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Essay

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Structural Shifts and Sustainable Futures: Transforming Higher Education for the Climate Century

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Abstract

How can we best leverage higher education to address the pressing issues we face? While the SDGs reflect a global landscape dominated by complex, interconnected ‘wicked’ problems, Higher Education Institutions (HEIs) remain largely tethered to siloed, decontextualized instructional models. The inability of HEIs to shift practices to foster transversal, 21st-century skills necessary to navigate uncertain futures is a critical competency gap. This paper highlights the transformative potential of challenge-based learning (CBL) and place-based learning (PBL), high-impact experiential pedagogies, as critical tools for sustainability transformations. The Consortium for Adaptive Futures, an interdisciplinary and transnational community of practice, was launched in early 2025 to promote co-learning among faculty from North America and Europe for these practices. Drawing on insights from an inaugural symposium in Dublin, we identify three critical elements to HEI transformations that support sustainability and 21st-century skills to address grand challenges. These are: the importance of real-world relevance in education; the need for pedagogical shifts and faculty development to support these new roles; and the essential role of supportive institutional structures and resources to enable sustained engagement. In doing so, we issue a call to arms to HEIs and forward a reimagining of undergraduate education.

Keywords: sustainability transformations; higher education institutions (HEIs); challenge-based learning (CBL); place-based learning (PBL); experiential learning; interdisciplinary collaboration; transversal skills



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1. Introduction—Higher Education and Our Adaptive Future

1.1. Grand Challenges and Limitations Within Higher Education Introduction

The grand challenges faced by society today have been termed ‘wicked’—they are complex, difficult to define, interconnected, and, therefore, difficult to make progress on [1–7]. The 2030 Agenda for Sustainable Development reflects the complexity and interconnectedness of societal challenges in the 17 Sustainable Development Goals (SDGs) [8].

Many of these challenges relate to the socio-environmental nexus—the green transition, the food, energy, water nexus, and climate change impacts on ecosystems and communities across the globe; they will not be solved by one discipline or sector alone [9,10]. Despite this, grand challenges have historically been approached without taking into account the interconnectedness of the issues [5]. Addressing these challenges requires interdisciplinary understanding and broadening approaches to innovation [11,12]. Higher Education Institutions (HEIs) have a role and a responsibility in tackling these problems, through both research and ensuring that the curriculum is aligned to provide students with 21st-century skills—namely, the opportunities, skills, dispositions, and knowledge to engage with complex issues and thrive both during and after their time at the HEIs [3,6]. Institutions and their faculty, however, are not often themselves prepared for building relevant skills needed to address wicked problems, such as adaptability, critical thinking, and collaborative capacities [3,4,6]; these deficits existed before the added challenges of thoughtfully integrating relevant AI skill development. In this paper, we highlight challenges and opportunities in higher education fulfilling its pedagogical role, and the convening of an international group of faculty and staff committed to understanding and translating the art and science of implementing challenge-based learning to foster these skills.

1.2. Pedagogies for Adaptive Futures

Experiential learning, often referred to as a learning-by-doing approach with structured reflection, is a high-impact pedagogical practice for building critical thinking and problem-solving, and has proven learning outcomes across a broad range of students and contexts [13,14]. It includes a suite of pedagogies with varied and overlapping definitions, practices, and terms across the disciplines. Common examples include challenge-based, problem-based, project-based, and place-based learning or education [15–23]. Given concerns regarding the potential influence of AI on critical thinking skills [24], these forms of active learning might be viewed as mitigative; combining AI with these pedagogical strategies may actually enhance critical thinking [25]. Depending on the practice, they have also been shown to have dispositional impacts for place attachment [26,27]. Challenge-based learning (CBL) and place-based learning (PBL) represent a subset of these high-impact pedagogical approaches, which are gaining traction within educational institutions seeking to enhance student engagement and foster deeper awareness of sustainability issues in real-world contexts. Built on the robust findings from decades of problem, experiential, and community-based learning, challenge-based learning is a collaborative engagement between students, academics, and external partners to address a real-world challenge, encouraging interdisciplinary connections and authentic cases and assessment. Its strengths lie in heightened engagement and autonomy for learners while addressing complex issues and with the external partners (the challenge-setters) that provide guidance and support; this cultivates a sense of ownership over the learning process and understanding of its relevance [19,28]. In place-based learning, the local environment and community are the primary learning environment, as opposed to the classroom. As with CBL, this approach can foster a sense of belonging and civic responsibility by connecting the curriculum to students' immediate surroundings and tangible experiences [20,27,29,30]. The potential benefits of both CBL and PBL are significant, including increased student motivation, the development of critical thinking, collaboration, and problem-solving skills, the promotion of civic engagement, and a more profound comprehension of subject matter [23,31–34]. Multi- and interdisciplinarity are key features of both CBL and PBL, with students integrating learning from different domains to tackle the challenge set [16,17,35]. These approaches also enable students to come to terms with the ambiguity and muddle of wicked problems [3]. Additionally, due to the collaborative nature of these pedagogies, they promote

the development of key transversal skills, such as teamwork, communication, problem solving, and leadership, which allow students to thrive beyond the classroom [16–18,23]. As traditional, often decontextualized, learning models face increasing scrutiny, these pedagogies offer promising alternatives and an opportunity to not just mitigate the negative impacts of AI on higher education, but also to strengthen its positive impacts.

These pedagogies could transform higher education to address the challenges that we face today in society. However, they require planning within the traditional curriculum, as well as resources and commitment at both the curriculum and institutional levels [23]. Collaboration between institutions that aim to integrate CBL and PBL into the curriculum can be highly beneficial, as practitioners learn from one another, and different institutions have different strengths and structures for supporting these pedagogies.

1.3. Importance of CBL and PBL for Environmental Sustainability

To achieve the UN SDGs, transformation will need to be multidimensional and multiscalar. One of the main purposes of higher education is to form critically reflective individuals and society, who are capable of addressing the challenges faced by humanity, and thus contribute to changing society for the better [32,36]. Engaging students in efforts promoting progress on SDG11 (Sustainable Cities and Communities) or SDG13 (Climate Action) in the heart of our communities underscores the significant role of the local environment and the community in place-based learning, enhancing education [37]. When the local region is a learning environment, PBL can cultivate a deeper understanding of academic concepts, particularly in relation to the complex issues of sustainability, and foster a strong sense of connection to the local context [22,33]. PBL also has the potential to cultivate in students a strong sense of civic responsibility and an openness to diverse perspectives, while contributing significantly to the vitality of local communities [37–39]. Challenge-based learning can strengthen PBL, as the intersection between context and authentic issues creates more meaningful learning experiences; for example, students may tackle a local environmental issue or use global challenges of environmental sustainability to frame a local issue.

Despite the value of CBL and PBL as pedagogical practices, the process of building community collaborations and crafting learning opportunities that appropriately challenge students is complicated [40]. Moreover, the role of the instructor is shifted. While there is guidance in the literature [23,41], most faculty have little opportunity to build these skills formally, either within an institution or externally [18,42]. Given the context-dependent nature of teaching and learning with these pedagogies, faculty must learn how to tailor their approach. Different kinds of faculty support structures, as well as different approaches to challenge scoping and student training, have mixed outcomes in various contexts [18,41]. What works well in one place may need adaptation in another—there is much to learn.

In an attempt to address this, and to promote collaboration, research, and co-learning among faculty, an interdisciplinary, transdisciplinary, and transnational community of practice was launched in early 2025—The Consortium for Adaptive Futures (The Consortium). Communities of practice, professional learning communities, and communities of transformation have the ability to support and sustain transformations within higher education [43]. This community of practice (CoP) draws on academic practitioners from North America and Europe, and from disciplines that span environmental science, engineering, social science, and humanities—all of whom are engaged in place-based and challenge-based learning with a sustainability lens.

2. The Consortium for Adaptive Futures Case

2.1. Roots of the Initiative

The Consortium has its roots in two years of challenge-based learning projects facilitated by Notre Dame Dublin (NDDublin). Beginning with a virtual project in partnership with the Environmental Change Initiative (ECI) at the University of Notre Dame during the COVID-19 pandemic, Notre Dame undergraduate student researchers explored and documented climate adaptation information and arrangements across Ireland. From this, faculty at Dublin City University expressed interest in collaborating on similar types of efforts with their students. NDDublin facilitated an exchange to build interdisciplinary undergraduate student teams at ND Environmental Change Initiative and DCU Futures, made up of two students from each university; these students worked on exploring Nature-Based Solutions (NBSs) in each campus region. This experience provided practitioners and students on both sides of the Atlantic a platform to collaborate on challenges and to share learnings from their practice. The initial collaboration also led to guest lectures from DCU faculty at Notre Dame in a course designed for developing integrative thinking across disciplines—Complex Problem-Solving in the Public Sphere. Given the richness of these experiences, organizers decided to extend an invitation to faculty from other HEIs to be included in the discussion.

2.2. Inaugural Symposium in Dublin, Ireland, and Virtual Continuation

Built on the aforementioned student exchange, an inaugural symposium for the Consortium for Adaptive Futures, CoP, was held in Dublin, Ireland, in February 2025—Building a Community of Practice and Research for Place, Community, and Challenge-Based Learning. Invited faculty were expected to be knowledgeable about CBL/PBL design or implementation. To recruit, one of the faculty organizers leveraged participation from collaborating campuses from an existing NSF Improving Undergraduate STEM Education (IUSE) project focused on disseminating a challenge-based learning model within the U.S. [20,26,29,30]. NDDublin also drew on existing professional relationships with academics who had implemented projects or challenge-based learning within Ireland. The symposium was hosted by NDDublin in association with Dublin City University and included academics from the Dublin region and six other institutions—including four universities in the United States, one in Scotland, and one in Ireland outside of Dublin. The structure of the meeting was a day-long workshop focused on sharing CBL and PBL strategies and capacities for sustainability. Organizers followed this with a day-long site visit to community-engaged projects in the north Dublin area. Three key themes emerged from the discussions: (i) the critical need for real-world relevance, context, and authenticity in learning, particularly for sustainability; (ii) the need for pedagogical shifts and faculty development for those shifts; and (iii) the role of institutional structures and resources to facilitate and enable sustained challenge-based and place-based learning. Next, we highlight some of the key elements discussed during the event.

2.3. Reflections and Co-Learning in the CoP

The symposium began with an overview of the higher education landscape: (1) reimagining undergraduate education and pedagogy; (2) an NSF-IUSE-funded CBL/PBL model at U.S. universities; and (3) CBL/PBL in Ireland and Scotland. Following brief overviews of activities at each institution, faculty reflected on their experiences of these pedagogies—the move away from teacher-centered instruction toward real-world relevance that ensures that the students have authenticity in their learning. Participants collectively recognized that CBL/PBL approaches, like sustainability challenges themselves, require interdisciplinary collaboration among students, which is a critical skill for addressing complex societal issues.

Faculty that curate and facilitate this collaborative environment break down traditional academic silos, such as building a team made up of an engineer, an economist, and an ecologist; this fosters an integrated approach to problem-solving among the students. CBL/PBL also increases communicative competencies and prepares students for the workplace, since students need to find a common language between disciplines and the local community.

While participants acknowledged the efficacy of these pedagogies, they identified the need for supportive structures that would facilitate more reliable and successful implementation, such as faculty and staff positions that are boundary-spanning and better training for faculty for engaged pedagogies. Ongoing community and enterprise partnerships are key to the sustained success of CBL and PBL, and participants identified the need for institutions to allocate adequate funding and other resources to support community partnership development and maintenance. They also identified the need to increase faculty skillsets and confidence for the different aspects of CBL/PBL project development. Faculty must learn to design fuzzy challenges that can effectively foster student autonomy, as well as act as facilitators of student learning rather than simply transmitters of knowledge. Scoping a real-world project for undergraduates that provides a challenge in the zone of proximal development [44] and can be accomplished in a semester (or a summer) is complicated. Although the solution may not be known at the time of problem formulation, faculty need experience and careful consideration in problem scoping to ensure that completion is possible by the students in the allocated time. Training also includes building the capacity of faculty to be at ease with a degree of project ambiguity as students begin to take ownership of their learning [44].

In discussing the various efforts across institutions, there was a wide variety of both CBL/PBL pedagogical integration and institutional supports for engagement. Some universities, such as Dublin City University and other universities within the European Consortium of Innovative Universities (ECIU), have implemented CBL systematically within the curriculum of particular degree programs or offer CBL opportunities to all students. The DCU initiative is facilitated by learning designers, partially funded through the Human Capital Initiative project DCU Futures and through a local CoP—the Challenge-based Learning Working Group. In some cases, universities create institutional structures to support university-community engagement. The University of Louisville in Louisville, KY, USA, for example, has invested in engagement structures through an Office of Community Engagement, which serves as a central support to connect faculty with the community and advance the needs of both the university and the community. The University of Edinburgh, through its Edinburgh Futures Institute, centers learning on challenges developed by a wide range of local civil and social partners, while the University of Galway adopts a ‘Learn-Live-Lead’ approach, which aims to scale sustainability success both within and beyond the campus through initiatives like its Green Labs. Similarly, Clemson University has identified CBL/PBL as a critical component of its Quality Enhancement Plan to achieve priorities in its ten-year strategic plan. Alternatively, some institutions, such as Youngstown State University, work with external nonprofits that serve as an intermediary for scoping and managing CBL/PBL; despite lower institutional investment in experiential learning, YSU can offer community-based opportunities through its partnership with the Economic Action Group and its programming, such as Civic Innovation Transforming Youngstown (CITY) [20]. The benefits of local student engagement are well-documented [26,27,33,45,46], but students can also gain a lot from international engagement with both other students and their communities. To that end, the University of Notre Dame established ‘international gateways’, which have served as vehicles for place-based learning for real-world challenges. As mentioned, it was a relationship between one of these centers and some academics that kick-started the initiative described in this paper.

2.4. Next Steps

The initial in-person gathering of the Consortium for Adaptive Futures catalyzed momentum for building a broader community for challenge-based research and learning, with a focus on engagement of faculty, staff, and community partners. Participants in the CoP agreed to continue to meet monthly or bi-monthly through video conferencing. At each of these meetings, one participant shares developments or insights about the institutional infrastructure for these pedagogies, followed by a group discussion. The routine meetings have increased collegiality among participants and have encouraged collaboration across institutions. While still in a nascent stage of development, the group recognizes that the founding membership does not represent a broader global voice. The reliance on Western-exclusive perspectives is limiting, and the Consortium members are committed to expanding the international network with representative participation across all continents in the immediate future. Interested faculty can contact the corresponding author.

3. Discussion: Implications for Impact

3.1. Changes in Higher Education

Globally, higher education is at a juncture, as are issues with climate change and sustainability, which present an opportunity. Higher education has been grappling with rethinking its pedagogical approaches to meet the educational needs of current and future challenges [4,36]. Much progress has been made, but often in isolated efforts within departments or institutions. Despite a plethora of evidence regarding ‘what works’ for building skills and dispositions within different disciplines to this purpose [26,47,48], higher education has struggled with investing and integrating these as normative practices. Similarly, transformations toward sustainability have been slow.

Implementation of pedagogical approaches, such as challenge-based learning, requires investment in both faculty and staff. Faculty need training and support to build competence for developing inter and transdisciplinary teams and scoping real-world problems for student skill-building (course-based or co-curricular); they also need new strategies for assessment that embody the complexity of the accompanying learning outcomes. Institutions need to invest in permanent staff or extension faculty that will serve as boundary-spanners and engagement specialists that hold process knowledge [7]; this is critical for the stable relationships needed to both frame authentic real-world sustainability challenges and for the translation of higher education efforts to real impact. In short, transformational change in the higher education sector is needed for transformative education, and transformative education is needed for transformations to sustainability.

3.2. Developing Interdisciplinarity and Transdisciplinarity

Aside from pedagogical practices, there is a distinct need for higher education and public policy and management institutions to understand the potential roles of different disciplines in addressing complex socio-environmental challenges. Whether challenge-based research or pedagogy, identifying problem boundaries for challenges in the broader theme of transformation to sustainability requires an interdisciplinary lens to account for interconnectedness in socio-environmental issues. Recent research indicates that social scientists play key emergent roles—knowledge integrator, broker, facilitator [49,50] within the interdisciplinary or transdisciplinary research team. Furthermore, the arts, humanities, and social sciences are critical to helping us understand context and culture, which can ‘connect with and critically imagine different ecological futures by enabling us to navigate and narrate solutions for the kind of (place) we wish to build in the next 100 years and beyond’ (p. 193, [51]). Globally, there has been an emphasis on STEM and STEM-related fields for translational research (e.g., medical sciences); yet there is an increasing understanding that

transdisciplinary translation of research is more impactful for many issues—such as sustainability. Through many non-STEM disciplines, we build understanding for less tangible yet critical factors (e.g., culture, values, etc.) that not only help us to more fully understand the barriers but also move sustainability and climate goals toward action. With increasing attention toward the interrelated topics of transdisciplinary research and challenge-based pedagogies for skill-building with students, the need to better understand the vital role of non-STEM disciplines in framing and addressing challenges is crucial, particularly for collective challenges like climate and sustainability transitions.

3.3. Co-Benefits: Impact on Communities and Student Development

Strengthening the capabilities of higher education to support faculty and student engagement in challenge-based research and learning will undoubtedly lead to greater impact in the communities with which these institutions partner. There is a substantial body of research [39,52] demonstrating the importance of long-term structural investment of higher education anchor institutions for community impact. With complex or ‘wicked’ problems, these structural investments are particularly important; they allow the relational support through the higher education shifts and transitions to help to address a challenge and the long-term commitment needed to see change. Although individual institutional missions guide the different levels of commitment to research and pedagogies that have real-world impact as a central aim, Ireland’s higher education system is incentivized by a government agenda aimed at impact through the Impact 2030: Ireland’s Research and Innovation Strategy and through the National Strategy for Higher Education.

With climate strategies, we now commonly consider the potential for co-benefits when investing in mitigation or adaptation. Similarly, higher education structures that support the community impact of research could also support pedagogies that tend to have greater outcomes for student development [13,53] than traditional teaching and learning approaches—which can be viewed as co-benefits. This alignment stems from the fact that challenge-based learning allows students to work with authentic, open-system, complex, and interconnected community issues, thus developing skills and dispositions—critical thinking, problem-solving, and adaptability—that are crucial to navigating uncertain futures. As mentioned, the purpose-driven projects and research that are inherent to challenge-based learning tend to be more engaging than traditional pedagogical methods. Understanding the potential for co-benefits both in outcomes from student-based work and to the students changes the value proposition of investment by partners external to the institution in structures and training to support challenge-based learning. This makes the case that investment in such structures can create public value.

4. Conclusions

Returning to the proposition that challenges with higher education and climate change/sustainability present an opportunity for a transformative shift in both spaces, the formation of the Consortium for Adaptive Futures can be viewed as a recognition of the need to leverage these two challenges to catalyze a way forward. With the Consortium, faculty gathered to build a supportive co-learning community regarding the structures, training, and skills that institutions and their faculty need to support that transformation. But even if faculty established a number of these communities of practice, it is a necessary but insufficient commitment to take advantage of this moment and move toward genuine transformation. Institutions must make structural changes and investments in community-based faculty and staff that act as boundary-spanners—this would support not only challenge-based learning, but also transdisciplinary research with community impact. The examples of institutional efforts identified during the inaugural symposium show

promise for reimagining undergraduate education for the 21st century to better support sustainability transformation and the future of work. Such initiatives, together with faculty support such as the Consortium for praxis, offer us a mechanism to develop faculty and structures to support creating the opportunities, skills, dispositions, and knowledge that students will need to engage and be adaptive in an uncertain future.

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Abbreviations

The following abbreviations are used in this manuscript:

HEI	Higher Education Institutions
CBL	Challenge-Based Learning
PBL	Place-Based Learning
SDG	Sustainable Development Goal
CoP	Community of Practice
NbS	Nature-Based Solution
DCU	Dublin City University
ECIU	European Consortium of Innovative Universities
ND-GAIN	Notre Dame Global Adaptation Initiative
ECI	Environmental Change Initiative

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