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Intersecting futures studies and challenge-based learning: Elements of queering in futures education☆

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ABSTRACT

This article investigates the intersection of futures studies and Challenge-Based Learning (CBL) as a possible tool to embrace the current "weirding times" to broaden participation in driving technological change and expand future imaginaries. Through a case study on an activity about microalgal technologies for the circular economy, we illustrate how intersecting futures studies with CBL may create educational spaces that promote the deconstruction of preconceived notions and power balances in education — a *lato sensu* form of "queering" of educational spaces. By reflecting on the results of two editions of the pilot challenge activity, we showcase how integrating futures methods in a CBL setting may aid students in devising innovative solutions aligned with sustainability goals. This study also raises the question of what futures methods are best suited to promote futures skills in non-specialist students, and what other pedagogical models futures pedagogy may synergise with. Ultimately, we propose that the synergy between futures and CBL may not only enrich pedagogical practices in higher education, but can also promote inclusion and broaden participation, aiding in envisioning more just and sustainable futures beyond the academic field.

1. Introduction

The world we live in today – which has variously been described as post-normal (Funtowicz & Ravetz, 2020) or simply "weird" (Dator, 2022) – is characterised by rapid technological change and sweeping global challenges. Addressing the post-normal and weird nature of our times, however, can be aided by a rethinking of one of the fundamental drivers of social reproduction, namely education. Futures studies offer a critical opportunity to reimagine education, through which learners can embrace our present and future. The parallel explorations on queering, also, started from questioning the premises of gender, and eventually challenged the validity of binarisms and normativity more broadly, offering the opportunity to ensure that our shared environment becomes more welcoming for a plurality of human and more-than-human identities. To aid in this process of pluralisation, when addressing education, we propose to start from the modes of teaching and learning, along with their preconceived equilibria and power dynamics.

Through this article, we wish to contribute to the literature exploring how elements of futures education can be integrated in higher education programmes — especially when the learners participating in those programmes have had no previous exposure to the field of futures studies. In this article, we caution against the temptation of making futures studies the "leading character" in such an effort, favouring instead the creation of an educational context that is holistically designed to support the building of key

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Table 1
Areas of intervention for our pedagogical design and associated normative assumptions.

	Pedagogical decision	*Normative assumption*
1	What content is taught	Content in an individual discipline
2	Who is the teacher	The expert in that discipline
3	Who are the students	A uniform group of non-experts in that same discipline
4	What other (human) actors participate in the learning space	None, or at most some reflection on technologies as participants in the learning context
5	How content is delivered	Through a formal lecture
6	Places of learning	The physical classroom, or at most an online learning environment
7	Purpose of the educational context	To facilitate learning of factual content)
8	Prioritisation of content	Decided a priori
9	Evaluation strategies	Rigorous, oriented to ordering students in a ranking

concepts of futures thinking (typically discussed in terms of "futures literacy" Gidley, 2016; Miller, 2018; Poli, 2021). If the goal of futures education is to prepare students for the complexities of the contemporary world and of worlds to come (Facer, 2011; Gidley, 2017; Lombardo, 2010; Sterling, 2001), teaching and learning contexts need to be designed from the ground up to support this mission. Our contribution takes the form of the exploration of the intersection between futures studies and Challenge-Based Learning (CBL), seeking to create an educational space where futures thinking can emerge as part of a collaborative, critical, and context-aware educational experience.

Contemporary higher education continues to rely extensively on lecture-based pedagogical models (Calidoni, 2016). In proposing our alternative to this dynamics, we argue we need to challenge several preconceived notions about education. We propose here a summary of key pedagogical decisions, along with the respective normative assumptions that are made in those areas, in Table 1. Questioning normative assumptions in pedagogy implies a significant redesign effort on the side of the teachers, and is bound to disrupt the learning flow students have grown to expect. We claim this is bound to provoke, if nothing else, confusion and discomfort. To be able to address competently all of these points, then, teachers need to be well-equipped not only with disciplinary knowledge, but also with the transversal competences that allow them to fulfil their duties of teaching while properly supporting the students' learning and overall growth.

The largest part of this paper focuses on instantiating these reflections in a case study of an educational programme that we have conducted at our university. By reflexively looking back on our own attempts to practice these changes, we wish to highlight points of friction and opportunities that these changes may bring. Our intervention, in other words, wishes to contribute to the knowledge base of Futures Studies by intersecting two calls for action in the current discourse of the Futures community. First, by challenging the normative assumptions of pedagogical design outlined in Table 1, we respond to Fleener & Coble's call of "delegitimizing and disrupting hegemonic and categorical thinking"; second, by intervening simultaneously and holistically at many different levels in the pedagogical process, we aim to create a "weird" educational space that, by leveraging the subject-matter of microalgae (organisms which are bioengineered in service of other human endeavours), encourages students to engage with the complexities of contemporary times.

The paper continues with a theory section, Section 2, relating our work to previous literature in two main fields: that of queer futures, and that of our chosen pedagogical approach, namely CBL. Later, in Section 3, we outline the general pedagogical design of our intervention, which we later instantiate in Section 4. Sections 4.1 and 4.2 detail the setting of two pilot experiences conducted in the Springs of 2024 and 2025, where we first tested our model. While we provide some preliminary reflections on the shortcomings and successes of each of the two pilots in their respective sections, we dedicate Section 5 to broader discussions of the overall concept, and Section 6 to future work and conclusions.

2. Theory

As mentioned in the Introduction, our paper bases its theoretical underpinning on the intersection of two fields: that of queer futures, that gives the broader epistemic positioning of our intervention, and that of CBL, that provides the practical methods for the creation of the educational context.

2.1. Queer futures

In a global context that has, among others, been described as post-normal (Sardar & Sweeney, 2016) and increasingly weirding (Sweeney, 2019), there is one process that is unquestionable: the disruption of binary, normative categories. Of particular interest for this paper is the process of embracing the opportunities that emerge from "opening up" binary or reductivist categories

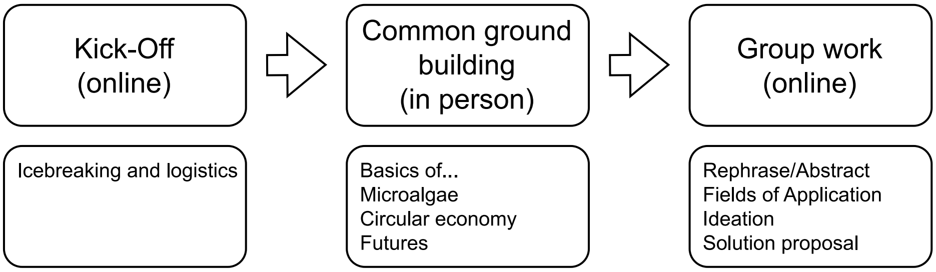

Fig. 1. The overall process of the two editions of the "Back to the Future" challenge.

into spectra and gradients, a common feature in processes of "queering" (Britzman, 1998; Halberstam, 2003; Luhmann, 1998; Manning, 2018).

Within the domain of futures studies, queering has entered the debate by defining a substream of literature relative to Queer Futures (Fleener, 2024). By drawing from the understanding of "queerness" developed in gender studies (Bisht, 2020), Queer Futures aim to broaden participation in futuring activities, as well as question which futures may be thought of, and by whom those futures may be populated. In education, Fleener and Coble (Fleener & Coble, 2022) further argued that reframing and expanding narratives of the present and past can be instrumental to make sense of the present, and put more inclusive and equitable futures into focus (Bryson & de Castell, 1993; Morris & Pinar, 1998).

In this study, we apply *lato sensu methods of* "queering" (i.e., deconstructing normativity and disrupting close binary categories, as further detailed in Section 3) to an educational context that prominently includes futures.

2.2. Challenge-based Learning

Challenge-Based Learning (CBL) is an educational approach for so-called active learning. CBL is one of the latest entrants (Dikilitaş et al., 2025; Leijon et al., 2022) in a broad category of *X*-Based Learning that include Problem-Based Learning, Team-Based Learning, Project-Based Learning, and several more (Freeman et al., 2014; Oriade, 2016; Prince, 2004; Sukackė et al., 2022).

In the original paper outlining the teaching methodology, CBL is defined as "an engaging multidisciplinary approach to teaching and learning that encourages students to leverage the technology they use daily to solve real-world problems. CBL is collaborative and hands-on, asking students to work with peers, teachers, and experts in their communities and worldwide to ask good questions, develop deeper subject area knowledge, accept and solve challenges, take action, and share their experience" (Nichols & Cator, 2008). Despite – or due to – its increasing applications recently summarised in literature reviews (Perna et al., 2023), attempts to provide an up-to-date unified definition of CBL have not yet yielded to consensus (Kohn Rådberg et al., 2020).

CBL ultimately distinguishes itself from other active learning methods through the simultaneous presence of three elements: (i) students working in teams; (ii) a flexible balance between structured and free-form educational activities (see, e.g., Bombaerts et al., 2022); and most crucially (iii) a "Challenge Provider" (CP) *external from the teaching team* that provides an open-ended task – the challenge – that students need to address. The combination of these elements makes CBL a teaching method that lends itself to broadening participation and directly empowering learners. In CBL, learners actively deal with real-world socio-technical problems (albeit in a protected context such as a university) creating an opportunity to design learning contexts based on individual and disciplinary diversity.

3. Pedagogical design and methods

The design of the pedagogical contexts presented in this paper emerged from the attempt to bring together Futures Studies and CBL. Within this combined framework, we applied the ideas of "queering" discussed in Section 2.1 to the nine areas of intervention outlined in the Introduction.

In education, much like in other areas of human activity, normative and dominant views are often tacit (Bisht, 2020). Given the nine elements of change we proposed in the introduction as potential spaces of queering (and some of the tacit assumptions present in those spaces), we drew nine areas of pedagogical intervention, which we also summarise in Table 2: (i) teaching natively-multidisciplinary content; (ii) including a variety of academic and non-academic professionals as teachers (i.e., the so-called "Teamchers" (Eldebo et al., 2022)); (iii) involving as diverse as possible a cohort of learners, in categories such as age, background and motivation; (iv) blurring the line between teachers and CPs; (v) mixing formal and informal lectures; (vi) teaching outside of classrooms; (vii) educating for and in ambiguity; (viii) adapting content to the emergent teaching and learning context; (ix) evaluating loosely, and as much as possible without promotion of adversarial dynamics.

We structured the educational programme as an extracurricular CBL activity to be conduced using the system of Erasmus+ Blended Intensive Programmes (BIPs) (Commission, 2025), which are configured as short-term Erasmus exchanges centred around

Table 2
Pedagogical decisions and matching design elements.

	Pedagogical Decision	*Proposed intervention*
1	What content is taught	Natively-multidisciplinary content
2	Who is the teacher	A variety of academic and non-academic professionals
3	Who are the students	A cohort of learners as diverse as possible in categories such as age, background and motivation
4	What other (human) actors participate in the learning space	Challenge Providers, other external experts
5	How content is delivered	Mixing formal and informal teaching
6	Places of learning	Teaching outside of classrooms
7	Purpose of the educational context	To facilitate learning of factual content)
8	Prioritisation of content	Continuously adapting to the teaching and learning context
9	Evaluation strategies	Loosely, avoiding ranking

Blended Learning. Our design ultimately landed on structuring a three-phase learning programme structured in: (i) an online warm-up activity leading to (ii) a one-week in-person intensive programme; followed up by (iii) a phase dedicated to online group work, as summarised in Fig. 1.

As CBL is part of a broader family of "student-centred pedagogies" (Oriade, 2016), the programme was structured to host a relatively small-size cohort of learners, composed of maximum 5–7 teams of 4–5 students each, giving a minimum size of 20 and a maximum size of 35 participants. The core consideration in establishing this principle is the partly-scientifically documented and partly-anecdotal best practice of having groups of learners large enough to trigger the construction of a team mindset (i.e., larger than 3 people) but as small as possible to reduce complexity and mitigate the emergence of team dynamics such as free riding (Johnson & Johnson, 2008; Mao et al., 2016; Oakley et al., 2004; Shlasko, 2005; Thompson et al., 2015).

As the main design principle for team construction, we aimed for maximisation of diversity. We built teams attempting to achieve as much variety in their individual participants as possible, according to all variables we could observe, gathered via a sign-up questionnaire. The parameters we asked in the questionnaire included: previous international experiences, level of studies, subject of studies, country of studies, home country, spoken languages, gender, age, and level of motivation (informally deduced from responses to open questions).

We applied the same principle of diversity to the composition of the core teaching and management team, including four people who have backgrounds in different subjects and hold different positions within the same university (faculty, administrative personnel, laboratory technicians, research fellows). We also applied the same philosophy of maximisation of diversity to invited experts: in addition to using internal resources at our university to teach elements of futures studies, economics, and circular economy, we relied on other universities to teach content on microalgae, a field that our institution does not directly have expertise in. The key guest lecturer for microalgae in the challenge was a professor from the University of Almería, who participated in a practice exchange on Blended Intensive Programmes and CBL by partaking in lessons held at our university's School of Innovation. The same person was also the contact person of another Blended Intensive Programme on microalgae (but not on futures studies) at their own institution, enabling an exchange of practices between the two programmes.

Pedagogically, each of the three phases of the challenge (again, synthesised in Fig. 1) served a distinct function: (i) the online kick-off created a first moment to kickstart the creation of the course's community; (ii) the in-person week facilitated the creation of a common base of knowledge, and made use of the rich contextual cues given by long-lasting physical presence to build social bonding and create the shared experience of navigating ambiguity as a team; and finally (iii) the online group work brought the teams back to familiar grounds in delivering a project that is more typical for this type of extracurricular activities.

In the last online phase, notably, the core teaching team (also known as the challenge's "teamchers", as per (Eldebo et al., 2022)) and the CP took radically different roles. While the teamchers' role was to open new scenarios and facilitate divergent thinking, the CP was instructed to facilitate convergence, aiding students in scoping their work and providing the directions that students should follow to continue the challenge. The CP served this role by choosing between alternative fields of application each team presented, and later between alternative ideas proposed by the students in the appropriate phases of the challenge, negotiating each team's path forward.

4. Case study: the "back to the future" challenges

As a case study of an application of our pedagogical design, we report here the results of our interventions in a challenge called "Back to the Future" carried out in two editions — "Volume 1" and "Volume 2" — in the springs of 2024 and of 2025 respectively.

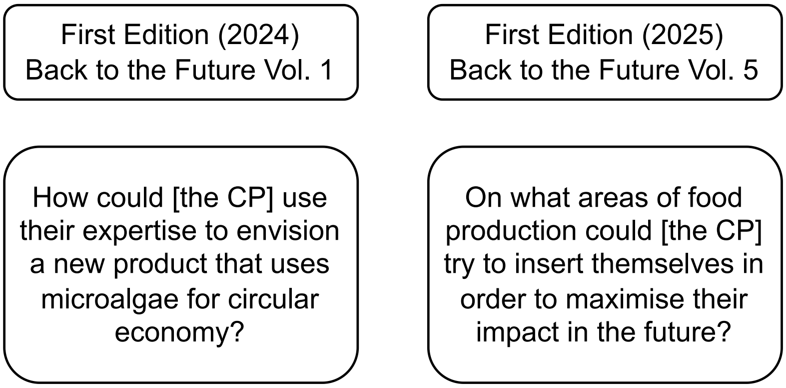

Fig. 2. The challenge questions of the two editions of the Back to the Future challenge.

Both editions of the challenge were constructed as extracurricular learning activities[1] using the design principles detailed in Section 3. In both challenges, the in-person part (five days, from Monday to Friday) was held at our institution's School of Innovation, an academic structure dedicated to offering extracurricular activities on various disciplines and providing the conceptual and practical tools to participate in CBL activities. The challenge was also included among the educational offerings of a European consortium of which our university is a member.

Following the principles of CBL (Gallagher & Savage, 2023), each challenge is based on a real and current problem faced by an actor outside the classroom context, called the Challenge Provider (CP). The two editions of the challenge had two different CPs that were in both cases local startups focused on microalgae-based products targeting the circular economy and sustainability. In both editions, the challenge centred on leveraging innovations in micro-algal technologies to explore their future applications in different sectors (e.g., commerce, industry, agriculture, domestic use). We summarise the key questions underpinning each of the challenges in Fig. 2. In order to address the challenge, the student teams were guided in imagining medium-term futures where these microalgae-based technologies could play a role in their respective sectors, keeping in mind global and local trends in the social, technological, economic, ecological, and political (STEEP) sectors.

The students' task, in other words, was to use their academic competences and imagination to discuss potential futures where the CP leverages their expertise in microalgae-based technologies to put principles of sustainability and circular economy into practice. In both editions, methods from futures studies supported students in seeing emerging technologies – and the business models of the companies transforming them into products – as opportunities and alternative paths, rather than performing a more traditional exercise in market analysis or forecasting.

4.1. First edition

The first edition of the challenge, called "Back to the Future, volume 1" saw, as the CP, a local startup that had thus far launched one single product: a lamp that uses microalgae contained in a photobioreactor to purify air. In this first challenge, the students were asked to imagine how the startup could use the expertise present in their current team to create their next product. This next product, however, should feature a clear way to reframe microalgal biomass from waste to a source of value.

The first edition of the challenge received applications from around 50 students, 34 of which were invited to participate. The selection of the students was, in this case, conducted using our principle of maximisation of diversity, as outlined in Section 3. After drop-outs for structural reasons such as overlapping commitments, participation stabilised to 28 students, divided in seven groups of four students each. Participants were of ages ranging from 19 to 32, studying in four different continents (with a majority of students coming from Europe), across ten different universities, and from heterogeneous study backgrounds. The in-person week took place in the first half of April 2024, and the online phase ended with final presentations in early May.

4.1.1. Online warm-up

The first phase, the "online warm-up", saw the instructors welcoming the participants, conducting an icebreaker activity, and providing an initial overview of the theme of the challenge (in this case: what are microalgae? What technologies are based on them?), and briefly explaining the adopted teaching methodologies (i.e., futures studies and CBL). The session, lasting about an hour, continued with a short presentation by the CP and practical information for the in-person week.

[1] Activities where participation is voluntary, is not awarded a mark, but grants ECTS credits. ECTS credits granted by extracurricular activities do not count towards the total credits a student needs to graduate (e.g., 180 for a Bachelor's, or 120 for a Master's).

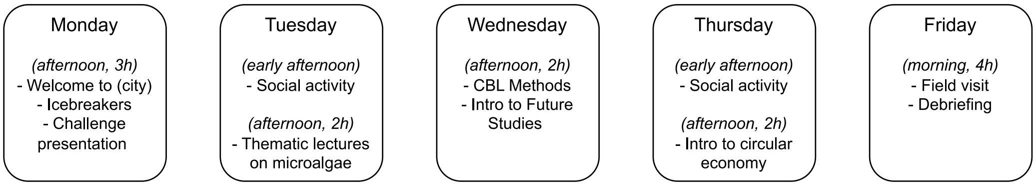

Fig. 3. The content of the in-person week for the first edition of the Back to the Future challenge.

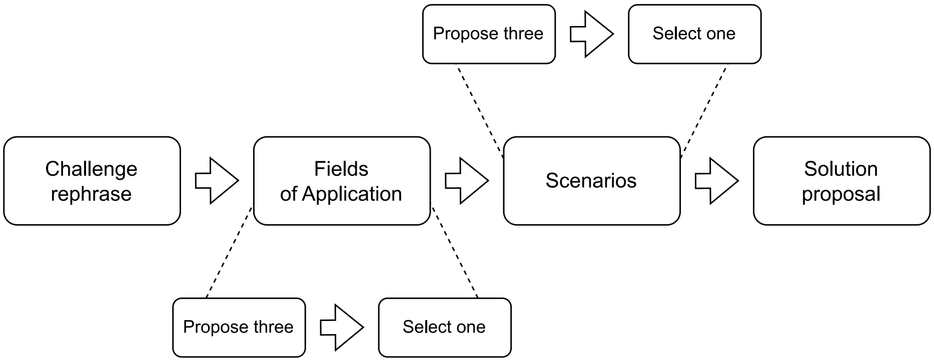

Fig. 4. The process of the online group work for the first edition of the Back to the Future challenge.

4.1.2. In-person week

During the in-person week, the main activities of which are summarised in Fig. 3, students focused on understanding their challenge, meeting the CP, and acquiring the basic knowledge needed to work on their projects. The week started with an icebreaker meeting between the students and the course staff, and a session with the CP, who provided an in-depth introduction to the challenge. The students were divided into teams (again, by maximising internal diversity within each team), and began their activities with lessons from experts in the various disciplines touched by the programme interspersed with practical workshops. On the last day, the instructors and the CP accompanied the students on a field visit to a local farm that produces essential oils from the distillation of aromatic herbs and that showed interest in exploring ways to recover combustion waste using microalgae.

On the first day, the main event was the official presentation of the challenge by the CP, a representative of the startup. This presentation gave students the opportunity to hear directly from the CP about the real and current problem they were tasked with investigating. At the centre of the CP's presentation is the challenge's key question: "What future innovations for sustainability and circular economy could microalgae-based technologies enable? What are their applications, and what is their impact?". The rest of the week featured lectures conducted by staff from our university and external experts, covering topics such as the use of photobioreactors (from small-scale systems to large-scale applications), microalgae cultivation and the various types of algae, circular economy and sustainability, and a more in-depth lesson on futures studies and CBL.

In the specific context of futures studies, the theoretical sessions introduced students to the concepts of preferable, probable and plausible futures, facilitating a multifaceted and critical view of the evolution of microalgae-based technologies and their potential applications. These integrated elements help participants develop analytical skills, crucial for addressing ever-evolving technological and social challenges. Students were also guided in discussing informal, high-level scenarios where microalgae could make a difference for sustainability by focusing on economic, social and environmental phenomena examined according to the STEEP factors. With the help of methodological tools such as the Futures Wheel (Bengston, 2016) and the 3 Horizons method (Sharpe et al., 2016), participants analysed how phenomena could evolve and influence the application of microalgal technologies.

4.1.3. Online group work

The greater part of the team's group work was carried out online, once the students returned to their home institutions, using the process summarised in Fig. 4. The process follows a convergent/divergent structure partially inspired by the "double diamond" process often featured in design thinking (Stickdorn & Schneider, 2012). In other words, the process features alternating phases in which the teamchers support the students to explore the challenge by investigating multiple directions and providing multidisciplinary stimuli (divergent phase), followed by a moment where the CP enters the discussion by focusing on a single option in an attempt to narrow the field and encourage exploration in greater depth (convergent phase).

In the days immediately following the in-person week, the students were required to email the instructors a "challenge rephrase" — a brief abstract reformulating the challenge proposed by the CP in light of their own understanding, and of the knowledge they gained up to that point. The teachers, then, responded to the email with feedback on the students' understanding of the challenge. Notably, this phase acknowledges that each team might develop slightly different understandings of the challenge. The fact that

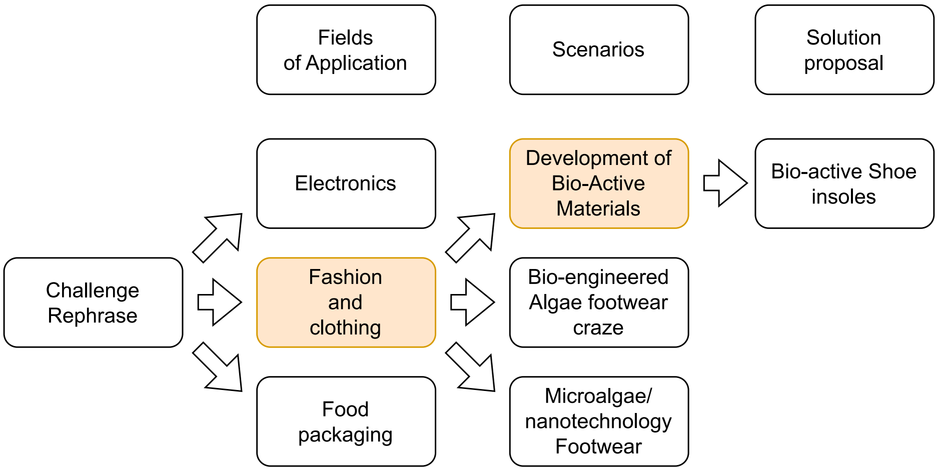

Fig. 5. The process of the winning team of the first edition of the Back to the Future challenge.

different teams develop potentially divergent understandings of the same challenge is welcome – and up to a point, encouraged – as it represents an additional way of *queering* the challenge itself (see Section 2). Since the teaching team accept as equally valid a variety of reframings that the students present, the challenge becomes not merely "understood" or "not understood", but an artifact shaped by the students themselves.

In the first divergent phase, which took place a few days later, the students identified and justified three fields of application in which they saw potential use for microalgae-based technology (e.g., manufacturing, households, agriculture) by sending them by email to the teachers. Again, the teachers provide feedback on the three fields of applications' plausibility, without judging their specific merits.

In the first convergent phase, each team presented their chosen fields of application to the CP in a half-hour online meeting. Following the presentations, in collaboration with the CP, each team selected one specific field for further investigation. From this point on, the team focused exclusively on that field.

The second divergent phase required each team to outline three informal scenarios, each discussing a way the chosen field of application might evolve according to the STEEP factors — and what opportunities might lie therein. The scenarios were again delivered to the teachers, that provided feedback only on the general soundness of the scenarios.

Later, the CP entered the picture once again in a second convergent phase. The CP supported the students in selecting one scenario, from which the students were invited to propose a product idea.

The online phase concluded with a plenary session, where each team presented its answer to the challenge in the form of a product idea, providing potential commercial, industrial, and environmental applications for microalgae-based technologies. The students were asked to offer mature, serious, and innovative proposals, with a positive societal impact, that were feasible and well-presented. The CP was asked to select a winning team based on their sole judgement, but using guidance provided by the teachers on the learning objectives of the course (featuring criteria such as quality of presentation, depth and feasibility of content and creativity).

4.1.4. Worked example and lessons learned

As a worked example of the process of the first edition of the challenge, we briefly present here how the team that was ultimately selected as the winner by the CP reached their solution proposal, summarised in Fig. 5. The first edition was won by a group that, after being directed by the CP to the field of application of fashion, presented as their solution a shoe sole made from microalgae-based plastics.

In the fields of application phase, the team explained in this way their eventually-chosen field of application:

> We would like to explore the option of use of biomass in the fashion industry to make more sustainable choices. Throughout one of the games in Trento we have chosen shoes as an option and as we were thinking about it, it sounded interesting for us to explore the use of biomass in this sector. For example, as a sole of a shoe — completely made from biomass. We chose this field because we found it interesting when we were playing the games in Trento.

Notably, the team's fields of application featured a social dynamic as a justification for their choice, highlighting the importance of integrating social activities in the programme's structure.

As for their informal scenario, the team wrote:

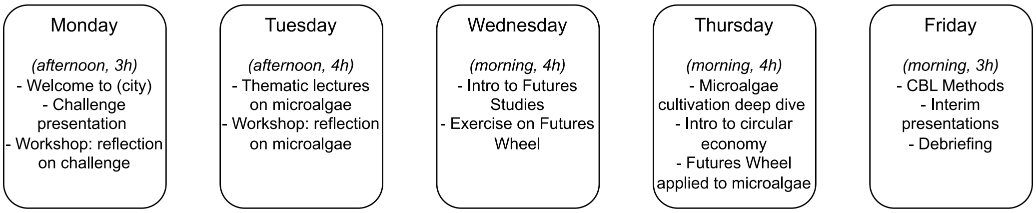

Fig. 6. The content of the in-person week for the second edition of the Back to the Future challenge. Its development follows the students' feedback.

> With an increasing focus on health and wellness, the footwear industry explores innovative ways to enhance comfort and performance. In this scenario, microalgae technology is utilised to create bio-active shoe insoles that promote foot health and circulation. These insoles contain microalgae extracts known for their anti-inflammatory and antimicrobial properties, offering wearers a more hygienic and comfortable experience. As awareness of the benefits spreads, athletic brands incorporate bio-active insoles into their footwear lines, revolutionising the way people think about foot care and performance enhancement.

While their description already heavily featured elements of marketing and product development, the team tried to connect their ideas with the broader societal context.

As the teaching team, this first edition let us learn several important lessons.

First of all, we learned that we could control the process only partially: the students' work has always been surprising, and often featured slight misunderstandings of the given tasks. Leaning on our principle of preparing students for ambiguity, we decided to embrace this state of affairs, knowing that this is also due to the spontaneous way in which the idea of the challenge was conceived and built, relying on the students' and teachers' multidisciplinarity. More practically, we also observed that the theoretical concepts of futures studies that we introduced were probably too advanced: our lectures introduced too many elements, taking understanding in a short time for granted; focusing on one single futures exercise would have probably, instead, aided retention. At an even more practical level, the students asked for more class time — a component of the feedback that we took into consideration for the challenge's second edition.

In general, however, our own observations and those of the CP have been that the quality of the results was remarkably high given the limited time the students had: many of the ideas were relevant and of high quality — the selection, ultimately, came down to deciding on the idea that best fit with the challenge's question, though several other proposals had strong merits.

4.2. Second edition

The second edition, starting once again with an online session (at the end of March 2025), and ending with the online final event (at the beginning of May 2025), followed largely the same format as the first. We highlight here the main differences from the first edition.

Once again, we received around 55 requests to participate, from which we invited 30 students according to our diversity maximisation criteria. After one drop-out, we formed six teams of four students each, plus one team of five students. The participant pool was once again highly diverse, with a similar distribution to that of the previous year: ages from 18 to 35, four continents, more than ten different universities, and highly heterogeneous study backgrounds.

For this edition, the CP was a different company, still from the local ecosystem, focusing on using microalgae to grow sustainable food. The initial phase of the challenge prominently featured a moment of "passing the torch" between the first edition's and second edition's CP, to show the participants that they were part of a broader project.

4.2.1. Online warm-up

The warm-up phase largely proceeded as in the previous year, featuring a one-hour online session. As the first icebreaker question, we decided to ask what the students had for lunch — opening up a small cultural embarrassment, as the session was happening at the end of Ramadan, with several people still fasting. Going beyond the embarrassment, we quickly realised that this was yet another way that showed the group's diversity. The session also featured a longer icebreaker online quiz, that we used to facilitate a short exchange about the participants' initial knowledge of microalgae, the circular economy and futures studies.

4.2.2. In-person week

For the in-person week (once more held at our institution in the first half of April 2025), summarised in Fig. 6, we generally increased the number of activities. Classes led by experts were accompanied by longer time for exercises and reflective workshops. The social activities were also rebalanced: while we eventually did not arrange a field visit, we conducted some of the educational activities outdoor.

Notably, the classes on Thursday were conducted in a hybrid online format with the Blended Intensive Programme with which we had established contact in 2024. The two programmes scheduled the in-person weeks at the same time, and the class foresaw a

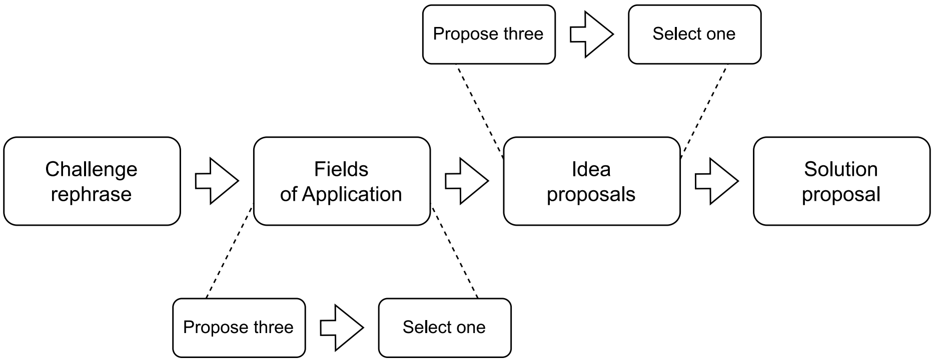

Fig. 7. The general process of the second edition of the Back to the Future challenge.

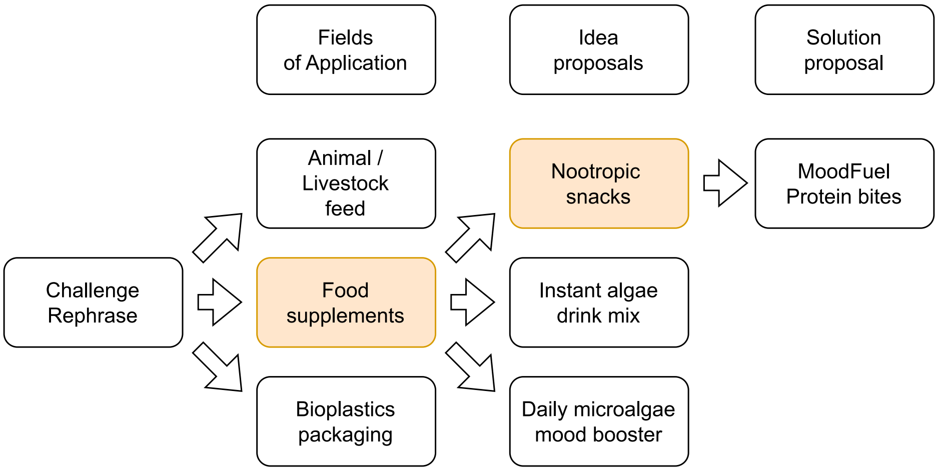

Fig. 8. The process of the winning team of the second edition of the Back to the Future challenge.

live lecture by an expert in our university, that those from the other university attended virtually, and another hour in which this structure was reversed.

We also restructured the programme's futures studies content: the sessions on Wednesday were solely dedicated to futures studies methodologies, and after a general introduction to futures studies (much briefer compared to the previous year), the course did a vertical deep dive on the Futures Wheel (Bengston, 2016) with an external expert co-facilitating an exercise on the use of the Wheel applied to a non-microalgae topic (in our case, lack of snow in the Alps). We then repeated the same exercise structure on the following day in the field of microalgae (asking students to define a triggering event for 2030 that somehow featured microalgae).

We used the Futures Wheel throughout the in-person week as the prime tool for the teams to navigate the topic of microalgae technology: the teams used the Wheel as a map to "fish" for opportunities for the application of microalgae. Specifically, students were encouraged to look beyond the immediate first-order effects and identify "innovation niches" within the second- and third-order consequences. By visualising these social and environmental impacts, the Wheel allowed students to pinpoint specific systemic gaps – such as a sudden need for new infrastructure or specialised roles – that they could then address through their project designs.

4.2.3. *Online group work*

The online group work followed the process outlined in Fig. 7, eliminating the three informal scenarios (that were methodologically unsound, since we did not rigorously defined "scenarios", and the term has a specific meaning in futures studies) focusing instead on proposing three ideas. The futures exploration, for this year, was rather frontloaded in the in-person week.

4.2.4. *Worked example and lessons learned*

The final event saw the team awarded by the CP, for which we summarise the process in Fig. 8, as the one that consistently engaged with the subject-matter in greater depth. The group, overall, presented a rather standard product, microalgae-based snacks, after choosing between three very different fields of application: fishmeal, carbon capture and sustainable feed alternative.

The team framed their solution proposal as "mood food" thus:

> MoodFuel can be a smart snack – bite-sized, high-protein, and packed with Spirulina, omega-3s, and vitamins that support focus and mood. These functional bites could appeal to health-conscious people who want something more than just a snack – something that helps them feel and perform better. With simple packaging and a shelf-stable recipe, they can be launched easily through campus vending, wellness stores, or online shops.

This year, too, the exercise confirmed that having a multidisciplinary approach can pay off not only for the students, but also for the teamchers. All student teams once again presented relevant, well-structured ideas, with the winning team (and two more teams) going into enough detail to present potential cost structures, the microalgal strains to be cultivated, and potential first research steps.

The teamchers also gained experience, achieving greater group cohesion, and consolidating the processes. The collaboration with the other Blended Intensive Programme was also useful, though managing the timing between the two lectures has proven to be tricky. Interestingly, by scoping the futures methods to the Futures Wheel only, we increased the students' understanding of the exercise and depth of analysis, but we also felt the students lost sight of the bigger picture. All in all, our impression was that the futures element somewhat faded in the later phases of the program. This element certainly needs to be strengthened, which is why for the third edition we are thinking of expanding it further, by giving a global perspective to the teaching team - CP - futures studies expert trio, inviting CPs and futures studies experts from outside the Western world, and/or opening up to challenges that are clearly linked to futures, such as a challenge centred on possible uses of microalgae in space.

It should be noted, however, that introducing Futures has always been, in our pedagogical design, a means to let students explore ambiguity. Overwhelmingly, the students shared during the debriefing a sense of "productive confusion" that permeated the programme, with the last couple of days providing the "click" that connected all the dots together. The element of ambiguity exploration, somehow, shifted from being confined to the futures content to permeating the whole experience.

Additionally, the CPs as individuals were radically different people from those of the previous year: initially a little shy in communication, they proved to be motivated, present, and engaged as the phases progressed. The CPs were careful in keeping the fields of application varied in the first phase, including architecture, nutrition and well-being for both humans and animals, and later guided the students in the moments of convergence, accompanying all the groups until the final event. The CPs also offered concrete opportunities to continue working with their organisation, opening internship and job opportunities to which some participants of the challenge applied.

In many ways, lessons learned and feedback from the second edition all stem from the consolidation of our process: what were exploratory ideas in the previous year became consolidated in the second, letting them mature as pedagogical design choices.

5. Discussion

Looking back at the two editions of our pilot activity, we feel we were quite successful in working towards challenging the normative dominant notions in education with which we began (see Section 1). The main area of improvement, conversely, remains the integration of futures studies methods in this type of programme.

The concepts of divergence and convergence played fundamental and complementary roles in the group work phase, constituting key dynamics along the entire path.

Divergence, fostered by the instructors, broadened students' horizons by breaking disciplinary boundaries, inviting students to question the basic structures and assumptions that define traditional disciplines (for example, by inviting chemistry students to explore applications in building materials). This approach promoted critical thinking, multidisciplinary reflection and the development of innovative and unconventional solutions. As enablers of this process of divergence, the instructors relinquish their role of holders of knowledge, acting instead as facilitators, encouraging independent discovery by students, and stimulating their creativity.

In contrast, the CP embodied convergence, providing specific, practical guidance. As an external stakeholder with a core business – be it a company, a public body or an NGO – the CP presents issues with clear parameters, concrete requirements and well-defined objectives. The CP's presence and feedback becomes a much-needed anchor to bring the students back to the familiar grounds of group projects, ensuring that the solutions proposed by students are feasible, relevant and oriented towards tangible results.

The interaction between divergence and convergence creates a closely-matched balance between exploratory creativity and concrete applicability. The tip of this scale, crucially, is in the hands of the students themselves, where each team – and their internal diversity – is empowered to shape their own learning paths, in an analogous way to a process that we have explored in our previous work. This continuous movement between openness and closure, between divergence and convergence, represents a deliberate destabilisation of disciplinary boundaries, domains, and power, challenging traditional educational models that focus on a single type of thinking. The approach we propose in this paper implements queer futuring as defined by Fleener & Coble (Fleener & Coble, 2022) to delegitimize and disrupt hegemonic and categorical thinking by redefining key elements of normative pedagogical designs implemented in Higher Education (as seen in Tables 1 and 2). One of the outcomes of this process, which we argue represents an intervention of educational weirding, if nothing else by sheer virtue of the amount of interventions, is ideally to challenge traditional educational models which normally only either develop convergent or divergent thinking, and thus are bound to exclude learners that privilege one or the other.

By bouncing between educational modes, and by having instructors shy away from providing precise guidance, the programme subverted power dynamics, calling into question the traditional teacher–student hierarchy. The students, rather than being simple recipients of knowledge, need to be actively involved in creating their own learning experience, bringing their interests and skills into the classroom and taking on a central role in their own educational path. The exploration of topics that are unconventional or not neatly framed within individual disciplines, such as future applications of microalgal technologies, forced the use of critical thinking and allowed all students to contribute, in many ways levelling differences due to their academic background.

And it is this overall "weird" atmosphere which opens up the main issue we encountered in the two implementations, namely the appropriate integration of elements of futures studies to non-expert learners. If in the first edition we approached the whole endeavour in a way that was too naïve – even with some methodologically problematic elements, such as not precisely defining the meaning of "scenarios" – in the second edition the integration has been somewhat excessively technical. In both cases, what we have observed was that some students followed the suggested exercises, but were all too eager to put them aside in favour of returning to more familiar grounds of product/solution ideation.

In reflecting on potential future developments of this model, we need to reflect on whether the design proposed in this paper may be suitable to cohorts of students with different modes of participation (e.g.: curricular courses; non-credit-awarding activities; ...). Beyond this, however, we are left wondering how we could lean on our same design principles even further — and if indeed there is also a design space for further pedagogies specific to Futures that may help to fill this gap.

6. Conclusions

The discipline of futures has been described as oriented to assisting work performed in other areas of human inquiry (Poli, 2019), and as a set of new competences that require the development of "futures literacy". Futures studies, however, are not the only discipline with this feature.

The technological evolution of the last decades has given rise to the programmes such as those centred around so-called "computational thinking" (Mills et al., 2025). Initiatives abound that teach this knowledge (or is it a skill? a disposition?), yet no higher education student who is enrolled in a programme in the computing disciplines does any course explicitly called "*computational thinking*". Programmes that explicitly address computational thinking feature methodologies and tools designed *ad-hoc* for the development of those competencies for non-specialists (see, e.g., Scratch (Maloney et al., 2010)), with some tools even being designed with the specific intent of achieving greater inclusion (see, e.g., Hermans, 2020). Through computational thinking, computing leans into its nature as a *discipline in service* of one's other competencies.

Our explorations, then, can be an invitation for the Futures community to lean further into the development of pedagogical strategies designed specifically to support the development of Futures competencies in higher education for non-Futures students. Practices, in other words, that lean into Futures as a *competence in service*. To do this, we argue, pedagogical practices need to go beyond the construct of "literacy", as the very idea of literacy creates a boundary between the literate and the illiterate, thus drawing an implicit value judgement. The risks behind this value judgement are, as it often happens, those of exclusion and adversarialisation. Leaning into the concept of *queering*, then, may once more be of help: how far can we broaden the category of "the futurist"?

In this study, we explored some potential spaces where these explorations could be conducted, namely educational spaces such as CBL, that structurally lend themselves to letting their participants embrace the "weird" nature of the subject-matters they are exploring, and that structurally invite a process of deconstruction of categories — of queering. Through the case study of the "Back to the Future" challenge, we demonstrated a possible way through which these integrated methodologies may help students imagine alternative futures and propose sustainable and responsible solutions to real-world challenges. The integration of Futures methods remains a prime way to promote this sustainable and responsible thinking, ideally with a goal of fostering transformative learning experience, though what exact methods should be used remains an open question.

An an appropriate pedagogical design, we argue, can let teachers effectively challenge deeply-held assumptions around the what, who, how and why of education, highlighting the potential of a futures-oriented education which aims not only to enrich pedagogical practices, but also to stimulate a cultural change within higher education. Through the adoption of multidisciplinary and participatory approaches, this integration opens new perspectives for envisioning more just and sustainable futures.

By highlighting the intersection between futures studies and CBL, we oriented pedagogy towards reclaiming equal dignity for deconstructed categories, showing an opportunity to rethink elements of university education and to build more diverse collective imaginaries. By leaning on an education that embraces contemporary complexity and challenges established norms, we hope future generations can be better equipped with the skills they need to navigate uncertainty and help create more inclusive futures.

Queering, in the context of this study, occurs through a deliberate destabilisation of disciplinary, domain, and power boundaries. It is enacted through the blending of knowledge systems, the rejection of rigid teacher–student hierarchies, and the openness to methods and topics that are often marginal, speculative, or ill-defined within traditional academic frameworks. By inviting students from specialised backgrounds to explore unfamiliar and domains that do not neatly fall into one discipline, such as imagining futures of microalgal technologies, the project cultivates a space where knowledge is no longer confined to disciplinary silos. At the same time, instructors step back from the role of expert authority and instead act as facilitators of uncertainty, ambiguity, and creative risk-taking. In doing so, the learning space becomes one of fluid roles, co-construction, and constant negotiation — a space that does not seek to resolve difference, but to generatively remain within it. Queering, in our approach, is not an additive gesture, but a foundational principle that challenges normative assumptions about what learning should look like, who gets to imagine futures, and which forms of knowledge count. It is precisely this displacement – this refusal to settle into fixed categories – that opens the way to more inclusive, imaginative, and just educational futures.

CRediT authorship contribution statement

Gianpiero Monittola: Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation, Conceptualization. **Stefano Turrini:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Conceptualization. **Lorenzo Angeli:** Writing – review & editing, Validation, Supervision, Methodology, Investigation, Conceptualization.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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