potentially share solutions in public.

Example 2: The EcoTech Challenge – Pioneering Innovative Technologies for a Sustainable Future

Programme: BSc Digital Business and Innovation
Module: The EcoTech Challenge: Pioneering Innovative Technologies for a Sustainable Future
Module Co-ordinator: Dr. Cliona McParland
School: School of Business
Faculty: DCU Business School

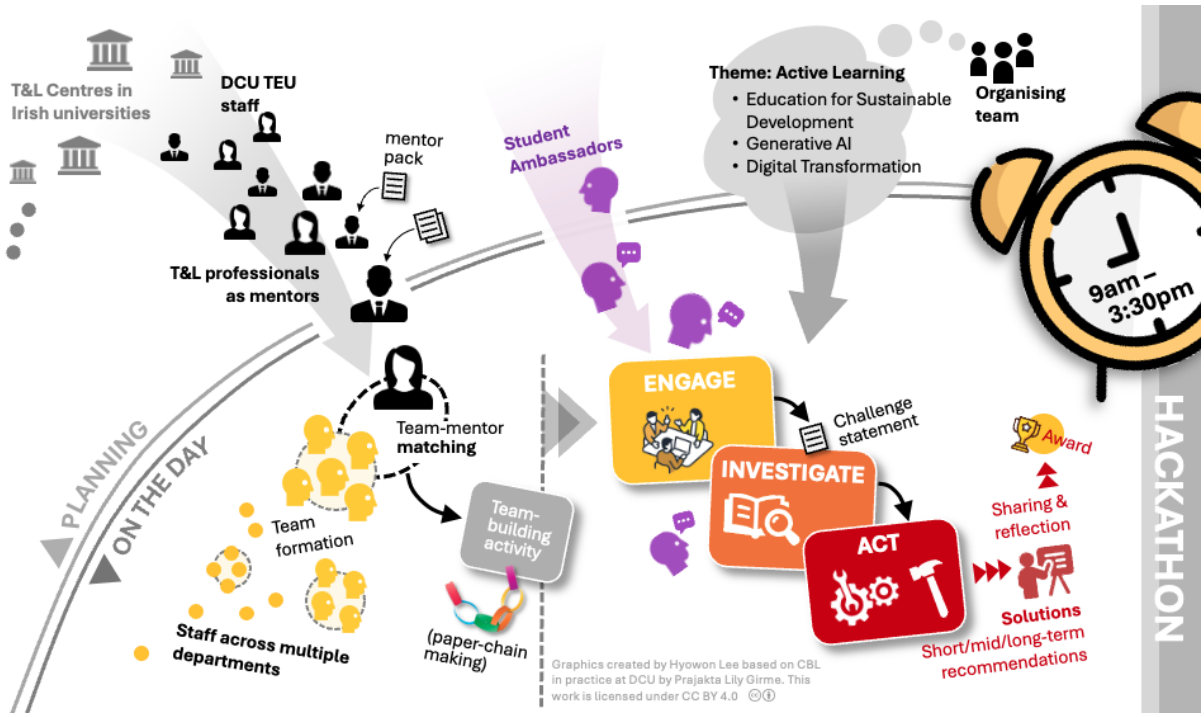


This module had Uisce Éireann, the Irish Water Utilities Company, as the main external stakeholder who provided the initial challenge (‘Foster a culture of diversity and inclusion’)

to student teams and offered valuable feedback throughout. Twenty-eight students from five countries came together through DCU and ECIU to tackle a critical sustainability issue: ensuring that clean, safe water reaches those who need it most, especially when supply is at risk. Students were tasked with: (1) identifying barriers that might be preventing eligible households from accessing additional supports; (2) exploring strategies to increase awareness and demand for these services; and (3) recommending additional services to provide better support for these individuals through a more diverse and inclusive lens. Formative feedback from multiple sources helped to steer each team's progress. Student recommendations were included in a proposal to the national regulator, influencing potential changes across other essential utilities serving the public.

Example 3: Professional Learning Event - Hackathon on Active Learning

Professional Learning Event: Hackathon on Active Learning
Facilitators: Ms. Prajakta Lily Girme & Ms. Clare Gormley
Unit: DCU Teaching Enhancement Unit (TEU)



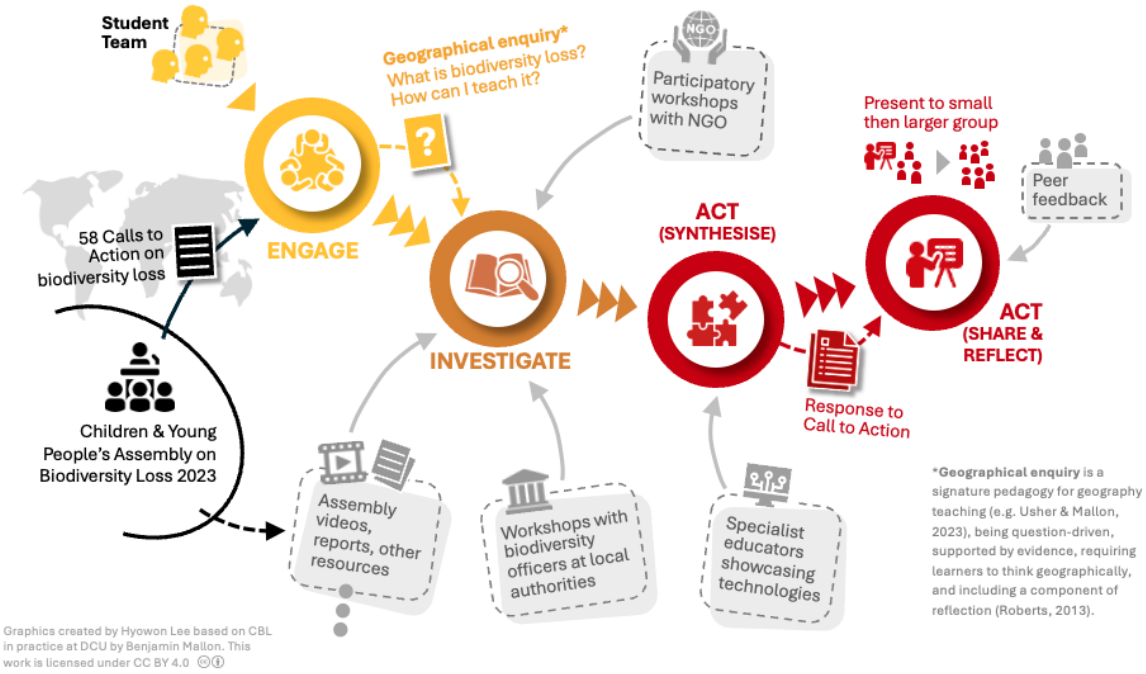
This was a hackathon-based professional learning event that was organised and run in CBL mode. Through the format of a hackathon – an intense, time-bound event where people

collaborate in teams to solve challenges – approximately 40 participants worked in small groups to investigate and co-develop potential solutions to issues of passive, predictable teaching. Throughout this one-day activity, staff, students, and mentors came together to tackle the overarching challenge of 'Activating Active Learning' while simultaneously experiencing CBL in action. The key aspects were: (1) participants were staff from diverse departments and faculties in DCU; (2) pedagogical and technological experts from the TEU and Teaching & Learning Centres in other Irish universities served as mentors/external stakeholders; (3) challenges related to active learning and the sub themes of Education for Sustainable Development, Generative AI, and digital transformation. Prizes were given to promote participation and reflection, and the hackathon ended with short presentations of proposed recommendations from each of the six participating teams.

Example 4: Sustainability & Geography Education

Programme: Bachelor of Education (Primary Teaching)
Module: Sustainability & Geography Education
Module Co-ordinator: Dr. Benjamin Mallon
School: School of STEM Education, Innovation & Global Studies
Faculty: DCU Institute of Education

The Irish Children and Young People's Assembly on Biodiversity Loss has proposed a series of 'Calls to Action' to address biodiversity loss. The challenge for undergraduate teacher education students in this module is to develop an educational response to these calls. During the Engage phase, students co-develop enquiry questions concerning content knowledge (what do I need to know about biodiversity and biodiversity loss?) and pedagogical knowledge (how can I teach about biodiversity loss?) relevant to the challenge. During the Investigate phase, students undertake a comprehensive process of locating and gathering data from different sources e.g. Biodiversity officers from local authorities and representatives from non-governmental organisations.

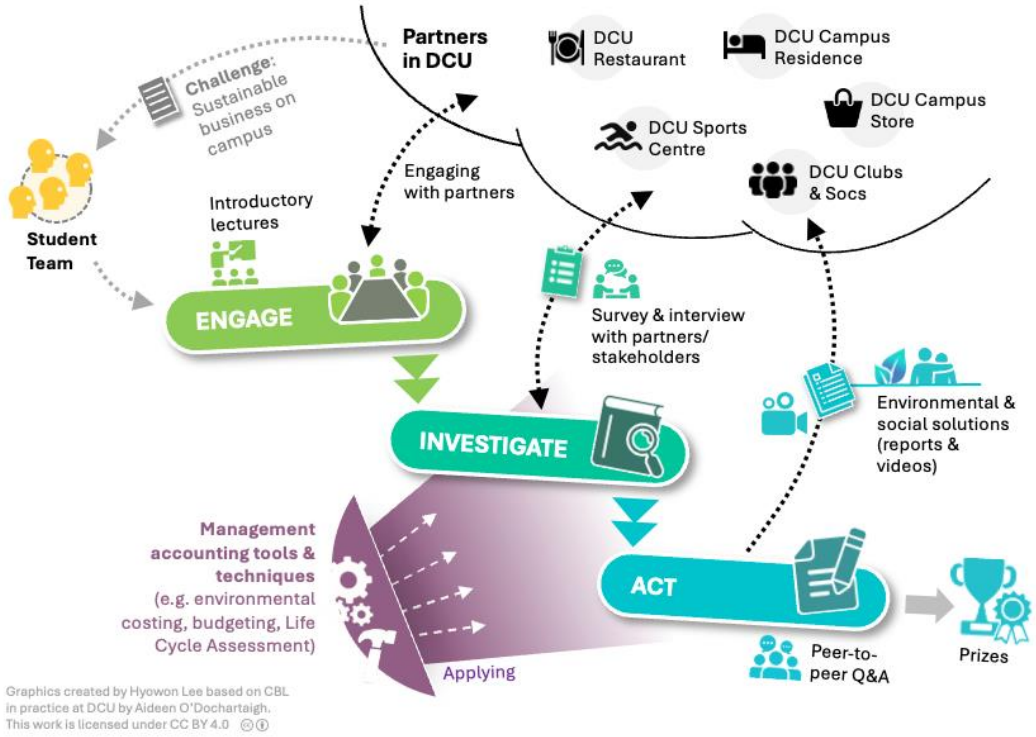


During the Act phase, students make sense of the information gathered and design their own response to some element(s) of the 'Calls to Action'. Each group presents their response, first to smaller peer groups, then to a larger audience. Students critically reflect on the process of their learning, the geographical enquiry, and wider challenge-based learning.

Example 5: Accounting for Sustainable Business

Programme: BA Accounting & Finance
Module: Accounting for Sustainable Business
Module Co -ordinator: Dr. Aideen O'Dochartaigh
School: School of Business
Faculty: DCU Business School

This CBL group project for Year 2 undergraduate students had an overall scenario in which student teams were hired as consultants to support a DCU campus business to become more sustainable. The challenge therefore has a management accounting focus for sustainable business. The management team asked students to identify three strategic sustainability priorities and to prepare a report on how these issues can be integrated into the organisation's planning, control and decision-making systems. Students were asked to ensure that the three strategic sustainability priorities included at least one social and one environmental issue.



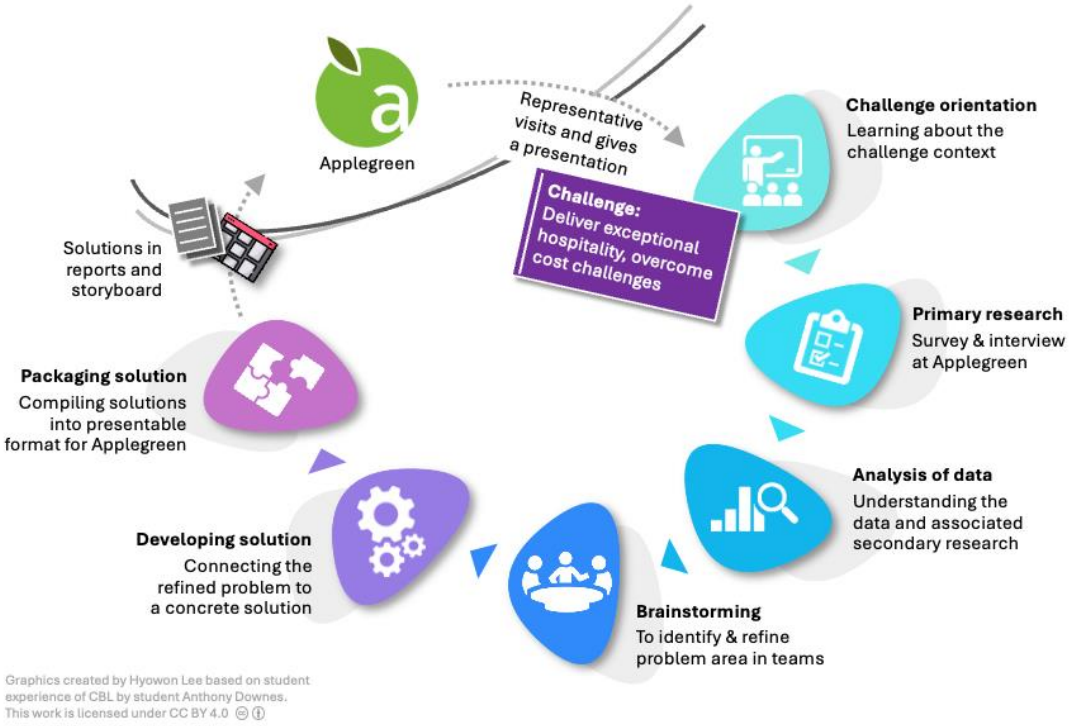
Five DCU entities/partners/businesses acted as external stakeholders and provided real and authentic feedback throughout the project. There were over 100 students involved in each of the three iterations to date. Assessment was done through videos, reports, and peer-to-peer Q&A and is worth 40% of the module overall. There has also been some sponsorship and prizes for top projects.

Example 6: LIFE module

Programme: BSc in Digital Business and Innovation
Module: LIFE module
Module Co-ordinator: Dr Catherine Faherty
School: School of Business
Faculty: DCU Business School
Student: Mr. Anthony Downes

This example shows a first-year student's perspective of a CBL project. The external stakeholder was Applegreen, a major petrol retailer in Ireland, which operates convenience stores and motorway service areas. Their Managing Director visited the classroom to present a focused challenge: develop an innovative product or operational solution that addresses

rising business costs, while maintaining and enhancing the company's commitment to delivering exceptional roadside hospitality.



Student teams went through the CBL stages to understand the challenge, identify/refine a specific problem, followed by developing a solution. They conducted primary research at Applegreen stores, including conducting surveys. The next step was to analyse the gathered data as well as conduct further research into trends and any other necessary secondary information. Eventually, this process led to the team agreeing on an idea that was an effective solution to the problem identified through research. Finally, the team compiled the research, developed the idea, completed a detailed report of the innovation challenge, and paired it with a prototype through the use of a storyboard to illustrate the innovation in a creative way.

Evaluation and Impact

Professional learning around CBL typically includes a range of documents and digital resources introducing the concept, often the first port of call for those interested in learning

how to apply it. The use of visually-oriented graphics represents another possible way to convey and explain actual instances of CBL while also highlighting the range of ways in which it can be implemented in various contexts. Developing visually-oriented resources also supports Universal Design for Learning (UDL) principles, providing alternatives to text-based explanations of the concept to potentially enhance further understanding of CBL in practice. Limitations of the project are that not all faculties engaging with CBL are represented in the examples to date and the visuals have not yet been formally evaluated outside of the working group. However, some initial pilot testing has been carried out by one of the members who has shared the examples with new lecturers and found that it led to more targeted questions about CBL and specific aspects such as external stakeholder involvement. The examples so far have also helped those within the working group get insights into (and ask questions of) each others' work. DCU's Teaching Enhancement Unit (TEU) will be sharing these examples on their website. There are also plans to integrate the visuals into a suite of cards for use as prompts for discussion within CBL staff development workshop activities.

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