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Curiosity, collaboration and co-creation: using Grand Challenges to develop employability and tackle 21st Century problems

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ABSTRACT

Taking action is crucial at all stages of career development learning to develop skills and employability with no particular career goal, or for specific career ambitions. This article explores the concept of grand challenges in the context of education for employability through the case study of an extra-curricular programme at a UK university. We describe the programme, examine the collaborative way the team works utilising a distributed leadership model and consider the impact the programme has had on students, staff and the institution. We conclude that this approach successfully introduces students to the concepts of sustainability, social justice and Equality, Diversity and Inclusion and changes the way that many educators globally approach their teaching.

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Introduction

The UN International Labour Organisation (2016) defines green jobs as “decent jobs that preserve or restore the environment”. Green jobs for sustainable development (Boromisa et al., 2015) are developing quickly across all sectors, and university career services must play a pivotal role in preparing graduates for these emerging jobs. This involves embedding a wide range of UN Sustainable Development Goals (SDGs) into career curriculum design (Blackmore et al., 2023) and influencing the embedding of sustainability thinking in its broadest sense within institutional culture. Graduates from all disciplines need to develop resilience, creativity and problem-solving skills to create new sustainable solutions to tackle the issues faced by humanity and by the fourth industrial revolution (Karaniola & Panagiotopoulos, 2018).

This article focuses on the concept and practical applications of “grand challenges”. We describe a well-established extra-curricular employability programme called Grand Challenges (e.g. Anderson et al., 2021; Burkill, 2015; Lees, Djordjevic, and Roberts, 2022, 2023) developed for undergraduate students, evaluating its reach, value and impact, and how team members contribute in varying ways to achieve educational success. The programme focuses on a week of intensive project work with participants defining sustainability problems, forming teams and developing innovative solutions, within a loose structure of knowledge exchange with experts, business leaders and people with lived experience. Over the years, this programme has evolved into a palimpsest of praxis where the programme develops and changes and echoes previous forms. Actions are required from both staff and students, so that students can learn from their experiences and test ideas. Staff learn from each other and from students, and programme developments are

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informed by student feedback and co-creation. This creates layers of activity and collaboration to enable students to explore, test ideas, and move forward in their career development thinking. We examine how this ecosystem of support positively impacts student employability and career experiences. This includes lessons learned from the collaborative effort behind the delivery of Grand Challenges.

All quotations were sought to continuously improve the quality of delivery and permission was obtained to publish qualitative feedback. Ethics approval was not obtained because this was not a research project. As this is not a research article, the format does not follow the usual research article structure.

Grand challenges in education

Mitchel's (2022) PhD thesis sets out a comprehensive review of the history of grand challenges providing context to our approach. The concept dates back to the 1900 International Congress of Mathematicians where David Hilbert presented ten unsolved problems that would "focus the efforts of mathematicians for the entire century and beyond" (Uehara et al., 2013). Hilbert's challenge was groundbreaking for identifying significant yet unaddressed problems, making it the first recognised "grand challenge" (Stephan et al., 2015). Vest (2010) defines grand challenges by their "difficulty" and "significance", stating that "the precise path is unclear. That makes them challenging and their deep importance makes them grand".

Uehara et al. (2013) argue that grand challenge projects have three characteristics: (i) they have high-level goals; (ii) they address broad and integrative social problems; and (iii) the problems appear to be solvable.

Under this definition, arguably Hilbert's mathematical challenges should be reclassified as intellectual challenges rather than grand challenges.

Not all social problems may be, or even appear to be, solvable. Rittel and Webber (1973) described this type of problem as defying formulation and are "at best ... only re-solved over and over again". They introduced the term "wicked problem" to describe the type of unique, interconnected, and complex problems that operate within a dynamic open system. Each action has consequences, and every solution has the potential to become part of another problem. They reject the idea that there is a right or wrong solution; there are only better or worse solutions. As such, the aim is "not to find the truth, but to improve some characteristic of the world where people live" (Rittel & Webber, 1973).

In the UK, higher education grand challenges are promoted as opportunities to gain insight into complex problems utilising experiential learning as described by Kolb (2014), fostering transferable skills, expanding networks, and making a difference in the world (Burkett et al., 2015). These activities provide an exciting platform for students to engage with shared problems beyond their studies, is motivational, allows risk-taking and exploration and develops students as "agents of transformation".

Taking action and safe spaces

Taking action is crucial at all stages of the career development learning process, whether it is to develop generic employability skills or for a specific career goal. Creating safe opportunities for students to test ideas, gain experiences and learn from failure (Lees & Sloan, 2023) are vital for the development of a culture of "career curiosity" whereby students are encouraged to engage with activities, and not pursue them if they are not right. This is not a failure but is a positive step in the career decision-making process. Involvement in Grand Challenges for both students and staff is a deliberate act. Embracing the theory of planned happenstance (Krumboltz, 2008) that acknowledges that "things will happen" whether you like them or not, means you can prepare to take up these opportunities. When staff or students get involved with Grand Challenges they do not know what the

outcomes will be and have to be open to the possibilities that present themselves. It is up to the individual to exploit the opportunities and make something unplanned and unpredictable happen and move forward in their careers thinking.

Praxis, the process of practice, action and change underpins Grand Challenges for both students who participate in the programme and staff who plan and deliver them. The student experience often parallels the staff experience, aligning it with Wenger's (1998) social theories of learning. Wenger (1998) asserts that learning occurs through actions and interactions, embedded in culture and history. Through these actions and interactions, learning transforms the social structure.

Grand challenges programme methodology

Established over a decade ago (Burkill, 2015), as part of an education for sustainable development curriculum initiative (Dawe et al., 2005; Sterling, 2001). Grand Challenges was intended to create action-orientated, sustainability literate graduates. Originally piloted as "Big Dilemmas" for cohorts of 30 students, our work fosters inclusive, supportive and creative environments for students to explore "wicked" problems (Rittel & Webber, 1973) and to develop their employability. The team promotes interdisciplinary problem solving, systems-thinking and the interconnectedness of social, cultural, economic and environmental issues. These principles inform how the team operates and influence decision-making.

To create impactful learning experiences, a complementary team of academics, Professional Services, Postgraduate Teaching Assistants (PTAs) and student interns operate under the strategic direction of the Grand Challenges Steering Group. The team is re-formed on an annual basis; Professional Services, the Academic Sponsor and many academic leads are constant. There is some fluidity in the academic leads, alongside PTAs and interns, influencing how Grand Challenges runs each year. That there is some continuity of academic leads means that experience can be built on year-on-year creating a mix of experienced and developing academic leads. The Steering Group integrates the team within university processes, facilitating our operations. Our annual-cycle framework reflects the values and ethos of the team and facilitates the achievement of our objectives.

The team's objectives are to:

- Develop skilled graduates
- Facilitate co-creation of knowledge through research-led, enquiry-based learning
- Transform student lives so they can transform the world
- Foster interdisciplinary collaboration
- Reach students who would most benefit
- Systematically evaluate and be evidence-based

The team's values are embedded in the way we work, and also the "wicked" problems the Challenges explore: to be inclusive, improve access and promote sustainability by being collaborative, creative and compassionate. We incorporated the United Nations Sustainable Development Goals (2015), social justice and Equality, Diversity and Inclusion (EDI), so that students can make a meaningful difference in the world (Basio, 2017), before these were articulated as core institutional values of being "Greener", "Fairer" and "Healthier" in the University's 2030 Strategy (University of Exeter, 2021). Grand Challenges addresses specific SDGs such as #1 No Poverty and #2 Zero Hunger (Food for Thought Challenge), #5 Gender Equality and #10 Reduced Inequalities (Social Inequality Challenge), #7 Affordable and Clean Energy, #11 Sustainable Cities and Communities, #12 Responsible Consumption and Production and #13 Climate Action (Climate and Environment Emergency Challenge) and #8 Decent Work and Economic Growth (overarching all Challenges through the development of employability). By contextualising SDGs in the delivery of the programme, we aim to help students grasp the broader implications of their career choices and understand how their work can positively impact others.

The team delivers the week-long programme across two university campuses. 15–20 academic leads frame Challenges by developing the focus and enquiry areas and sharing ideas and good practices across the Challenges. PTAs facilitate c.400 students, half of whom are first years, from all departments, in c.70 enquiry groups across five Challenges. These are supported by 0.8FTE of Professional Service staff who co-ordinate programme delivery. An interdisciplinary group of educators working with external contributors from both within the university (e.g. the Library, Technical Services, Student Start-ups, Wellbeing, Students' Union) and from external agencies such as charities, schools and businesses supports each Challenge. The partnerships depend on which Challenges are being run and academic, business and alumni contacts; guest speakers and non-academic experts are brought in to give their perspectives to Challenges, opening students' imagination, curiosity and sense of agency. External speakers are often high profile, such as from the Meteorological Office or BBC, and these give keynote speeches at the beginning of the week to inspire students, give real-life perspectives and insights into problems that students might be able to help with.

Students select from one of several Challenges, such as Climate and Environment Emergency or Social Inequality. Each Challenge has sub-themes, or enquiry areas, such as Policymaking and Inequality, Recognising Inequality in Media and Film; Economic Poverty; Global Economic Inequality and Safety on the Streets in the Social Inequality Challenge. Students select their enquiry area, generate ideas, form project groups and create solutions. Teams form around common enthusiasm for a new idea or a new approach to solving an existing problem, or around specific skill sets, or desire to create a particular output, or similar. Each group has a unique mix of gender, degree programmes, years of study, cultural diversity and skill sets. The diversity and interdisciplinarity of each group expose students to different ways of thinking and working. Challenges blend pedagogy, andragogy and heutagogy into academa-gogy so that students have a high degree of control over their own learning (Jones et al., 2019).

Groups work on projects, supported by PTAs as facilitators, experts and can access bespoke skills support. Creative spaces are available in which they can create digital and physical outputs illustrating their solutions. Outputs take many forms, including apps, social media campaigns, posters, videos, blogs, books and games. At the end of the week, groups pitch their ideas to a panel of experts and their Challenge cohort. As part of the closing celebration, selected projects are present to all Challenge cohorts, university staff and invited guests, and all groups exhibit their outputs in a showcase.

To develop skilled graduates, the team creates a safe space that allows students to be creative, take risks and follow their passions. We focus on exploration and learning, not on obtaining grades. Reflection In Action (reflecting while the intervention is happening, making adjustments to practice as it happens) and Reflection On Action, (taking the time after the intervention to make sense of what happened, how to improve future interventions and think about development needs) (Schön, 1983), are crucial reflective practices for Grand Challenges to be effective as a learning experience for students and staff. Students learn from failure without realising they are learning and developing skills in the semi-structured environment we create. They subsequently utilise new knowledge and skills in their academic studies and in employment after graduation. Increased sustainability awareness shapes their behaviour and they will take this learning with them into whichever sector they end up working in. This student-centred approach focussing on global issues is scalable and applicable to different contexts and is relevant anywhere in the world. We have created a safe environment for playful experimentation without judgement.

We are future scientists, researchers, politicians, engineers, writers, CEOs and our opinions on these topics will largely influence the future world. [student]

A distributed leadership model

We have adopted a distributed leadership model (Spillane, 2006), where authority and responsibility are shared among many leaders who have common goals and objectives. This approach fosters

symbiosis, sharing skills and expertise at all levels of learning and teaching. It enables team members to develop shared practices and engage with development opportunities. The team is agile, adapting quickly to varying resourcing levels, priorities and partnership possibilities and accelerates the speed with which things can be achieved as decision-making is devolved. Emphasising the importance of interconnectivity and collaboration empowers individuals to contribute to the overall goal. Our approach cultivates a community of practice (Wenger, 1998), fostering collective learning for a shared purpose. There is no line or matrix management, and responsibility is based on expertise rather than role ensuring that all voices are equal.

- Academic leads contribute research expertise, networks, and contemporary discourse on inspirational topics to develop theme-specific Challenges. For example, Future Food originally focussed on three lenses of food sustainability; global, local and individual but now focusses on partnership with local initiatives.
- Professional Services bring management and employability skills, which empower others and facilitate the team's operations.
- PTAs contribute facilitation and research skills.
- Student interns bring experiences of being participants and student perspectives.

The team values the learning process over product, and this can only be achieved through collaboration. The team focuses on students developing the “critical literacies” (Andreotti, 2014) and “ethical anchoring” (Barnett, 2000) necessary to make sense of living in a super-complex world.

At the beginning of the annual cycle, academic leads collaboratively with PS, who guide them through the process of developing new Challenges. Academics often need help getting students from a range of disciplines and career ambitions to work collaboratively and encourage them to draw from their own discipline knowledge and expertise to develop a common outcome. Feedback from academics shows that PS expertise in this area is crucial in preparing them for this task. The coaching approach feeds forward as described in Gonzalez (2018), who argues that feedforward is more impactful than feedback as it expands possibilities, regenerates talent and refines group dynamics. For example, Professional Services successfully worked with new academic leads to develop Challenges on Brexit, Fake News and Planetary Health, taking them out of their comfort zones as they had to adopt a different pedagogical approach and move away from knowledge delivery and assessment towards academagogy. This demonstrates the success of adopting the distributed leadership model which aims to consistently grow new leaders through sharing skills and knowledge.

Professional Services enable students, PTAs and academics to develop the skills and understanding to engage with this type of teaching that is otherwise quite unusual for the University. Communication, planning and a culture of trust and creativity are critical, with everyone understanding what is expected of them to collaboratively ensure the programme's success. Professional Services occupy the “Third Space” Whitchurch (2018) where boundaries between academics and Professional Services become blurred and roles converge.

Entrepreneurial creativity brings together those more likely to be disruptive in their approach to education and comfortable with an Academagogy approach (Jones et al., 2019). The team's collaborative nature enables us to cut through any barriers between research and education academics, as well as Professional Services, that can create hierarchies and silos. Divides between Humanities, Arts and Social Sciences and Science, Technology, Engineering and Mathematics, and academic and non-academic expertise are eliminated as everyone operates with mutual trust and respect. Distributed leadership encourages engagement, leading to quality outputs and innovation as everyone feels empowered to contribute.

Academics *choose* to get involved, seeking out interdisciplinary collaborators from across Faculties to enrich the delivery of each Challenge. Academic collaborators vary year-on-year depending on student interest, topicality and availability. Academics work across Faculties to achieve shared

goals in the same way that students work in interdisciplinary groups: for example, in the Social Inequality Challenge, academics from Engineering and Humanities worked together on the Poverty sub-theme. This is unusual for some academics who may rarely venture outside of their research group or discipline.

Originally based on research beacons, since 2018 Challenges have been selected based on student interest and topicality. This operational change was a consequence of the team's collaborative philosophy and listening to student voices, with the proposal developed by the team and approved by the Steering Group. This amendment enhances team resilience and sustainability. Academic leads are provoked to react to student interest and devise new Challenges that are engaging and relevant. Academics move away from the starting point of being experts who deliver knowledge to students as passive recipients. They develop the confidence to explore new topics, be curious themselves, mirroring the student experience and facilitating the co-creation of knowledge *with* students (Bovill, 2020), and with colleagues from other disciplines. This approach is reflected by Freire (2021), where the scholarship of the teacher does not drown out the ideas, curiosity and experience of students, but attempts to equalise power based on learning through shared dialogue. This student-led approach provides a solid feedback loop to academics, resulting in their re-thinking research and teaching practices. For example, the "Gender Equality Challenge" evolved into the "Social Inequality Challenge" to explore a broader range of areas, including racism and poverty. The academic lead worked hard to engage collaborators and respond accordingly, the way the team works is reflected in the high quality of the student experience.

Academics from 20 disciplines have impacted teaching across all three Faculties. In Engineering, a new module used Grand Challenges as exemplar, and new lecturers attended the PTA facilitator training so that they were ready to teach in the Faculty. For Law and Business, our Grand Challenges model was used to teach across subjects in a week-long event for second years and our facilitator model increased group collaboration. These examples demonstrate the team's willingness to share resources and support the development of others.

Thirty students are employed annually as PTAs and interns supporting the research-led and student-led aspects of the group work respectively. Both roles feed into how the team evolves and operates and are instrumental to our student-led pedagogic approach. PTAs are a mix of Masters and Postgraduate Research students, and it is unusual for these to work together. The team facilitates opportunities for collaboration and normalises interactions, creating a greater sense of community for otherwise quite segregated groups. PTAs receive training from Professional Service to develop interdisciplinary facilitation and co-creation skills, learn about ethics, intellectual property, equality, diversity and inclusion – training they are not necessarily able to access elsewhere. PTAs appreciate that active learning training is integrated into their work as facilitators, enabling theory to be applied to practice. Postgraduate Research students use their new skills to enhance discipline-specific facilitation. One PTA from politics commented "*through Grand Challenges I learnt how to communicate with a wider group of students than I would normally engage with. As a result, I am more relaxed and a better teacher*". PTAs gain practical experience for recognised accreditation and develop skills and networks of value when applying for jobs.

Through Grand Challenges I came to appreciate the fulfilment of teaching. The experience has shaped my career ambitions as I want to remain in academia to help students follow their passions. (PTA 2022)

All student interns were previously participants, so have the experience to understand how objectives are met. Interns gain valuable work experience to develop their employability, and they directly support the participants' employability development too. One intern supports each Challenge, alongside interns who co-ordinate work between Challenges. Interns now contact senior academics directly, something that was unthinkable a decade ago; hierarchy is removed as a direct result of the team's way of working. Grand Challenges programme is truly transdisciplinary, and perceptions of what academics should do, and students could do, are broken down, with acknowledgement that students are sometimes better than academics at doing certain things. Professional Services

develops interns to become “experts” so that they can collaborate and become the “operational” leads for the team during the week; leadership is distributed to these students. They are the main points of contact for all academics, facilitators and students for practical information, queries and logistics. This approach leads to talent retention, a feature of distributed leadership, where interns come back year after year, or return as PTAs.

Students are informed of the programme’s collaborative nature, aligning their expectations with staff values. Student groups mirror the Professional Services and academic collaboration model; students learn the skills staff deploy as they model good practice. The programme embodies its values, fostering mutual learning between staff and students.

“... perhaps I have learned more from the students than they have from me ...” (academic lead 2020)

Evidence and impact

The team has robust review and evaluation processes in place, monitoring the quality of student experience, the extent to which our objectives are met, how our messages are received and understood, how user-friendly our processes are; all informing the next cycle. This loop impacts all areas of the team, supporting innovation and improvement. Our approach enables flexibility and responsiveness, e.g. during the 2020 pandemic, the three-month lead-in enabled us to re-imagine Grand Challenges delivering a broader, more inclusive and more heavily networked online programme (Lees, Djordjevic, and Pardoe, 2022). Engaging over 360 students from 16 time-zones, we collaborated with three institutions globally (Manheim, Leiden, University of South Florida (USF)), which increased the cultural diversity of groups and enabled the sharing of global perspectives. For example, USF students were surprised that genetically modified food was the subject of discussion for UK students as they accepted it as the norm, leading to richer debates.

This collaborative approach fosters autonomy and influences stakeholders, inspiring others to develop their own initiatives and take their own action. Other institutions have used the model, replicated it and adapted it. Some have trialled it and realised it is difficult to achieve within a similarly lean resource base to ours, and have halted delivery, or focussed solely on one discipline, school or college, removing one of our central objectives. The delivery model had a sustained impact on academics, thousands of students, the institution, our wider community, and the Higher Education sector nationally and globally. The team has the skills and agency to translate strategy into outputs, which includes the Challenges themselves, policy change, publications, research grants and new modules. We have changed ways of thinking about what teaching and learning is and can be, changed the way students are engaged with and listened to, and given them the power to lead their own education. Examples of these are explored below.

Impact at exeter university

At a university macro-level, there are many examples where the team’s approach to collaborative working has inspired others and learning from Grand Challenges has influenced University strategic policy or had an impact on learning outcomes:

- Originating from Grand Challenges in 2013, the *Economics of the Financial Crisis* module first ran in 2014 and has subsequently had over 2,000 students enrol. The module lead won a Students’ Guild Teaching Award in 2016.
- A new approach to Intellectual Property Rights for participants was adopted. Students now own the IP generated from Grand Challenges. A student challenged University ownership of IP and had developed the confidence and advocacy skills to question the *status quo*. The team negotiated with Legal Services to make IP student owned. This makes it easier for students to create start-ups and continue their projects as they no longer need to negotiate with the University after

Grand Challenges take place. The student who raised this participated in three subsequent Grand Challenges, became the President of the Students' Union, where he further developed his advocacy skills, and then became a Civil Servant. This example of a student driving change demonstrates the impact resulting from the team's approach; utilising distributed leadership is working.

- Research Services developed a new agile ethical protocol for research undertaken by undergraduates. This involves granting ethics for the umbrella Grand Challenges programme, enabling students to conduct primary research without going through a lengthy approval process that would impact their ability to progress research within the week. Any research that falls outside of the umbrella-ethics approval is escalated to the Ethics Officer who processes queries quickly.
- One of the academic contributors to the development of the University's Education Strategy took the Grand Challenges team's interdisciplinary approach as a model to inform their thinking, commenting that there is value in risk-taking and embracing uncertainty *versus* staying with the safe and familiar.

The Transdisciplinary Pedagogy Network (TPN) has used Grand Challenges as an exemplar for delivering transformative education. The Transformative Education Framework (2022) focuses on decolonisation, SDGs and EDI and states that "we will use the power of education to transform our students' lives so that they, in turn, can transform the world". This has always been a central tenet of Grand Challenges. The impact of the collaborative team approach, as well as the framework of Grand Challenges, has been recognised centrally as a powerful model to effect change.

The reach, value and impact of the team were recognised in case studies in the Teaching Excellence Framework 2017 and 2023 submissions, contributing to Gold Awards and by a Collaborative Award for Teaching Excellence from Advance HE in 2023. The approach has been placed as Highly Commended in the Green Gown Awards 2017 in the Employability category and won a QS Reimagine Education Bronze Award 2018.

Impact on students

Over 4000 undergraduates have participated over the past decade. In line with the Office for Students (2023) ambition that "... all students, from all backgrounds, with the ability and desire to undertake higher education, are supported to access, succeed in, and progress from higher education", the team attempts to reach students who would most benefit from this opportunity. In most years, the number of Widening Participation (WP) students, exceeds non-WP proportionally, which fits with the team's ethos of championing EDI. A total of 34% of participants are Access to Exeter Bursary holders, compared with 28% of the student population. We are empowering these students and supporting them to enhance their employability.

Students learn from researchers at the cutting edge of each Challenge while also engaging in peer teaching. There is huge value to students in participating, from developing teamwork, communication and presentations skills, to addressing real-world problems and making an impact themselves. Students make new friends, meet like-minded people, essential to mental well-being and a sense of community. In 2023, 93% agreed that Grand Challenges demonstrated how different disciplines can work together to address an issue and 85% confirmed that it provided them with experiences they wouldn't have otherwise had. 75% report that Grand Challenges has improved their confidence in demonstrating their skills to any employer. The impact also includes increased self-awareness, re-evaluating values, motivations and capabilities, and developing enterprise and entrepreneurship skills. Students are introduced to a mode of collaborative working through the distributed leadership model that they may not have come across before and can experience first-hand through our approach.

The team monitors student reach, value and impact via evaluation and monitoring processes, and the team use these data to continuously improve delivery. In a typical year, 90% of participants report Grand Challenges gave them positive experiences they would not otherwise have had and

92% would recommend Grand Challenges to a friend. Consistently, there is a 94% student satisfaction rate, as illustrated:

- Students understand the value of developing knowledge and skills sets for the workforce “Challenges pushed me to convey my medical knowledge to non-specialists – invaluable communication skills for the modern workplace”. (student)
- Students have been motivated to think about new career-paths “GC offered my first opportunity with video production and editing. I am considering a career in television production and broadcasting as a result”. (student)
- Students have used their experiences to secure jobs “Participating in Grand Challenges helped me to secure a placement at PwC”. (student)

Career Registration enrolment data (Cobb, 2019) shows that for students who have completed Grand Challenges at least once, a lower proportion were in the “decide” phase and a higher proportion in the “compete” phase compared to their peers who have not engaged.

This collaborative approach creates opportunities for students to co-create physical outputs which are not assessed and are fun to make and is a different approach to that typically experienced in most degree programmes. Experiential learning is made possible, enabling students to focus on the process, having space for reflection and behavioural change, rather than focusing on outputs (Kolb, 2014).

Through Grand Challenges a unique pipeline of talent has emerged, from participant to intern to PTA and sometimes all the way to academic lead; an unintended, but highly beneficial outcome. The team genuinely supports the pedagogic development of tomorrow’s academics and Professional Services and the career ambitions of participants who take up roles in a range of sectors. Participating in Grand Challenges has provided opportunities for students to gain experiences and reflect on these to secure roles.

PTAs state that facilitating Grand Challenges has influenced their research, enabling them to gain multiple perspectives:

“Working as a PTA enabled me to evaluate whether my research on social media was correct and helped me develop my thesis conclusions”. (PTA)

Impact on staff

Working as part of the team has had a significant impact on staff reward and recognition. Distributed leadership creates opportunities to expand horizons and for the team to share knowledge, creating stronger bonds within the community of practice. Staff benefit from this collaboration in their teaching, research, and professional development. The experience, values and ways of working support Advance HE Fellowship applications. Academic and Professional Services have used their involvement in the team to provide evidence in support of formally recognised accreditation.

Two academics have used their leadership of a Challenge as prominent components of successful Associate Professorship applications due to the innovative pedagogic and team approach.

As a PTA I developed invaluable teaching skills. As academic-lead creating a new Challenge around my research, new themes and collaborations emerged, and evidence – of considerable leverage – of the ability of students to advocate for their mental health and co-design interventions on loneliness at university. (Lecturer History of Medicine)

Academics are inspired by students’ work, form new research clusters, and break siloed ways of working. Grand Challenges research-led teaching leads to the successful development of further research grants, collaborating with new partners, such as the Social Inequality Challenge academic lead’s successful grants collaborating with Korean Universities. This has had an impact on teaching at other institutions, through the development of new programmes and modules, creating a virtuous circle of knowledge exchange, where a greater number of students feed into, and benefit from,

academics' research and teaching practices. These experiences feedback into module and Grand Challenges development at Exeter, further enhancing teaching and learning.

Impact on community

Grand Challenges impacted the local community prior to the university becoming a Civic University in 2021. Grand Challenges *helped shape the consultation process and identify the priorities and ambitions of our Civic University Agenda.* (Regional Engagement Manager)

Examples of where the team made an impact on the community prior to the Civic University Agenda becoming formalised, are set out below:

For one sub-theme of the Climate Change Challenge, undergraduates visited a local primary school and worked with 200 pupils between 2017 and 2019. The academic lead, and parent at the school, persuaded the Head to get involved. The school was teaching nothing about climate change, so this enabled students to raise awareness of climate issues and develop new sustainability-related knowledge.

Students worked with school pupils to co-create the brief and jointly decided which outputs (games/apps/songs) to develop. For students, it was an opportunity to test the idea of working with primary-aged children, and we directed those who were interested in our Aspiring Educators programme to explore education as a career option. As a result of working collaboratively on this Challenge, the academic has changed their practice:

I've made my lab-sessions more interactive and engaging with more focus on practical outputs which provides greater evidence of independence for prospective employers. (Climate Change Challenge academic lead)

The Future Food Challenge has made a considerable impact on the local community. In 2018, one group developed a map of local foodbanks that is now used by the charity "Food Exeter" to help people on low incomes access nutritious and sustainable food. "Food Exeter" state that at least 1500 households were supported with emergency food each week during 2021 with another 500 helped during school holidays. In 2020, the team secured university "education incubator" funding to work with not-for-profit organisation, The Kids' Kitchen. Six Grand Challenges students learned how to work with community partners (parents/carers and under 5's) to develop educational resources (factsheet and storybook on sustainable diets) for families, disseminate academic research and share learning from Grand Challenges with a diverse audience. Kids' Kitchen estimate that over 5,000 families have been reached.

I was part of a group developing a factsheet ... I learnt how to present my research clearly so that it is useful to people outside of academia. (participant 2020)

Being part of the team has shaped this academic lead's teaching by giving them the confidence to bring external stakeholders into the classroom and make both formative and summative assessments more applied in their third-year psychology module, which now takes the form of policy-briefings or newspaper articles aimed at specific target audiences (policymakers, parents, teenagers). This has an impact on student outcomes by creating more real-world assessments.

Working with local communities, supporting authentic outputs, providing a voice for marginalised communities, Grand Challenges sets the standard for education we aspire to that transforms students and gives them skills to transform the world. (Academic Developer)

Impact on the higher education sector

Supporting others to adopt this approach is consistent with the team's values. The impact across the sector has been far-reaching. At least five institutions have used the GC model, replicated and adapted it. These are successful examples of activity that would not have taken place without the collaboration of the team:

- Having observed Grand Challenges through two cycles on campus and one online, University of South Florida (USF) adapted our model to be part of their Global Citizenship Project. This proved popular with USF students; more than 1,000 having completed it. Professional Services mentored USF academics. A result of our team's approach has been an impact on their pedagogic approach to curriculum design. I have been reflecting on the ongoing collaboration between Exeter and USF ... Thank you for hosting the 18-strong USF contingent so we could see how GC works. You have helped shape OUR programme – we owe you SO much. (Associate Dean USF)

Like Exeter University, USF also encourages the participation of students from their partner HEIs (UniNorte, Colombia, Penn State) and UniNorte is developing their own version "Global Action" as a result.

- A PhD student from UCL interviewed Grand Challenges staff as part of their research and used it to inform the development of a new module "#AcrossRCA". Launched at the start 2022–23 for over 1,000 students, it brings students together across disciplines to think critically about their creative practice and generate innovative responses to complex global problems.
- The Social Inequality academic lead was a guest speaker at a Teaching and Learning Conference on Design-Thinking at Nanyang Technological University Singapore in 2021. As a result, NTU with over 33,000 students is designing a new compulsory module for the entire First Year, based on the Grand Challenges model. Subsequently, the academic lead has developed a new challenge-based module, "Communications Challenges", focussing on aspects of social inequality in Western society for delivery to our undergraduates.

Knowledge transfer and sustainability

The approach could potentially be adopted by others outside of higher education, in schools, community settings or by charities, for example, to enable people other than undergraduates to develop their critical thinking and problem-solving skills and to support the development of people entering the green economy. To achieve this, a complex mixture of experts, facilitators and other support would be required to deliver a robust and meaningful learning experience.

Limitations

Whilst there are many limitations, these are outweighed by the benefits of investing in such a complex programme. Running a programme such as Grand Challenges is costly and requires long-term commitment from the institution. Grand Challenges is time consuming to organise and complex to run, involving many stakeholders who need to be self-sufficient in their approach. The team was limited to running Grand Challenges after the teaching timetable for the year was completed to avoid timetabling clashes for students across different disciplines, and to be able to use multiple rooms on campus in parallel. Because Grand Challenges is extra-curricular, participants do not get credit towards their degrees. Being extra-curricular means we have limited capacity to accommodate student participants but making it modular could remove the fundamental interdisciplinary aspect of Grand Challenges. Increasing participant numbers could significantly increase the cost and complexity of running the programme. However, running this for a single discipline or Faculty could make it easier to manage in many respects. That students do not get credit for participation also encourages risk-taking which student feedback indicates is what they want.

As part of the feedback process, participants are asked to comment on what could be improved. Feedback from student participants is consistent year-on-year:

- Students ask for more information about the programme to be shared in advance. They would like to get a better understanding of what Grand Challenges entail and what they will be expected to do.

- Students say they would have benefited from a more structured approach to their work and more support from facilitators.

Whilst communication and messaging to students have improved to make expectations clearer, we intentionally do not explain everything in advance. This aligns with the theory of planned happenstance and supports the academagogic goals; with Grand Challenges being student-led, participants are deliberately put in a situation where they need to self-organise, agree as a group what they want to do, conduct their own research and design their outputs. Facilitators provide support rather than give answers and suggestions for what participants should do.

When first joining the programme, academic leads and PTAs give similar feedback at the end of their first cycle of delivery. Grand Challenges are unusual as a teaching concept and most of them have limited experience of a student-led approach. We address these questions in PTA training delivered in the months leading to Grand Challenges, with new academics being invited to attend these sessions if they want to.

Other recurring feedback from students is about the number and level of involvement of external speakers. They find external speakers inspirational and value direct interactions with academic and non-academic experts. However, once participants have formed their groups around specific problems they want to address, they get excited about their projects and do not want to spend their time in lectures with guest speakers, unless those are relevant to their projects. The most effective approach is to have guest speakers deliver short sessions sharing their expertise about specific enquiry areas, followed by informal interactions with students through questions and answers or panel sessions, or establishing direct channels of communication with speakers later in the week as students develop their solutions.

Conclusions

The Grand Challenges framework developed by the team is an example of transdisciplinary collaboration that leads to the excellent outcomes of the Challenges themselves. Through our Grand Challenges model, thousands of students have been introduced to the concepts of sustainability, equality, diversity, inclusion and social justice, preparing them for burgeoning jobs in the green economy. The approach has also changed the way that many educators globally approach their teaching; to be research-led, enquiry-based and student-led, facilitative and inspirational. Through the processes of action and reflection, students and staff become more resilient, adaptable, empathetic, and better able to solve problems, all useful skills for the workplace in any sector.

Students are given a unique opportunity to explore ideas and try something new in a safe environment where they learn through action, failure, reflection, and self-direction. Through this process, students examine their motivations and values, leading to self-awareness and impact on long-term career decision making.

Using the distributed leadership model, academic staff, professional services, postgraduate facilitators, and student interns across the institution collaborate, with no direct line management and no hierarchy and form strong communities of practice. The student experience reflects the staff experience as they work in interdisciplinary groups, learn new skills and explore new ideas. The team has set up a programme that embodies its values, and as a result, staff in turn learn from students. We have created a palimpsest of praxis where the programme develops and changes and echoes previous forms. These layers of activity and collaboration enable students to explore, test ideas, and move forwards in their career thinking.

Delivery of this complexity requires careful planning and excellent communication to ensure collaboration. Everybody who collaborates benefits is inspired and empowered to change their practice, whether that is creating new ways of working, reacting to changing environments or co-creation with students.

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No potential conflict of interest was reported by the authors.

Data availability statement

Data contained within this paper is held by the University and will be made available upon request.

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