Beyond business as usual

The transformational promise of Challenge-based Education

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1 The case for Challenge-Based Learning

1.1 UK higher education's inflection point

UK Higher education is at an inflection point. It is being buffeted from all sides: from government, which is expecting it to behave like a market but with heavy regulation; from students recast as consumers seeking to maximise value and from employers who frequently claim that universities aren't producing work-ready graduates (Sandeen, 2014). And, if that wasn't enough - the question of higher education's future-proofing role from the risks of AI and automation have never been more pressing, especially given that 80% of jobs in 2025 haven't been invented yet (Elmes, 2017).

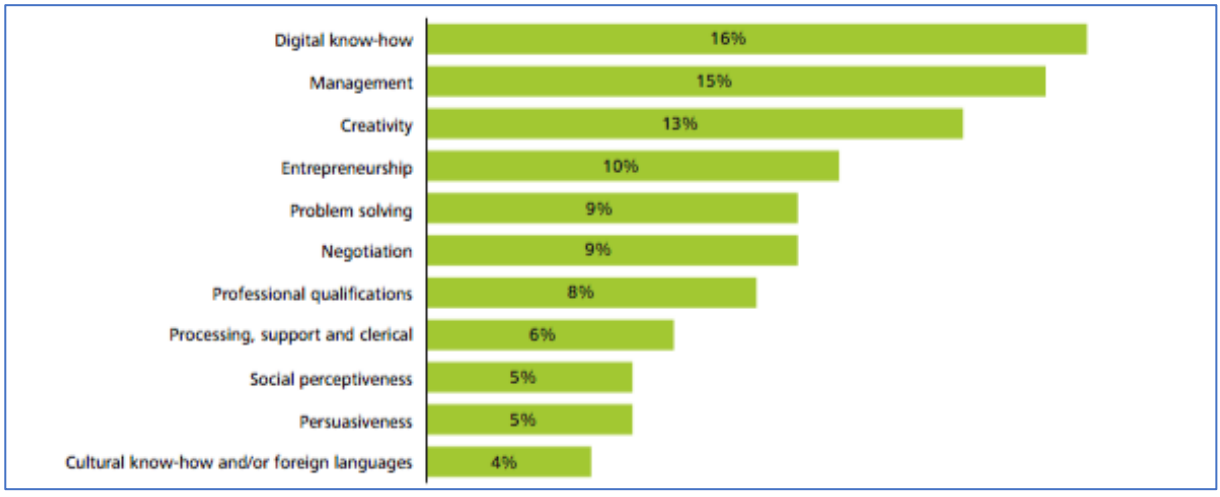
And yet, despite these challenges, we know that higher education continues to offer a return on sizeable investment. Chief among these are of course employability and future earnings, but there are others: graduates are more likely to be fulfilled in work than non-degree holders (77 to 66%); they live longer, are healthier, and the cognitive development of children is better. Alongside returns to individuals, society benefits too: universities are the hubs of regional economies (housing, retail, services); they are often the largest employers, and at a national level, graduates bring in larger tax revenues, are more productive, are low consumers of public welfare and have a lower health cost than non-graduates (BIS, 2013).

Perhaps that is why, as a recent NESTA report has argued, despite the boom in technology-led teaching over the past decade, universities have not had their "Uber" moment yet (Mulgan, Townsley & Price, 2016). MOOCS have come and despite threatening disruption, remain on the margins. Knowledge is still by and large transmitted through physical lectures, courses are still 3 or 4 year long, and university campuses have not opened up to any meaningful degree.

1.2 Skilling graduates for the 4th industrial revolution

Despite the stasis, a view is emerging that the university model is no longer fit for purpose in the twenty-first century (eg, Nesta, 2016). Although some take issue with universities' organisational structures as a whole, the most pointed criticism is reserved for educational models. In particular, universities and the higher education system in general is charged with producing an over-qualified and under-skilled workforce (CIPD, 2015). Although much of such commentary comes from the private sector, sociological research has also suggested that increasing the supply of graduates is neither a guarantee of economic growth or of access to fulfilling work (Brown *et al*,2011).

The skills which are believed to offer insulation from the threats of automation and artificial intelligence - and which can harness their power in the fourth industrial revolution - are arguably those which have been relatively neglected by the global higher education sector. When we look at two influential guides, a clear set of common skills emerge.



Skills required by businesses and public sector organisations, Deloitte survey of 100 Businesses (2014). Source: Deloitte, *Brawns to Brains* (2016)

Compare this to the World Economic Forum's Skills Forecast, which lists complex problem solving, critical thinking, creativity, people management and co-

ordinating as the 5 skills which the global economy of 2020 will most be in need of.

It's worth noting that though in each case they're listed as individual skills, they are also skill 'bundles'; you can't be an effective complex problem solver without good people management skills, or the ability to co-ordinate with others. A recent PISA study showed that students who scored highly on social interactions also scored highly on complex problem solving - and vice versa (Nesta, 2017).

1.3 Challenge-Based Learning

This report investigates the growth of a loose cluster of teaching practices with the potential to activate and cultivate the exact skills which employers and intergovernmental agencies argue can make higher education relevant for our current social and economic era. Challenge-based learning (CBL) is growing in popularity around the world, with models at various levels visible in Europe, North America and parts of Asia. Although practical examples of CBL reveal considerable diversity, they centre around the cultivation of advanced skills for the 21st century, while also adding to our capacity to tackle global challenges in local contexts.

As we will touch upon in a later section, CBL might also have some strategic value for universities as new evaluative frameworks where teaching quality, assessed through student satisfaction, outcomes and employability, looms larger, as does the imperative for knowledge transfer and a corresponding engagement with local stakeholder networks.

2 What is Challenge-based Learning?

Because challenge-based learning is in its infancy, the literature on challenge-based is scant. Correspondingly, so are conceptual and critical engagements with CBL, which is also because much of the small literature on CBL is either reflective (from the perspective of academic staff and teachers who are experimenting with CBL) or prescriptive (such as Apple's 2011 classroom guide). Another factor is that while this report is focussed on university-level challenge-based learning, the concept has also been used for secondary education level teaching and learning.

One way to make sense of CBL is to trace its evolution from and relationship to other pedagogies. CBL is an emerging branch of inquiry-based learning, where teaching and learning activities are fundamentally experiential and orientated around a central point of inquiry. The most developed articulation of inquiry-based learning is problem-based learning, and both literature and the practice is well developed and diffused across educational levels.

2.1 Problem based learning

PBL is focussed, experiential learning centred around the investigation, explanation and resolution of chosen problems (Barrows, 2000; Torp & Sage, 2002). Historically, PBL originated in medical education as it became evident that, devoid of a clinical context, students were failing to properly engage with and master clinical knowledge.

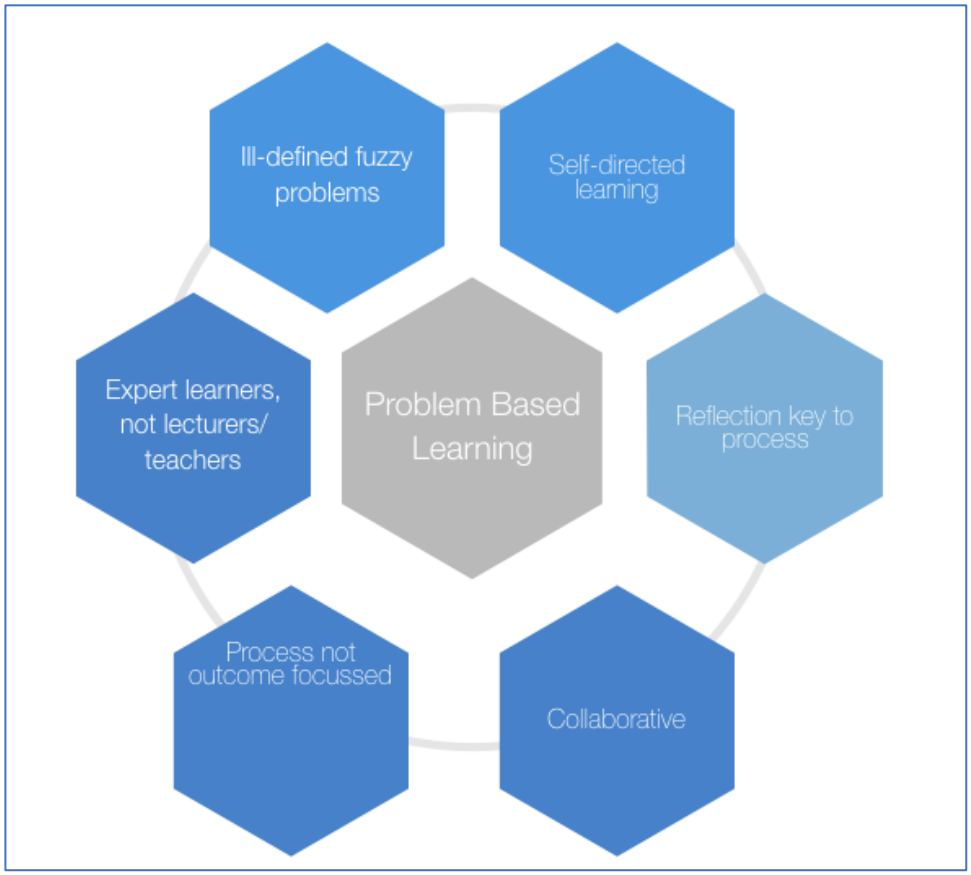
Since then, PBL has diversified applications but remains most popular in medical and engineering education. It has also proliferated across a range of educational levels, including primary, secondary and higher. While it is possible for PBL to be adopted institutionally (see Nesta, 2015) it is commonly used at curricular level, either as the basis for entire programmes (see the Best Practice section) or as individual sessions in a syllabus.

There has been some debate about the efficacy of PBL versus traditional higher education pedagogies, and these have largely centred on PBL's value for short term knowledge retention (Kirschner, Clark, and Sweller, 2007). A large scale meta-study of PBL found that while it is less effectiveness than traditional instruction for memorisation and retention of short term knowledge, it was more effectiveness at long term retention and skill development (Strobel & van Barneveld, 2009).

2.2 PBL: key features

There is some debate about the common features of PBL because there are diverse approaches to it. Below is a list of its most foundational properties:

- Students work in collaborative groups
- Problems must be ill-defined and fuzzy (so that understanding the problem becomes an integral part of the process)
- There are no single correct answers to the 'problem'
- Students engage in self-directed learning (SDL)
- Learning outcomes are focussed as much on process as content
- Reflection on the process is key
- Teaching staff adopt the roles of a facilitator (a "metacognitive coach", using Barrow's term) rather than a transmitter of knowledge



The properties of Problem Based Learning

2.3 The benefits of PBL

PBL has multiple goals. Firstly, PBL seeks to help students go beyond learning subject facts to integrating information from multiple disciplines, and using that knowledge flexibly when required (Kolodner, 1993). Secondly, PBL seeks to develop effective problem-solving skills - what are sometimes called "meta-cognitive skills" (Hmelo-Silver, 2004).

Secondly, low student engagement in material is widespread across higher education, and PBL is used to boost students' intrinsic motivation. Anecdotal evidence from lecturers shows that students are more engaged in subject material when situated in the context of a meaningful problem (Torp & Sage, 2002).

Thirdly, PBL promotes self-directed learning (SDL). SDL itself covers a subset of skills including metacognitive awareness of what they know, what they don't,

and what they need to advance their understanding of a problem (Hmelo-Silver, 2004). Additionally, they have to set their learning goals and plan how to learn. While teaching staff facilitate and 'scaffold' the learning process, they are not expected to map this out in detail, since part of the key learning gain for students is learning how to problem-solve and learn how to project manage.

Lastly, PBL emphasises collaborative skill development since all PBL involves collaborative problem-solving, underscored by the premise that learning is at best a social process (Nesta, 2015).

In PBL the role of the facilitator is critical: their task is to scaffold learning through the use of questioning strategies. Effectively, PBL practitioners are coaches rather than lecturers. They are not necessarily subject experts (and given the multidisciplinary nature of meaningful problems, cannot be) but are "expert learners, able to model good strategies for learning and thinking" (Hmelo-Silver, 2004: 245).

As we will discuss later, training staff to become effective PBL practitioners is essential, since the skillset required is far removed from the traditional transmission of higher education, and being able to make good judgements about the line between appropriate scaffolding and obstructive intervention is a fine one.

2.4 Project- based learning

Problem and project based learning are sometimes used interchangeably but often incorrectly so (Savery, 2006: 15). Whereas problem based learning is often open-ended, with no direction from the teacher/facilitator on a specific outcome, project based learning is far more directed, with students given clear directions on what should be produced at the end of the learning process (summative assessment is invariably linked to those products).

The Aalborg model of PBL, used extensively at Aalborg University, blends project and problem based learning, which works well in the context of a predominantly Engineering curriculum (see Practice section for more on their specific programmes). Where problem based learning is used in a non-engineering or multidisciplinary programme, directed *product* outcomes are less successful and arguably less valid.

2.5 What makes CBL distinctive?

Despite the similarities to PBL and project based learning, CBL is distinctive in both its applications and in its dimensions. In this section, we set out 6 distinctive features of CBL. These represent an ideal type of challenge based education, and while some programmes featured in the next section exhibit some of these characteristic features, they do not feature them all.

2.5.1 Challenges vs problems

The problems in PBL must be meaningful, messy and complex (Savery, 2006), since some of the skills developed through it relate explicitly to understanding and deconstructing problems. In CBL, the difference is that the problems are real world. In Apple's CBL Classroom guide they have a very prescriptive and specific definition of what constitutes a challenge. They propose that the challenge in CBL must be the local manifestation of a global challenge, and their process suggests that students must first identify the "Big Issue" and follow that with "Essential Questions" (Apple, 2011).

As we will see in the Practice section which follows this one, there are other - equally valid - interpretations about what constitutes a challenge. Many of their teaching and learning methods begin with the identification of a global challenge, but refracted through the practice of a business, non-governmental organisation or social enterprise.

Apple's definition is limiting because it also privileges a certain conceptualisation of entrepreneurship and innovation that overlooks *intrepreneurial* action, and therefore both the necessity and scope for intervening in challenges through existing organisations. It can reinforce the fallacy of the "hero social entrepreneur" acting without a sufficient understanding of the solutions landscape of a given socio-environmental challenge (Papi-Thorton, 2016).

Our more inclusive definition is simply a project related to a real-world project. Our definition also leaves it open to whether the challenge is open-ended or not: in Apple's definition, the outcome is to be decided by the students themselves. In ours, it could relate to a problem set by an organisation whose mission relates to a global challenge (in a local context).

Where the challenges are open-ended or not, CBL demands greater, deeper and more sophisticated research skills than PBL. In the case of open-ended challenges, they also require the capacity to locate challenges in interrelated systems and to critically differentiate between different intervention types and levels. In the case of closed challenges, they require the capacity to understand organisations, their position in a solutions landscape in order to meet their expectations. The products of CBL are also diverse as a result (see the section on openness below).

2.5.2 Use of 21st century technology

In CBL, A Classroom Guide (2008), Apple describe CBL as:

"an engaging, multidisciplinary approach that starts with standards-based content and lets students leverage the technology they use in their daily lives to solve complex, real-world problems". It is not entirely surprising that Apple would emphasise the centrality of technology to the CBL process, but they're not the only ones to argue that CBL offers a unique opportunity to integrate technology.

In their report on the challenge based university, Nesta argue that one common feature of challenge based programmes is the use of technology, and that technology can be used at various points. Because a large proportion of CBL takes place through collaboration between stakeholders who are not co-located (students with practitioners, for example, or students working at different universities), the need for digital collaborative tools to share ideas (interactive whiteboards) and project manage (web based kanban board tools like Trello or Asana) are required. It is because remote collaboration is so common in CBL that technology becomes essential to the process.

c. Engaging outside community stakeholders

In either it's closed or open-ended formats, CBL necessitates that students work with a range of external stakeholders, including local potential beneficiaries, service users, subject experts, local government and service agencies. As a consequence, while CBL can take place over a compressed period of time (such as during a hackathon) it is often best conducted over a sustained period of time so that students can build effective relationships with each of these external stakeholders. Unlike PBL, which can be relatively self-contained, CBL demands a more expansive approach which builds into a set of accountabilities and expectations.

2.5.3 Deliverables

Once local stakeholders are engaged, students are expected to deliver something to the stakeholder community (Malmqvist, Rådberg, Lundqvist, 2015). The necessity of a deliverable is what positions CBL between project and problem based learning, where deliverables are at the discretion of the learners and not the result of a consultative or design process (Savery, 2006). In some cases where CBL is run out of Engineering departments (and primarily for Engineering students) this can be in the form of physical prototypes, but in other cases it could in the form of reports or service pilots.

2.5.4 Entrepreneurship

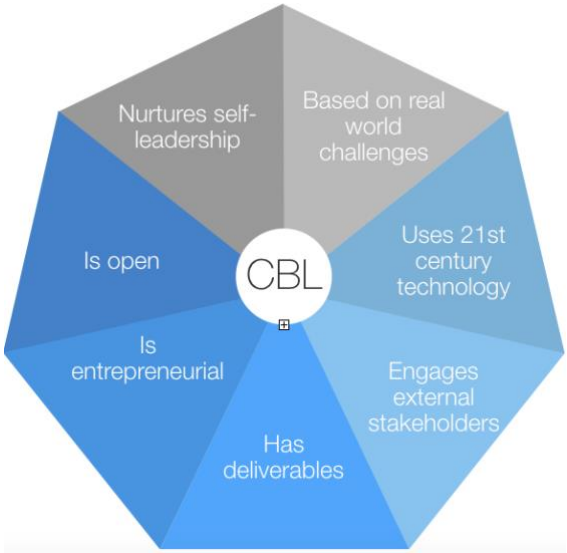
More often than not, deliverables are coupled with an expectation of some kind of economic sustainability, so in many cases (as we shall see later) there is a strong onus on entrepreneurship and the production of business models, and some of these are directly linked to on-campus incubators. In other cases, especially where the challenge is "closed" and well-defined, the products are report, presentations, strategies or business models.

2.5.5 Openness

In Nesta's (2015) description of the challenge based university they describe one of the key features of challenge based programmes as an engagement with the open economy. Unlike problem-based learning, which can be a closed classroom process, in its open-ended format CBL depends on students engaging with the open innovation process. Not only are students expected to take from the open economy but equally to contribute to it. There are numerous examples of socially focussed open innovation platforms, including the Open IDEO Innovation Challenges, which are founded on the premise that learning and innovation must be shared and not subject to proprietorial ownership. This can present problems, of course, especially when students design products and services which they believe have value and where they would like to develop them further themselves.

2.5.6 Self-leadership

The final distinctness characteristic of CBL is also perhaps the least common, but recognised as crucial to the many of the learning outcomes and processes which animate CBL. It is a "post-hoc" dimension, as practitioners have run up against capability gaps in students in regards to specific areas such as values literacy, time management, team management, and persuasive communication.



The key features of challenge-based learning

Some of the characteristics above follow on from others; the use of remote collaboration tools is a natural connection to interdisciplinary and international collaboration. Implementation and entrepreneurship result from engaging external stakeholders, which itself is a natural outgrowth of working on the local manifestation of global challenges.

What results from these pedagogic features and their related activities are a set of interrelated learning outcomes (LOs) which taken together form a 21st century skillset. Many CBL activities are structured so as to replicate real life working situations which organically necessitate the cultivation of specific skills - a process called “mirroring”. These include innovation skills, complex-problem solving skills, creativity, design thinking, cross-cultural collaboration skills. All of these skills are cited by the World Economic Forum in their 2020 skills forecast.

As we move into a labour market marked by great uncertainty, and where AI and machine learning are both making jobs redundant and creating new professions, it’s a skill focus which is vital to the future employability of our graduates, and that’s where CBL has such strong strategic value.

Despite belonging to the same family tree as PBL, project-based learning and inquiry based methods in general, CBL extends those principles and leverages the collaborative opportunities afforded by technology and the open economy. It also contributes the re-articulation of higher education as not just a space for collaborative problem-solving where the engaging of external stakeholders is fundamentally integrated into teaching programmes, rather than a decorative flourish.

In the next section, we'll explore some of the innovative and diverse ways in which CBL is being practiced around the world as challenge-based education (CBL) programmes.

3 CBL in practice

Having identified some of CBL's defining features - especially those which distinguish it from PBL - it's now time to turn to some of the ways in which CBL is manifest in higher education itself (what we'll call challenge based education, or CBL).

PBL can be adopted at the modular, programme or institutional level (Hmelo-Silver, 2006). CBL is similar, though due to the nature of challenges it is harder to implement CBL at the institutional level (and possibly also not desirable, but more on that later).

In Nesta's report on challenge-driven universities they flatten the difference between universities where challenge-based learning is institutionalised and those where there are one (or two) challenge based programmes, modules or (extracurricular) competitions. Thus, we saw full university approaches (such as Utrecht's) included in the same section as individual programmes (such as Northampton's). I'd argue it's important to draw these distinctions because we can't call a university "challenge-driven" unless such approaches and methods are institutionalised. On the other hand, we should also not the make the mistake of discounting the flexible integration of CBL into traditional degree programmes (nor why it might be better to do so than moving entire universities in challenge-based directions). In the spirit of this distinction, this section will therefore proceed as follows: with an overview of what a challenge-based university looks like, and then an exploration of challenge-based programmes.

The list of universities and programmes featured here is not meant to be exhaustive, but indicative, showcasing a range of different approaches which each have different merits, approaches and learning outcomes.

3.1 University level CBL

We'll start with a look at two universities who are moving toward an institutionalised CBL approach underpinned by a commitment to problem-based learning: Aalborg in Denmark and Maastricht in the Netherlands.

3.1.1 Aalborg

Aalborg is one of the original homes of PBL is Europe, and boasts not only its only PBL Chair, but the ownership and editorship of the *International Journal for Problem Based Learning.* All their taught programmes, whether at undergraduate or taught Masters levels, include PBL components. As a general rule, project work is worth half of all curricular credit (15 ECTS for project work per semester).

Each year students are expected to work on a project in collaborative teams, facilitated by a research-active lecturer whose role is to guide through structured prompting rather than directly answering questions. Projects on programmes vary across each year (as each has a different thematic focus). While not all of the problems used in their programme project work are global challenges, some are. The programme in Sustainable Biotechnology, for example, (one of just 10 in their undergraduate suite) is directly concerned with using biotechnology for sustainable economic development.

Project topics on the Sustainable Biotechnology programme include:

- Biogas production from macro algae for municipal waste processes
- The production of biodegradable cigarette filters with seeds
- The biological production of nano-particles for cancer treatment
- The production of bioplastic
- Using the bio manufacture of green microalgae for low cost pharmaceutical manufacture

In terms of our criteria for the unique characteristics of CBL, Aalborg's institutional pedagogy is explicitly committed to the use of the involvement of external stakeholders (predominantly businesses) and twenty-first technology. Those dimensions which are less emphasised are openness, entrepreneurship, self-leadership.

The Aalborg model is clearly built on the principles of PBL, and is evolving, particularly on its engineering programmes, towards a challenge-based approach. While it doesn't exhibit all of the features of CBL, there are signs that the natural extension and evolution of programmes will naturally lead to the addition of entrepreneurial elements - especially given the fact that students are working the development of specific products which could be commercialised and form the basis of new social enterprises serving the bottom of the pyramid (Prahalad, 2004).

3.1.2 Maastricht

Like Aalborg, Maastricht University in the Netherlands bases all of its teaching and learning on an extended model of PBL which incorporates elements of CBL. Integral to their pedagogy is collaboration, problem-solving, and the engagement of external partners. They place a big emphasis on the employability of students and the acquisition of skills which prepare students for the 21st century labour market.

On programmes such as Data Science and Knowledge Engineering students gain work experience through the honours programme KE@Work, where students spend 50% of their time on their curriculum and 50% working in businesses such as Vodafone on business challenges.

As at Aalborg, all students work in small groups in interdisciplinary programmes with a member of staff who acts as a facilitator. The small groups are supplemented and guided by traditional lectures.

Uniquely, as a young university (ranked the 6th best young university in the world) Maastricht has also recognised the need for institutional innovation capacity by establishing its own education innovation lab (EdLab). Edlabs role is not just to support instructors but to research and design new teaching methods including updating its PBL approach, and constantly seeking internal and external feedback to enhance its teaching and learning.

It is now well recognised that universities don't only suffer from a lack of innovation in education, but more fundamentally in the capacity to innovate, and the need to invest in innovation processes is therefore key to the continued growth and relevance of higher education.

The elements of CBL which are currently absent from Maastricht's offer are entrepreneurship, self-leadership and using global challenges as the framework for problem-based learning. Based on our argument that the engagement of external partners (including businesses, but also local governments and NGOs) naturally produces expectations about outputs and communicative excellence, we expect these dimensions to follow soon.

3.1.3 Programme level CBL

3.1.3.1 Global Challenges, Monash University

Monash University (Australia) runs a Global Challenges programme in Science, which itself is unusual given the high number of CBL programmes which are Engineering based. The programme has a high entry tariff (higher than Monash's Science undergraduate programmes) is very competitive (1 in 6 acceptance rate) and has a small cohort (30) per year. This year (2017) its first batch has graduated, so data on learning gain and attainment is not yet available. Students are drawn from all the science disciplines.

The programme is 4 years long, and combines traditional science subjects with core modules in the 3 streams of leadership, entrepreneurship and science communication.

Leadership is explored in depth in year 1, when students undertake a leadership "quest" designed to explore their values and a global challenge that's important to them. In year 2, entrepreneurship is the main theme, and students are tasked with designing a (capstone) project using science to address a global challenge. As is quite common with undergraduate students, the reuse of waste is a popular theme. Examples include a project which up cycled waste beer grains into protein-rich cookies, and an app which connects builders with DIY enthusiasts in need of waste building materials. In year 3 students work in collaborative teams on university science research projects, and in year 4 they work with industry on business challenges.

Special features

The programme combines open-ended and closed business challenges, with the closed challenges reserved for the last two years when students' work is externally facing and when they are correspondingly expected to produce higher quality outputs. As a consequence, "scaffolding" is highest in the first two years when the emphasis is on skills development and knowledge acquisition. To allow students who design projects in year 2 which have potential for scale and growth, they have special dispensation to allow students to go part-time to allow them to finish.

3.1.3.2 Sage, San Diego State University

An interesting spin on CBL takes place at San Diego's State University's (SSDU) Sage Project. The Sage Project works by enabling faculty at SSDU to link their units or modules to city-wide projects in San Diego.

Sage is a collaboration between SSDU and the City of San Diego, as well a consortium of NGOs in the city.

Annually, Sage Project connects 10–15 different community projects with 20–30 courses. Approximately 500 students are engaged across the disciplines (data is not available for the spread across disciplines), making it one of the larger CBL projects. Examples of projects include those working on homelessness outreach, strategic planning, city budget solutions, air and water quality, GIS mapping of city assets and land use analysis.

All students from year 2 onwards on their degree programmes are eligible for Sage projects, as long their courses they take have enrolled in the programme. The structure of programme varies depending on faculty requirements, but projects typically run for a semester.

Like many challenge based education programmes, the Sage project emphasises the "triple" value of CBL: providing students with real life skills and experience valued by employers, helping universities to boost their employability returns as a consequence, and also providing community benefit. Nesta describe CBL as a means of renewing the "social contract" between universities and local communities. Similarly, Sage describe the "true benefit" of the programme as: *"the positive attention, collaborative learning, and new momentum the partnership provides for students, faculty, city staff, and residents"* (From Sage Project, Guide for Cities).

Special features:

The challenges which student teams work on are closed rather than open-ended; students are assigned to existing projects in order to increase their operational capacity in specific areas. Closed challenges can of course led to open-ended challenges and the formation of new interventions once students have "apprenticed with the problem" well enough.

Research skills are a resource which students are highly trained in but which community organisations sometimes lack capacity, so there is mutual value assurance in assigning students research led challenges.

The SAGE project team effectively resource and manage the entire process of embedding projects in courses. They connect faculty with local organisations, broker agreements, and promote both the organisation's projects and students work. As a central resource, SAGE reduces the burden of finding, establishing and maintaining external relationships on faculty staff (which can provide a large obstacle and entry barrier, see below).

3.1.3.3 EPICS programme, Purdue University (and others)

Another variation on CBL is Purdue University's EPICS (Engineering Projects in Community Services) programme. The programme is one of the longest running CBL projects in the US, having started in 1995, and is closely aligned to the "service learning" model adopted throughout the US university system.

Unlike SAGE at San Diego State University, the programme is solely for Engineering students (reflective of a tendency for CBL courses to be Engineering and therefore product rather than service orientated). That said, the programme does pull together students from across a diverse range of Engineering disciplines with a mission to "design, build, and deploy real systems to solve engineering-based problems for local community service and education organizations" (EPICS, Purdue, 2015). Like SAGE, EPICS seeks to add value to community organisations who lack capacity or the financial resources to pay for specific areas - in this case technological solutions.

For students, the value lies in being able to apply their disciplinary knowledge in real world contexts and to complement it with twenty-first century workplace skills such as design, communication and skills. As the programme website argues, *"undergraduate students face a future in which they will need more than solid*

expertise in their discipline to succeed. They will be expected to work with people of many different backgrounds to identify and achieve goals. They need educational experiences that can help them broaden their skills".

Examples of the projects include "shelters for safe-housing to impoverished and natural disaster areas", and "alternatives to firewood for fuel in Uganda". Unlike SAGE, EPICS has a global scope, and challenges are co-designed with organisations, and through them, beneficiary communities.

The course structure includes weekly lectures and workshops on design, ethics, empathy, leadership and prototyping. Because EPICS is embedded within the Engineering faculty, there is greater standardisation of the learning process across all projects.

Special features:

EPICS runs on a large scale: it has about 30 projects per year, with between 8-18 students at Purdue. It has since scaled with the formation of the EPICS consortium, with over 25 colleges and universities in the US (and 5-6 in India) replicating the model and sharing best practice with other members.

Uniquely, as a function of its proven value to community stakeholders and the longevity of the programme, EPICS is resourced by a combination of Federal grants ($51 million and corporate and alumni gifts ($5.5m) since its inception 20 years ago.

3.1.3.4 GU Impacts, Beeck Centre for Social Innovation and Entrepreneurship, Georgetown University

GU Impacts is an extracurricular programme run from the Beeck Centre for Social Innovation and Entrepreneurship at Georgetown University.

GU Impacts places students with partner organisations around the world, including in India, Nicaragua, the Philippines and the US. So far 98 students have been chosen as GU Impact Fellows. Like SAGE but unlike EPICS, it is multidisciplinary, with students being able to take the programme during their

second year. The fellowship is 8 months long but structured around a 10-12 placement.

"The best part of my GU Impacts experience was certainly the unexpected moments of community immersion that put the work we were doing into sharp focus and allowed me to understand why it was important." - Kshithij Shrinath, GU Impacts 2016 Fellow

Because the programme is international, projects vary from country to country (and like most international CBL programmes, the concentration of projects is also not evenly spread, with far more in the local area around Washington in Maryland state but also in the countries listed above.

The placements may not be described as challenges, but are discrete, finite 'projects' with well-defined organisational briefs in areas such as Storytelling, Marketing and Fundraising. Each project brings has key deliverables, and an induction period in which Fellows must identify SMART goals in consultation with their placement organisations. Some projects require disciplinary specific and technical expertise, but many projects are disciplinary generic so that students from a range of subject areas could take them.

Special features:

Because GU Impacts operates internationally, it combines physical and virtual interfaces. All GU Impacts Fellows are required to be in country, working directly with partner NGOS and community organisations for the majority of their fellowship. Beyond that, they are encouraged to maintain relationships with partner organisations through web technologies such as Skype and Google Hangouts. As these technologies (and underlying internet infrastructures) proliferate, the scope for a combination of offline/online challenges will also increase.

The programme's Fellowship structure means that while it is not credit-bearing, it's 8-month duration overlaps with credit-bearing commitments. Students must attend GU Impacts Orientation (before the placement) and, post-placement, write a capstone project for their placement organisation and present it on campus in the following semester. The Fellowship is therefore demanding and combines offline and online relationship management.

Students on a GU Impacts programme

GU Impacts is resourced, like the Beeck Centre itself, through philanthropic donations. The Beeck Centre has dedicated administrative staff to run the programme, and so there is no administrative burden on mainstream academic staff. The scalability of CBL programmes - especially international ones - unsurprisingly depends on the strength and quality of administrative staff. International CBL programmes are by their nature more complex, subject to more risk assessment, deeper logistical planning, and are in general more resource-intensive. Where such administrative staff are dedicated to that CBL programme and thus have the opportunity to build up operational experience and expertise,

not only is it easier to scale, but the quality and speed of the administration also increases.

From their 2017 cohort, 100% of students reported gaining clarity on their higher education goals and career interests. Secondly, students reported an expansion and strengthening of their professional networks. Specifically, they cited increased confidence in leveraging their networks for career guidance and direct referrals. Significantly, 83% of the 2017 GU Impacts Fellowship claimed that they had developed a useful professional network as a result of their participation in the programme.

3.1.3.5 Urban Innovation Lab, Ash Centre for Democratic Innovation, Harvard

The Urban Innovation Lab at the Ash Centre for Democratic Innovation at Harvard is a curricular and credit bearing CBL programme which brings research, education and innovation together in local contexts. The Lab is structured through a course called Field Study in Urban Innovation, which is taught jointly by Ash Centre academic staff and local public officials, including the mayor of the city of Somerville. As part of the module, students can take part in projects in 5 cities across Massachusetts, and the partnerships are with municipal authorities rather than individual NGOs or social enterprises.

Unlike the other programmes featured here, it is a graduate (UK: post-graduate) level course, which is reflected in the nature of the projects: mainly centred around designing and implementing data-driven strategies. The projects also invite students to investigate the role of social innovation on areas of public policy, so that as well as working with city governments on specific urban issues, they generate policy-level insights. The combination of real world problem-solving with “helicopter-view” critical reflection and evaluation allows students to get field-level insight and then to pan out from their specific intervention to the field at large, helping to feed into students’ other curricular work.

Special features:

The Urban Innovation Lab specialises in the use of data-driven approaches to municipal government, and is run with the assistance of 5 graduate students who serve as Field Lab Co-ordinators. put together "City Files" on which each project is based, together with background research. They have also established working relationships with officials in each five cities, and accompany each team working on one of the 5 city projects, which are mainly centred around designing and implementing data-driven strategies. In the PBL style, these co-ordinators serve in the capacity of coaches, not teachers/lectures, and are not responsible in assessing students.

3.1.3.6 Spark India, Social Impact Lab, University of Southampton

The Spark India programme began in 2014, and annually selects 10 students from a two-stage open competition. Last year there were 13 applicants per place.

It selects students from across the University of Southampton (a comprehensive research-intensive university) on an annual basis. Like GU Impacts, Spark India is a fellowship programme and each cohort joins and grows the historic fellowship community.

The programme has evolved to its current iteration where it partners with social enterprises and innovative NGOs in Mumbai, India on in-country closed organisational challenges for 3-4 weeks.

Each challenge is preceded by an orientation period where each team, in consultation with partner organisations, agree on key deliverables and milestones during the placement period. These challenges are then extended with remote internships where fellows with in-country experience are joined by other students (potential applicants for the next edition of the programme).

Spark India 2017 fellows at partner organisation, Dharavi Diary

Unlike GU Impacts, where fellows are distributed among international locations, all Spark India Fellows are based in the same location (Mumbai) for the duration of their placement with partners. This co-location facilitates the combination of team-based organisational challenges with personal leadership workshops and both individual, group mentorship and peer mentorship.

The Spark India programme also uses soft skills benchmarking and self-reporting to evaluate the success of the programme in achieving its intended learning outcomes and helping students reflect on their learning experiences. It seeks to be needs-blind, with funding coming from a combination of central mobility funding, faculty scholarships, and educational enhancement funding.

Longitudinal data from the programme has been successful in attracting students with Protected Characteristics (women, BAME students) as well as those from Widening Participation (WP) entry routes. 40% of the programme's 126 applicants in 2017 were either PC or WP, rising to 60% of the chosen 10 fellows. Additionally, 60% of Fellows from 2014-2017 were female.

Name of programme	*Curricular/ extra-curricular*	*Scope (Local/ National/ International)*	*Team-based/ individual*	*Closed/open challenges*	*Disciplinary specific/disciplinary generic*
Global Challenges, Monash	Curricular	National	Team	Combination	Specific (Sciences)
EPICS, Purdue	Curricular	Local	Team	Open	Specific (Engineering)
SAGE project, San Diego State	Curricular	Local	Team	Closed	Generic
Urban Innovation Lab, Ash Centre, Harvard	Curricular	Local	Team	Closed	Specific (Political/Social Sciences)
GU Impacts, Beeck Centre, Georgetown	Extra-curricular	International	Individual	Closed	Generic
Spark India, University of Southampton	Extra-curricular	International	Team	Closed	Generic

A comparison of CBL programmes

3.2 Differentiating and unifying features

From the CBL programmes selected above, there are a number of differentiating features and unifying factors.

3.31 The difference between open and closed challenges

The first is the distinction but equally the interrelationship between open and closed challenges. As we've seen, some definitions of CBL insist upon the open-ended nature of challenges (Apple, 2015 amongst them). They do so to emphasise on one hand the need to propose difficult problems "and the skill of problematising", and on the other, for students to propose solutions which can feed into an open innovation process.

We've seen a number of programmes where closed challenges are used in CBL programmes, where universities or university centre co-design real life organisational challenges with charities, NGOs and businesses for a social (or non-social purpose). In some cases, these might fall outside the desirable parameters of CBL because these challenges do not have a social purpose, or one which can be related to a global challenge.

In other cases, however, closed programmes with social purpose organisations (or in collaboration with businesses or governments) on social challenges, such as in SSDU's SAGE programme, can be valuable for two reasons. Firstly, they offer resource-constrained community organisations access to specific technical expertise in areas such as fundraising, social media, website design, business planning and cashflow management (among other areas) at no cost beyond hosting interns and orientating.

Secondly, value flows the other way by giving students a real context to apply their disciplinary and develop cross-disciplinary working skills (teamwork, creativity, adaptability etc.) as well as giving them an in-depth opportunity to "apprentice with a problem" (Papi-Thornton, 2016). With that in depth knowledge of one specific intervention for a social challenge, they are then better-prepared and informed to launch their own intervention into the problem-space (if appropriate).

3.32 Curricular vs extracurricular

From our small sample selection, we've also seen a variety of curricular and extra-curricular CBL programmes. Both have their merits; curricular programmes are income-generating and can be subsidised through fee income. They are also more closely regulated and subject to quality assessment.

Extra-curricular programmes have the advantage of being 'bolt-on', and therefore require less quality assurance bureaucracy. As a consequence, they can

be more innovative, experimental, and ambitious (see GU Impacts as an example). They are limited, of course, by their place on the margins of the academic year, since they can only take place out of curricular time. Because they're not credit bearing, there might also be issues with student performance and relatedly with meeting the expectations of partner organisations. As non-curricular programmes, they are either subsidised by taught programmes, donations, or a combination of both.

Finally, we've seen that CBL is a spectrum. All of the programmes featured in this section exhibit most of the features we listed above in our ideal-type CBL programme, but none exhibit all of them. As an evolution from PBL, CBL programmes exist on a spectrum, with some closer to PBL and others further towards a 'fuller' CBL expression with more emphasis on global challenges, the use of collaborative technologies, open innovation, and entrepreneurship.

4 Assessing Challenge-Based Learning

4.1 Learning outcomes

Just as universities as beginning to experiment with news modes of teaching and learning which respond to the call by employers and government to cultivate 21st century skills - of which PBL and CBL are examples - we're seeing a corresponding growth in experimentation with new assessment methods. Such methods deploy assessments which mirror real world deliverables and outputs which are intelligible and valued to the world outside the university.

A starting point for these experiments is how best to assess the intended learning outcomes of challenge based education. In a PBL context, Barrows (2000) argued that "the focus on short-term learning gains as a measurement of PBL seems a particular mismatch considering that learning within an authentic context is a key criterion of the definition of PBL (Barrows, 2002).

When the intended learning outcomes for CBL include collaborative skills growth, design skills, presentation skills, persuasive communication, project management skills and self-leadership, it's easy to see that the assessment methods for CBL are necessarily very different from those used on traditional programmes.

4.2 Formative vs summative assessments

Formative assessment in CBL principally takes two forms. The first is informative, and involves continuous feedback to groups on their progress at every point in learning process. Feedback in this context is often given by the facilitator, who, acting as a "master learner", scaffolds their problem-solving and decision-making process reflecting the priority for students to work through problems themselves and to cultivate that particular cognitive "meta-skill" (Hmelo-Silver & Barrows, 2006).

The second is in the form of iterative feedback on the same deliverable at incremental stages. This can include documents such as a business plan, a product, or iterations of a service. This feedback comes not only from faculty but also from their peers where appropriate (such as prototyping showcases) and from their own expert networks when their projects are hosted online as part of an open innovation process. The digital innovation platform Babele (www.babele.co) hosts the projects of several social entrepreneurship programmes, and is designed to enable external experts to offer remote feedback on specific elements of students' projects. Some CBL programmes, such as our Social Enterprise module at the University of Southampton, also bring local mentors from local businesses and community organisations into classes.

While these multiple and diverse forms of feedback can be enriching, they can also be confusing: our own experience shows that stakeholders have to be guided to offer feedback on specific learning outcomes rather than all, and that it takes careful planning and management on the part of CBL facilitators.

Capstone or summative assessments often involve engaging external stakeholders, and can be used to test learning outcomes related to persuasive communication, public speaking, and report presentation. Often summative assessments combine oral and written presentations, and showcase events.

4.3 Formative assessment: examples

Formative assessment in CBL takes multiple forms, but is usually associated with offering feedback on what some facilitators call "process" rather than product. On the EPICS programme for example, the distinction between formative and summative assessments are narrow, reflective of the need to cultivate skills and demonstrate skills at different points in the challenge based process. For instance, on most CBL programmes, students move through different stages: understanding the systems context of global challenges, problematising,

evaluating the solutions landscape, and them moving through to designing interventions. As a result, EPICS programmes have deliverables at regular points, and assessment is cumulative rather than bunched at the end of the course.

There are pedagogic benefits to assessment design like this. For one, students are required to engage consistently throughout the programme, rather than selectively engaging only during assessment periods at the end of courses. It can of course mean that facilitation is resource-intensive, since faculty have to facilitate classes/workshops alongside assessing milestone deliverables. Depending on the size of the cohort, this can stretch academic staff (but also potentially receive marking "bottlenecks" at the end of courses).

The course organization (Spring term 2015) includes weekly lectures on design, ethics, empathy, interviewing & observation, leadership and prototyping/craftsmanship. There is a detailed schedule for the project work including deliverables per week, indicating that the projects are run in a highly structured and similar way.

4.3.1 Reflective learning journals

A key method used to assess students' self-leadership journey is the use of a reflective learning journal. While there has been little research on the best way to use such journals, they can be used either for personal use only, for students and academic facilitators, or a combination of both.

Students can be asked to use such journals to reflect on their deployment and development of core-intended learning outcomes. For students, an interesting approach with regards to skills tracking is to use electronic journals or blogs with specific tags related to each skill 'area', where students are invited to use the tags as an organising tool which they can later reflect on. In turn, such tracking can be used to help facilitators to measure cohort level changes (Wurdiger & Qureshi, 2015).

Reflective learning journals are difficult to assess, but parameters can be set around them, including directing content to reflect on specific tasks during the challenge process, skills progress, and reflecting on difficulties and corresponding coping strategies which emerge. Clear expectations and rapid feedback on reflective learning journals is important to ensure that students understand the value they offer, rather than viewing them as a distraction from the project itself.

4.3.2 Mid-term reports

Mid-term reports are also useful tools in formative assessment. Because CBL is an iterative process, it can help to submit early versions of deliverables such as business plans, business model canvasses, impact canvasses, or theories of change (*Dale et al*, 2015). Again, iterative submissions can reduce students' stress by offering feedback at incremental stages reducing uncertainty about final grades, and keeping them more "mindfully" focussed on present tasks rather than heavily-weighted final assessments.

4.4 Summative assessment: examples

4.4.1 Pitch presentations

A common assessment tool used in CBL programmes are pitch presentations. Such presentations typically involve project teams presenting their project deliverable (whether a plan, strategy, prototyped product or service) to external stakeholders, including those involved in the project process. Pitch presentations are used on Monash's Global Challenges programme, for example, but also on smaller courses such as the University of Southampton's Social Enterprise module.

Pitch presentations serve a double function: they can be used to assess learning outcomes such as presentation skills (oral and visual), but they can also be used as a springboard to continuing support. On Southampton's Social Enterprise module students pitch for cash support and mentorship for up to six

months after the end of the course, and that also means they receive two different types of feedback pitched at different levels. While faculty offer detailed feedback matched to learning outcomes and to an academic rubric, external judges offer faster and often oral only feedback on content. The format also mirrors real world pitching events. Appointing mentors as judges during the pitching event also increases their investment in the students' journey, helping to secure their involvement in future iterations of the programme.

4.4.2 Prototype showcase

A variation on the pitch presentation is a prototype showcase, where students host clients and/or external stakeholders at an event at the end of a course. Such showcases are more likely used on product-based programmes, which are common in Engineering but less so in other disciplines and interdisciplinary programmes.

Both pitch presentations and prototype showcases are used to assess both the project deliverable and presentation/communication skills, as well as students' mastery of knowledge areas (which might also be assessed during formative assessments).

4.5 Soft skills gains

4.5.1 What are soft skills?

CBL is valuable not only because it is proven to boost student engagement but also because it priorities the development of so-called soft skills. Soft skills, unlike hard skills (e.g. suturing for medics), are not restricted to a specific application but can be used in a variety of workplace and non-workplace contexts. Graduate employability can be conceptualised as a combination of hard skills, soft skills, and knowledge (Rich, 2016).

Although there are a number of different soft skill lists, a useful and globally recognisable one is the World Economic Forum's quinquennial skills forecast.

According to their forecast for 2020, the soft skills which will be most in demand are:

The World Economic Forum's 2020 Skills Forecast
Source: Future of Jobs Report, World Economic Forum

As Rich (2016) argues, soft skills such as these might be what be definite 'graduateness', and explains why graduates are in demand by employers across a spectrum of disciplines. At present, however, soft skill acquisition and development is often assumed rather than made explicit. As a result, students tend not to concentrate on them, academics tend not to emphasise them when designing assessments or rubrics, and employers find it difficult to know what soft

skills student possess when they enter the workplace (Rich, 2016). CBL does not - and should not - seek to develop all soft skillsets in superlative measure. Its intended learning outcomes centre around complex problem solving, emotional intelligence, and collaborative skills.

4.5.2 Ways to evidence soft skills learning gain

If we were to use the WEF Skills forecast as our list of CBL intended learning outcomes, we could then start to measure the level of development using common descriptors or a rubric (much as is done for other skills areas on traditional programmes, such as making a coherent argument, understanding a specific concept, and research skills). Each skillset could have somewhere in the region of 1-5 levels, with the first being the most basic, and the 5th being the most advanced.

Once these indicators and an overall rubric are produced, they could be attached to programme and modular level courses so students would be made aware of the specific skill areas which are intended as learning outcomes, and where they can therefore target their learning gain. Making skills focus areas explicit in this way would also help facilitators to align their learning and teaching activities to their achievement, and draw attention to them when introducing new activities.

4.5.3 Soft skills self-assessment

There is also an argument that alongside formal assessment by academics (which requires the creation of new skills rubrics for CBL programmes) students could also use self-assessment to measure their skills performance at the beginning and at the end of programmes. Such self-assessment could also be conducted at the modular and semester level, and used in performance reviews with personal tutors.

The GU Impacts programme, for example, has started to collect data about their impact of their programmes, and these include soft skills development. From their 2017 cohort, they found that Community outreach, design and data analysis were the most common skills that were either neither acquired or improved across the cohort. Marketing and finance skills were also improved.

The reflective learning journals discussed as a formative CBL assessment would also serve as an excellent tool for tracking and reflective on skills.

5 Obstacles and entry barriers to Challenge-Based Learning

Despite its numerous advantages as a future-proofing and high impact pedagogy, there's no denying that CBL is resource-intensive and has a distinctive set of entry barriers. Some of these resources are "start-up" costs, while others escalate with linear growth (Dale *et al*, 2015). In this section, we'll explore these resource challenges in two categories: those generally applicable to CBL programmes, and those which specifically relate to curricular programmes.

5.1 Skilled & capable staff

The first resource and entry barrier is a capable and skilled teaching staff. Like PBL courses, CBL demands a distinctive skillset and mindset: staff play the role of facilitators rather than lecturers. Their role is not in the transmission of knowledge as subject experts but as "master learners" who model effective problem-solving (Savery, 2006; Barrows, 2000).

Effective facilitators are effectively coaches with the dexterity to deploy a variety of techniques to scaffold, model and reflect in order to move students towards intended learning outcomes which might be radical departures from those on traditional programmes.

In order to serve a large cohort - or more accurately to scale from a small cohort - dedicated training programmes are required, which requires institutional investment and commitment. When a critical mass of trained, experienced staff is reached, there is scope for train the trainer schemes, and there's possibility this can be employed at an inter as well as intra-institutional level (Dale *et al*, 2015).

5.2 QA processes

Quality assurance procedures are necessarily rigorous in higher education institutions, but they can be sclerotic with the unintended consequence of choking programme level innovation. Developing unique CBL programmes can move very slowly through QA processes because the learning and teaching activities, leaning outcomes and corresponding assessments might be unfamiliar to institutions. Establishing suitable external examination procedures might also pose a challenge. Once an initial programme has been through the QA and validation process, however, these entry barriers should dramatically reduce over time.

5.3 Curricular boundaries

According to the traditional 'building blocks' model foundational disciplinary content is taught first, with later (year 2,3, and 4) modules building on it. The problem with such a model is that engagement with early content can be low as interesting empirical topics only emerge later in programmes (Mulgan, Townsley & Price, 2015). A secondary problem, from a CBL perspective, is that the metacognitive, problem solving skills required for CBL activities might not be developed early enough, disadvantaging students' attainment of desired learning outcomes.

The building blocks model also disadvantages CBL because it means its teaching and learning activities cannot take place until year 2 because of curricular commitments to foundational content. Monash's Global Challenges programme has managed to circumvent this problem by combining basic content with skill based training in the first year, and allowing for what might be considered to be core science leaning to be staggered over the first two years rather than just one.

5.4 Teaching and learning architecture

A basic but significant challenge for PBL and CBL programmes is suitable teaching and learning spaces. Ideally, CBL should take place in open collaborative workspaces where design thinking activities can take place with room for posters on walls and whiteboards (Apple, 2011). They should also be equipped with breakout meeting rooms and loose seating.

Unfortunately, most universities were designed for a transmission model and remain as such, with fixed and uni-directional seating. There's some evidence that students find the traditional set up alone demoralising and disengaging (INSERT REF). There's been some progress towards learning spaces which are more conducive to project based work, but further capacity will require capital investment since transforming existing spaces isn't feasible.

5.5 Timetabling

A related but major challenge to any kind of project-based learning work is timetabling. In the UK at least, most sessions have a default duration of 45 minutes, and due to modular clashes, it can be difficult to allocate longer slots for CBL style programmes which typically need at 90-120 minutes to introduce new activities, for group mentoring, and for student groups to make sufficient progress despite the flipped classroom model.

In project and challenge based learning, building the capacity to learn - "leading through learning" - depends on adequate curricular space and appropriate balance between action and reflection in order to integrate reflective practice into the curriculum. Without that, challenge or project based learning become wholly - and wrongly - all about the project and its constituent tasks, rather than the opportunities to learn skills through reflection (Hu *et al*, 2008).

5.6 Classroom privilege

Understanding how systems do and don't work necessitates the viewpoint of diverse groups, including those who might be constructed as beneficiaries or service recipients. Put another way, having a cohort of students from similar socio-economic backgrounds discuss such systems without the input of other voices results in the production of a stultifying echo chamber. That demands that challenge based educators are able to bring non-paying people into the classroom environment not only as experts or guest speakers, but as participants (Bonnici, 2016). While there are examples of courses where this does take place, such as the programmes run by the Bertha Centre for Social Entrepreneurship & Innovation at the University of Cape Town, they remain the exception rather than the norm.

5.7 Administrative capacity

Lastly, a major resource for CBL programmes is administrative capacity. On Monash's Global Challenges programmes this mainly relates to finding and maintaining relationship with external organisations to partner with on the course, as well as managing their bank of external mentors. The same is the case with the Wicked Problems in Sustainability Initiative (WPSI), which is run by a consortium of engineering higher education institutions.

On Monash's Global Challenges programme, a significant resource drain relates to finding external organisations to partner with the course. The Wicked Problems in Sustainability Initiative (WWPSI) run by the Engineers for a Sustainable World consortium has reported similar obstacles.

In mature universities the task of sourcing suitable partner organisations, clients and mentors would be a collaborative effort between faculty and

professional service staff located in Alumni relations or Employer Engagement teams.

In the absence of such support, the ability to recruit organisational partners (either as sites of challenges themselves or as co-creators in the challenge-based process) often falls on the shoulder of teaching staff. There are obvious limitations involved in this kind of dependency; some faculty will have good levels of access to relevant organisations, but others will not, and if key staff leave programmes themselves are fundamentally weakened.

5.8 Working with external organisations

Beyond these organisational challenges, which are as much about culture shifts as finding resource capacity, are the less predictable challenges of finding external partner organisations. This is a much higher risk, since it depends on environmental factors which faculty and programme administrators cannot control.

At a macro level, it depends on the state of local and international third sectors, polities, and even economies at large (in the case of the involvement of business partners). For example, under the New Labour governments from 1997-2010, the UK third sector was (relatively) well funded and resource-rich, with a polity which supported their work at a policy level. Under the coalition government from 2010-2015 and the successive Conservative governments from 2015 onwards, the third sector has been less favoured, with large cuts to many parts of the third sector and reduced scope for third-public sector partnership.

At a micro-level, regions have uneven resource distributions (see London versus the South-West or North-East). Beyond local engagement, international collaborations - such as the Beeck Centre's GU Impacts programme or Southampton's Spark India programme - is also volatile and even less predictable.

In a higher education environment where planning and funding takes place in annual cycles, this can present difficulties.

5.8.1 Finding partner organisations: listening to create value

Finding partner organisations therefore demands skill, time, dedication and open lines of communication. The most important incentive for external partners is value creation, rather than using them to achieve a particular set of learning outcomes for students.

When it comes to the global third sector, including NGOS and social enterprises, we know that while there's no shortage of founders and CEOs, there's a severe dearth of "second line talent" in operational areas such as finance, marketing, technology, and human resource management, among others (Paul, 2017). Challenge-based education can't address long-term human resource constraints, but client-focussed closed projects centred around organisations challenges can address immediate problems. They also have the added benefit of helping students understand the constraints under which third sector organisations operate, and can potentially direct second line talent to such organisations upon graduation.

Ultimately, effective and ethical community partnerships start with a willingness to listening first and proposing later. When universities seek to collaborate, they must be open to co-design too. That means listening to what individual organisations - and coalitions around socio-environmental issues - need in the first place, rather than telling them what they should be doing or the value university programmes seek.

Alan Harlem, whose own Swearer Centre for Social Entrepreneurship at Brown University is well experienced in forging enduring community relationships, talks about the need to listen to community organisations, rather than defining challenges in advance and prescribing the agenda (Harlem *et al*, 2016).

Once programme co-ordinators understand what partner organisations need, they are then in a much stronger and legitimate position to identify collaborative opportunities and to serve organisations through collaborative co-design.

5.8.2 Maintaining long term partnerships

Attracting partner organisations and maintaining those relationships in the first place depends upon the intention to forge long term relationships. Partner organisations - particular the more resource-constrained, including NGOs, charities and local government - are only likely to commit when there's a long-term time horizon to deliver returns on their social, financial and emotional investment in students and university staff.

Alongside forging long term commitments to partner organisations universities need to engage in continuous and non-reciprocal support for partner organisations (Dale *et al,* 2015). While this might sound like another demand on time-starved academic staff, such support can be swiftly delivered: informal conversations, publicity on social media, or making introductions to others in their professional network. Such "five minute favours" can keep relationships warm out of term-time, and build trust (Grant, 2014).

There's understandable and inevitable pressure for teaching programmes to scale by tacking on additional students and thereby increasing instructional efficiency. The "challenge" of challenge-based learning centres around navigating the question of scale with care, since partner organisations cannot scale their involvement so easily. Creativity in finding resource-light approaches to scale -

when necessary - is essential to successfully managing relationships with partners.

6 Strategic value: Challenge- based learning and the Teaching Excellence Framework

So far, we've seen why challenge based learning is desirable, the forms it takes, and entry barriers to programme development. We'll now look in more depth at its potential strategic value in the context of the Teaching Excellence Framework, the UK's new evaluative framework for teaching quality. The TEF might only be used in the UK, but its emphasis on student satisfaction, outcomes and employability is not unusual, and comparable with those used in other developed higher education economies. In the section below, we select some areas of teaching quality where challenge-based learning might make a contribution.

6.1 Course design

A major theme among Gold level submissions to TEF 2 were references to course design, including the core elements of CBL: live projects, practice-based approaches, employer engagement and experiential learning opportunities (Moore *et al*, 2017). Flipped classrooms, which featured in more Gold submissions than any other award category, is also integral to the CBL process.

Lastly, CBL's foundations in self-directed learning is an interesting complement to personalised learning - a major theme in Gold and Silver submissions - since it empowers students to be self-aware of their skills portfolio, identifying signature strengths and where these might need development. The self-awareness cultivated through CBL therefore supports and provides a compass for personalised learning, so that students can make informed module and extra-curricular choices, as well as seeking out appropriate and suitable support from personal tutors and employability co-ordinators.

6.2 Learning gain

Learning gain is a central plank in the measures used to evaluate teaching excellence but often focus on disciplinary knowledge and research skills, rather than the soft skills which are *directly* useful in work. such as creative, collaborative and communication skills. These skillsets or areas are often rendered implicitly.

In CBL, however, these skillsets or "areas" are explicit learning outcomes, which many of the learning and teaching activities geared towards student development in each of them and self-reflexive awareness of that progress.

There's evidence from TEF written submissions - which allowed 33 of institutions to move up a TEF grade - that attention to whole person education is well received by TEF assessors and institutions have been advised to demonstrate how they nurture students social and emotional intelligence (Beech, 2017). CBL therefore offers a distinctive domain of learning gain, as well as novel means of evidencing it through student reflective blogs, pitches, and video presentations.

6.3 Employability

The TEF is unlikely to remain in the same format as it did in the first two exercises, and the Chair of TEF 2 acknowledged that it is likely to shift further as

new proxies and priorities emerge (Husbands, in Beech, 2017). Already, three "small" but significant "refinements" will be made in the next TEF exercise, including halving the weighting of the NSS metric and including new measures to take grade inflation into account and track student labour market outcomes (via LEO, Longitudinal Educational Outcomes).

The reduction of the weighting of TEF from satisfaction to employability in particular will provide challenges particularly for subjects where salaries are used proxies for labour market outcomes. LEO is problematic for a number of reasons: it only measures past performance, it is uncontrolled and raw, it cannot provide information on graduate premium (because it doesn't have comparator data for apprenticeships, for example) and lastly it can't control for macro-economic variability (like the financial crisis or the potential impact of Brexit).

Nonetheless, it is likely to be more popular than DELHE (Destinations of Leavers of Higher Education) because it is not self-reported, and can also (theoretically) track outcomes from 1 year to 10 years post-graduation (DELHE data is typically 6 months post-graduation). The longitudinal nature of LEO is useful in tracking factors such as the "ethnic penalty" faced by BAME students, which are often most acute immediately after graduation (Morris, 2017).

CBL has the potential to boost employability particularly for subjects where historically, earnings have been low relative to other subjects - (non-Economics social science subjects and Humanities subjects, for example) with its focus on transferable soft skills development.

6.4 Employer Engagement

The first is employer engagement, which was integral to all the examples of CBL covered earlier, and which is foundational to its design and core learning outcomes. Employer engagement is important because it not only potentially leads to improved employability outcomes but equally to the creation or (co-

creation) of teaching activities that was highly valued by employers (Moore *et al*, p.85).

Importantly, the most commended forms of employer engagement were those where employers were involved in educational programmes - as they are in CBL as mentors, critical friends and judges - since that is judged to increase the "authenticity of students' experience of learning" (Moore *et al*, p.59). So, while engaging external stakeholders and maintaining productive relations might be demanding, it is also likely to be a feature of higher education course design in an age where employability gains are closely monitored and tied to evaluations about teaching excellence (and potentially also course fees).

6.5 Learning Environment

Employer engagement is not the only way in which CBL, viewed through the TEF lens, might boost student employability. One recommendation for HEIs seeking Gold awards is to create learning environments which "simulate the workplace" (Beech, 2017). CBL explicitly seeks to do this, through its project-based nature and the teaching and learning architectures it demands, such as co-working spaces instead of lecture theatres and lab-style spaces for designing and making (Apple, 2011; Nesta, 2016).

6.6 Entrepreneurship

While entrepreneurship doesn't feature in *all* of the examples of CBL discussed earlier, it is one which we believe is a natural outcome of open-ended challenges, and we expect to see it extended to more CBL programmes over time. Entrepreneurship provision was mentioned in all of the submissions, and though there was no simple correlation between mention of entrepreneurship support and higher awards (Moore *et al*, 2017:97), the most evolved ecosystems,

including those which offered graduate enterprise systems and start-up support were found in Gold rated submissions (Beech, 2017:34).

General commentary suggests that the most effective TEF submissions were those which didn't only mention discrete provision of employability and entrepreneurship support, but where these were woven together into a narrative about how such support fed into the institution's wider vision for student development and value-added education. Submission were at their most compelling when they conveyed a distinct institutional identity (Beech, 2017:50). CBL is one such vehicle to bring these disparate areas together: employability, employer engagement and entrepreneurship, while lending some credibility to universities generic claim to "change the world".

6.7 Student satisfaction

CBL, like PBL, has an interesting relationship with student satisfaction. While there are a number of salient reasons why student satisfaction might be dampened by the novel demands placed by inquiry based learning methods - grade anxiety, expectation of direction - long term evidence suggests that they actually boost student satisfaction (Hmelo-Silver, 2004). By doing so, CBL has the potential to lift student satisfaction scores on individual modules and programmes, whether measured through National Student Satisfaction Surveys or others.

CBL, PBL and other inquiry based methods have the capacity to enhance student satisfaction because they are based on students' own interests and challenges. In CBL this is especially the case where the challenge is chosen by students rather than dictated by course facilitators, or challenges are framed individually or in small groups based on a large "big question" (Apple, 2011). The UN Sustainable Goals is a good mechanism to enable students to choose

personalised individual goals, since each of the 17 SDGS have on average 10 objectives at a "sub-goal" level, and students can choose those which have the greatest personal or local resonance.

6.8 Feedback

In a higher education environment where the quantity and quality of feedback is under greater than ever scrutiny, CBL adds value because it has inbuilt feedback mechanisms through engagement with stakeholders. Because the feedback is from multiple stakeholders - academic, community organisations, and businesses, it also enables diversity of feedback. More diverse feedback also means that a range of intended learning outcomes can be assessed on a continuous, iterative basis, including skills such as teamwork, project management and time management.

Feedback from external audiences - especially employers - can also be used to evidence graduates work-readiness and their potential value to the labour market (Moore *et al*, p.86).

7 Beyond buzzwords and business as usual

Whenever a new pedagogy becomes a buzzword, it's easy to be sceptical. We hope we've shown why challenge-based learning is not a fad but a direction of travel, which has its roots in problem based learning but has distinctive characteristics such as its embeddedness in complex open-ended global challenges, a project orientation, self-leadership, and entrepreneurship.

It's a teaching and learning format which speaks to the challenges to higher education which mean that business as usual is no longer an option. We know that new attempts to systemically capture teaching excellence, such as TEF in the UK, means that we are likely to see continued scrutiny on the graduate premium and how it can be communicated to non-academic audiences (read: employers and parents).

Challenge-based learning is just one teaching and learning approach - and one in its infancy at that – but it does bring with it a means of making higher education less opaque, more relatable, and possibly more relevant than others. Even if it is not implemented wholesale, even at a modular or sub-programme level it brings with it a set of technologies to capture soft skill development, to engage local organisations, and to help students build attractive project based portfolios for use in the labour market and for their career development at large. It can have a catalytic effect, and help to drive transformation in how universities teach.

7.1 Metrics for CBL

For CBL to grow, however, it's important that the body of practitioners develop a set of metrics to help us understand what constitutes effective practice (and also to relate those metrics to sector wide measurements of learning gain and employability). 5 are sketched below, but there is scope for others.

7.1.1 Attainment

The most important measure for CBL is attainment: ensuring that students move towards intended learning outcomes. CBL centres on soft skills and whole person development as well as the development of specific disciplinary skills and knowledge (such as in the WPSI programme), and as a community, CBL practitioners are getting to grips with how best to track progress towards the former.

It is vitally important that rigorous and credible forms of learning gain evidence are developed for areas such as creativity and innovation, although already a combination of project evidence, (benchmarking-based) self-reflection and skills-based rubrics are emerging. These measures are important not only to help understand how course design can be improved to meet learning outcomes, but also for QA procedures (including external examination) and for transparency

for prospective employers, given the potential employability benefits of such skills.

7.1.2 Instructional efficiency

The next is all important from an organisational perspective. Can CBL be made instructionally efficient? As we've seen though the models showcased earlier, CBL is a high-resource pedagogy. Chief among them is the task of successfully engaging external organisations, and maintaining those relationships. In an ideal world, professional service departments such as alumni relations or employer engagement teams would conduct the bulk of that work, but in reality, we know that often it falls on academic staff.

Much of that work can be classed under "start-up costs", and once established, such relationships are easier to maintain than activate in the first place. Similarly, though CBL requires the development of new rubrics for its distinctive learning outcomes, once courses are established, they are one-off tasks. The same of course goes to the process of training academic staff in delivering the teaching and learning activities to meet such learning outcomes.

It goes without saying that business as usual pedagogies are lower resource, but of course cannot deliver skills our graduates need to thrive in an economy shaped by the 4th industrial revolution. If universities are committed to skilling and preparing graduates for that world, they will require investment (including in physical and virtual teaching and learning environments).

7.1.3 Student numbers

A third metric, not unrelated to instructional efficiency, is student numbers. There's understandable pressure for all courses to scale, especially where this can be done without incurring linear increases in teaching and administration costs. There are instances of large scale challenge based programmes (see Chalmers' University's C-Labs, for example), but by and large, challenge based education has occurred on a small scale (Dale et al, 2015).

There are multiple routes to scale: enrolling more students on individual courses or replicating course designs to other programmes, for example. More complex scaling options might involve centralising course support with dedicated staff supporting course in unrelated (or uncoordinated) departments.

The most successful models of scaling have occurred where established models have been replicated with the same local partners, or where challenges are mapped over a 1-2-year period, so it's possible to new cohorts to pick up where previous ones finished. Ensuring continuing and reducing friction between cohorts in vital in reducing resource strain for local partners and course convenors.

Another option is to scale by institutional collaboration, so that more students are brought in to work on challenges in a local area (Dale et al, 2015). This can help make CBL more instructionally efficient, but can also present difficulties where institutions have misaligned course designs and learning outcomes at programme level.

7.1.4 Student diversity

Fourth is the question of student diversity. For CBL to grow successfully, it must be able to attract students from across the socio-economic spectrum and with a fair gender and ethnic mix in each cohort. As innovation experts will argue, the greater the diversity of a group of problem-solvers, the greater the chances of innovation (Hewlett, Marshall and Sherbin, 2013). It's also important that no groups are excluded from CBL, so that employability gains are shared among less privileged groups.

7.1.5 External impact

Perhaps the most difficult metric for CBL is trying to gauge external impact. Whether challenges are open or closed, the goal of all CBL is to create some form

of external impact, whether in the form of a product or service prototype or pre-defined output for a partner organisation.

Evaluating external impact is difficult, and there are no off the shelf metrics. One of the challenges which CBL facilitators face is how to evaluate the impact of the former. In many cases, the impact of a product/service prototype will only be realised several years after the course finishes when it reaches beneficiaries, and short-term data will appear to show minimal-to-zero-impact (the longer the CBL programme, the more likely it is to demonstrate external impact, since students will have had the opportunity to engage beneficiaries and develop their output. Correspondingly, shorter programmes will deliver little immediate demonstrable impact).

While closed challenges can yield clear external impact - the completion of a strategy document, a crowdfunding campaign or a website - they require individual project metrics. They can therefore be difficult to *compare,* and so aggregate quantitative data on the external impact of an individual programme is difficult to forecast or evaluate.

7.2 The case for flexible integration

"However, almost all challenge-based learning experiences surveyed here are on the periphery of the curriculum, operated as introductory or special courses or master thesis projects. Challenge-based courses still have a way to go before they are part of the regular curriculum" (Malmberg, Radberg, & Lundqvist, 2015).

CBL is in its infancy, and we need more analysis of best practice, and that too in non-engineering disciplinary contexts where challenges are closed and outputs are not product-orientated. We also need to more information about

international CBL where partnerships are not local, and how technology can enable remote collaboration between international cohorts.

We also need a better understanding of how CBL can be flexibly integrated into existing programmes and even at a modular level to reduce barriers to entry, to provide 'quick wins' and to understand institutional barriers and synergies. There's no need for institutions to go straight into full-blown CBL programmes but instead to incrementally build their expertise, local networks and the credibility of CBL approaches at a small-scale.

7.3 The need to institutionalise innovation in HE

For even small-scale CBL implementation to happen - and to build on that - universities globally but particularly in the UK need to build their innovation infrastructure. While there is plenty of pedagogic innovation in (UK) higher education, it is not systematic, nor systematically incubated, evaluated or diffused. As one commentator argues, "universities do R&D on everything else but not on themselves" (Mulgan, 2016).

In the most innovative universities worldwide, there are dedicated innovation centres which dedicated resources to facilitate innovation at the modular, sub-programme and programme level (see San Diego State, for one). Beyond incubation for innovation, infrastructure is needed to break down budgetary and political silos (Nesta, 2016), particularly between inter-faculty and between academic and professional services.

A recent study has shown that US universities have started to invest in such innovation centres, with Stanford, Maryland and Purdue all reorganising and "revisioning" several functions, with many directly under the Vice-Provost's office (Bishop and Keehn, 2015). The same is true at Georgetown, who's *Designing the Futures* centre encapsulates this wider, common mission. Theirs is:

"Supporting curricular innovation as an inquiry into new ways for Georgetown's educational practices to align with its institutional identity and values. This work is especially urgent in the context of the institution's social obligations to serving as diverse a student body as possible, while living out its multiple missions in a competitive global landscape"[They are] Committed to equity and a robust conception of educating the whole person in the 21st century, Future(s) uses iterative research and design processes to explore the expanding contexts of liberal and professional education, the well-being of students and faculty, and the ways in which higher education can renew its greater purposes and ultimately serve the common good". (Georgetown, *Designing the Futures,* 2017)

These new academic innovation centres are interesting because they bring areas which have historically been understood as entirely separate, such as academic skills and student welfare, into dialogue and take a higher-level view of the student experience and how all experiences (both curricular and extra-curricular) feed into overall student outcomes. They make the possibility of whole person education much more feasible, as is the aim of UT-Austin's new Centre for Teaching and Learning.

From a CBL perspective such centres are essential because they can facilitate scaling operations (especially using a hub and spoke model where centralised support is used to support multiple courses across faculties). They also offer a resource to map best practice, perform analysis on learning outcomes and student feedback, and guidance on how best to deploy learning technologies which are beyond the capacity of individual academic staff of academic teams. They can also map the field and perform landscape and horizon scanning exercises to ensure that CBL across the institution is up to date and taking advantage of new pedagogic innovation.

7.4 Challenge-based models and the future of higher education

Higher education finds itself at a disruptive but also transformative moment. Alongside regulatory change, the lowering of market entry barriers and employer

demands, is the expectation from students that higher education goes far beyond the knowledge transmission model to a skills and experience model. Metrification, particularly in the UK, seems to be dictating the game, but as one commentator has argued, the sector cannot use it as an excuse to take its eyes away from the ultimate and enduring goal of whole person education in a rapidly changing world with demands adaptable leadership (Minochal, 2018).

To future-proof students for a future where expertise will quickly become outdated and jobs will have short life-span, we especially need to cultivate skills such as emergent leadership, flexibility, complex problem solving, creativity and cross-cultural communication.

Contrary to many predictions, MOOCs have not and will not will not be the big disruptors, because these skills cannot be learnt alone, online, or without a real-world context. They demand rich human interaction which can only happen "offline", even if technology will be an important catalyst in the process. What MOOCs have done is to bring into greater focus what universities need to provide beyond their virtual environments.

Challenge based models are one of a number of potential innovations which are beneficial for students but which also spread an ethos of service, harnessing student development to the problems most in need of solution. It offers a way to reconcile private and public benefits of higher education, while rehabilitating relationships between universities and local communities.

One thing is clear: business as usual won't do any longer. Our educational models need to move on much faster than they have to date, and show some of the flexibility, agility and entrepreneurialism the world expects from our graduates.

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