Connecting the curriculum with the iGEM student research competition

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Introduction

The International Genetically Engineered Machines (iGEM) competition is an annual activity in which undergraduate and postgraduate university students from different degree programmes are encouraged to form teams and develop their laboratory, computer and communication skills through exploring a project of their choice, with clear links to research-based education. Students can apply to join an iGEM team during any year of their degree course but most often UCL iGEM team members have completed at least one year of undergraduate study. The Connected Curriculum Framework is a university-wide initiative at UCL with the goal of empowering students to learn through active participation in research and enquiry (Fung 2017). At the UCL Biochemical Engineering Department, iGEM participation has been harnessed as a driver for this institutional agenda. This chapter will provide a brief disciplinary background and a discussion of the ways in which iGEM has enabled and energised a Connected Curriculum approach. The Connected Curriculum Framework is defined by six themes, or ‘dimensions’ (Fung 2016; Fung 2017). These dimensions can be briefly summarised as: dimension 1: enabling students to connect with researchers and with the institution’s research; dimension 2: providing a ‘throughline’ of research in a programme of study; dimension 3: encouraging students to make connections across subjects and out to the world; dimension 4: providing students with opportunities to connect academic
learning with workplace learning; dimension 5: providing students with opportunities to learn to produce outputs directed at an audience; and dimension 6: encouraging students to connect with each other, across phases and with alumni.

The iGEM competition is large and successful (300 teams participated in 2016) and, though interdisciplinary in nature, it is principally led by science, technology, engineering and mathematics (STEM) topics. However, the iGEM concept – small, multidisciplinary, student teams working on self-defined projects – potentially can map onto non-STEM disciplines or disciplines that encompass STEM but are led by the Arts and Humanities. The discussion that follows highlights how the UCL iGEM programme actively delivers dimensions 1, 2, 3, 5 and 6 of the Connected Curriculum framework (Fung 2017). Workplace learning (dimension 4) is not a distinct iGEM activity but entrepreneurship does play a key role in the UCL iGEM experience and to date two spinout companies have been founded from UCL iGEM teams (Table 6.1).

The discipline of synthetic biology and the connected curriculum

Making connections across a curriculum is increasingly recognised as an effective way to help students acquire skills, knowledge and insight in a given subject or discipline. Most academic disciplines are made up of a collection of distinct areas of knowledge and practice, and because of this there can be an organisational inclination to teach disciplines in a process akin to sequentially dipping students in and out of different silos. With this approach connections between silos are implied and hinted at but rarely explored in a way that has impact for students.

In common with many academic disciplines, synthetic biology can be difficult to define and has fuzzy borders with other disciplines. For many research-intensive academic institutions, synthetic biology could be in principle taught by assembling a selection of pre-extant courses available across multiple departments and divisions. Arguably a better approach is to make explicit connections across courses and to make those connections credible and meaningful for students. Activities such as iGEM give students the opportunity, autonomy and guidance to make these connections themselves.
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<th>Year</th>
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<tr>
<td>2009</td>
<td>Stress Busters (UG)</td>
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<td>2010</td>
<td>Hypoxon (UG)</td>
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<td>2011</td>
<td><em>E. coli</em> (UG)</td>
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<td>2012</td>
<td>Plastic Republic (UG)</td>
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<td><strong>Top-ranked UK Team at World Championship Jamboree</strong></td>
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<td><strong>Best Presentation Award Winner</strong></td>
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<td><strong>First BioBrick™ submitted by members of the public</strong></td>
<td>(with London BioHackspace)</td>
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<td>2013</td>
<td>Spotless Mind (UG)</td>
<td>Gold Medal</td>
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<td>Spectra (PG)</td>
<td>Silver Medal</td>
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<td><strong>Top-ranked PG UK iGEM Team at European Jamboree</strong></td>
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<td></td>
<td>Morph Bioinformatics (Entrepreneurship)</td>
<td><strong>Founded spin-out company Morph Bioinformatics</strong></td>
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<td>Darwin Toolbox (Entrepreneurship)</td>
<td><strong>UCL Academy school team</strong></td>
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<td>Mature Papyrus (High School)</td>
<td><strong>First UK school to attend iGEM Jamboree</strong></td>
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<td>2014</td>
<td>Goodbye Azo-Dye (PG)</td>
<td>Gold Medal</td>
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<td></td>
<td>Cyano-Busters (High School)</td>
<td><strong>UCL Academy school team</strong></td>
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<td>Juicy Print (Community Lab)</td>
<td><strong>London BioHackspace team</strong></td>
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<td><strong>First UK community lab to attend iGEM Jamboree</strong></td>
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<td>2015</td>
<td>Mind the Gut (PG)</td>
<td>Gold Medal</td>
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<td><strong>Top-ranked PG UK iGEM Team at Jamboree</strong></td>
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<td><strong>Best PG Entrepreneurship Award Winner</strong></td>
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<td><strong>Best Composite BioBrick™ Award Nominee</strong></td>
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<td>2016</td>
<td>BioSynthAge (UG)</td>
<td>Gold Medal</td>
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<td><strong>Best Entrepreneurship Award Nominee</strong></td>
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Biochemical engineering

The disciplinary provenance of biochemical engineering makes it a natural fit for the aims and objectives of synthetic biology and iGEM, defined below. The emergence of biochemical engineering from chemical engineering was necessitated by the new products and processes of the biotechnology industry (Shamlou et al. 1998). As the need for biological knowledge and expertise increased, the demand for biochemical engineering to become a distinct discipline grew.

Masters of Engineering

In the United Kingdom, the Masters of Engineering (MEng) degree was launched in 1980 with intended learning outcomes (ILOs) that encompass both academic standards and the accreditation requirements set by professional engineering bodies such as the Institution of Chemical Engineers (IChemE). Typically, such accreditation standards place a premium on students’ demonstrating teamwork skills and independent, creative thinking. At the UCL Biochemical Engineering Department staff experience developing MEng programmes informed their view of iGEM as a potentially highly valuable student activity. UCL Biochemical Engineering, with the support of the UCL Faculty of Engineering Sciences, has hosted UCL iGEM teams since 2009, providing full laboratory facilities and sponsorship.

Synthetic biology

Synthetic biology has recently emerged as an academic discipline that forms the philosophical underpinning of the iGEM competition. It can be defined as the application of engineering principles to biological material in order to design biological devices that do not exist in nature (Kwok 2010; Nesbeth 2016). From around 2005 onwards the retail cost of DNA synthesis and DNA sequencing has continued to fall significantly. This has created favourable conditions for the expansion and development of the discipline of synthetic biology. Low cost synthesis, or ‘writing’, of DNA gives synthetic biologists capabilities for assembling DNA at scales that were previously impossible. This has led researchers to assemble the entire complement of DNA needed to control a living cell, known as a cell’s genome, and use such designed, synthetically originated DNA to generate an entirely synthetic organism (Lartigue et al. 2009).
The iGEM competition

iGEM is an interdisciplinary science competition that was first organised by the Massachusetts Institute of Technology (MIT), USA, and has since become an independent foundation. In the early years of operation, iGEM participants were mainly undergraduate and postgraduate university students, with a small number of secondary schools also participating (Campos 2012). Participation has since widened to include community laboratories run by members of the public. The competition structure encourages teams to carry out research projects that encompass computer modelling, public engagement, website design, exploration of ethical issues, standardisation of biology, artistic expression and molecular biology (Figure 6.1). The typical schedule of UCL iGEM activity is set out in Figure 6.1, and a UCL iGEM cycle extends from

### Fig. 6.1 UCL iGEM activities, schedule and participants.

A) Major types of student activity required by iGEM. B) Faculties from which UCL iGEM students have been drawn, plus student participants from Central Saint Martin’s College (CSM), King’s College London (KCL) and the University of Westminster (West.). C) Typical annual schedule of UCL iGEM organisation and activities
November to October of the following year. The competition concludes with students attending a large event, the ‘iGEM Jamboree’, in October/November to present their work. Most participating universities design a curriculum that enables students to gain a valuable educational experience from iGEM participation.

The group-work and collaboration requirements of iGEM prepare students for common modes of working in commercial settings, where small, interdisciplinary teams of employees/contractors/licensees work towards defined goals with set deadlines. Such business-oriented, group-based approaches to project management have also been reported to be effective in educational settings (Gaudet et al. 2010).

A core requirement of iGEM is that teams submit DNA constructs that conform to a set standard for their construction, known as the BioBrick™ standard. Construction using the BioBrick™ standard tends to be less technically demanding than standard molecular biology methods. As a result, iGEM teams can be recruited from students studying disciplines beyond science and engineering. Sources such as the Synthetic Biology Handbook (Nesbeth 2016) provide a detailed introduction to the discipline of synthetic biology and technical elements of the iGEM competition, including the BioBrick™ standard, for readers interested in exploring the topic further.

**Designing a throughline of synthetic biology into the UCL iGEM programme**

A programme of basic molecular biology and synthetic biology teaching is designed so that students’ learning builds on previous learning in a throughline of research activity. This begins with traditional transmission of content. The programme then progresses through to students defining and advancing their project in the laboratory, while engaging in cycles of feedback and discussion of challenges and achievements with staff and peers. UCL iGEM team recruitment is open to the entire university. On average, the recruitment results in a team composed of 40 per cent students from the Biochemical Engineering Department, 40 per cent students from the UCL School of Life and Medical Sciences and 20 per cent from other disciplines, ranging from social sciences, physical sciences, arts and humanities. Basic molecular biology and synthetic biology, particularly the roles of the BioBrick™ standard and low-cost DNA synthesis, comprise the scaffold of knowledge within the iGEM programme from which all other areas and topics extend.
Teaching foundational molecular biology

The molecular biology curriculum for UCL iGEM has been structured in a manner that approximates the ‘spiral’ approach to curriculum design as described by Harden and Stamper (1999). In a spiral curriculum design topics are revisited, levels of difficulty increase as topics are revisited and new learning relates to previous learning as student competency is assessed to have increased.

This ‘spiral’ approach (Bruner 1960; Coelho and Moles 2016) is often recommended for molecular biology teaching (Anderson and Rogan 2011). The theme of ‘engineering biology’ is revisited repeatedly in deepening exploration of the chemical and informational structure of DNA. A series of lectures or whiteboard-and-pen ‘project hack’ days are typically scheduled with the aim of introducing the basic science and, critically, informally assessing the knowledge base that already exists within the team. Once students’ level of knowledge has been appraised, a series of tasks will be set for sub-teams in which team members are grouped so that knowledge can be shared by peer-teaching (Benè and Bergus 2014).

Teaching foundational synthetic biology

Understanding the fundamentals of molecular biology equips the students to take the first steps in defining their project. The laboratory element of their iGEM project must be achieved using DNA molecules that comply with the BioBrick\textsuperscript{TM} standard. Teaching of this standard is delivered by lecture and seminar complemented by the exhaustive online resources provided by the iGEM Foundation and their online Registry of Standard Biological Parts (http://parts.igem.org/Main_Page). This teaching shifts from transmission to interaction over a series of workshops and ‘project hack’ sessions in which students explore their project proposals with academic staff. Importantly, these discussions must explore topics beyond the BioBrick\textsuperscript{TM} standard, particularly when considering potential impacts of the project on stakeholders in wider society. However, any project must ultimately find expression in the form of several designed BioBrick\textsuperscript{TM}-compliant DNA molecules so the concept runs through the programme from start to finish.

Progression along the synthetic biology throughline

The UCL iGEM programme begins with delivery principally via lecture and seminar. The teaching goal at this stage is for students to gain knowledge of the type of DNA-based tools they will design and use in
the project. Next there is a transition to peer-teaching while project ideas are developed. This is followed by discussion and debate with academic staff when final project topic choices must be made. At this stage the students should finalise the DNA tools they need to design and how they will be constructed in the laboratory. For the remainder of the programme students access online resources and work collaboratively with academic staff and student peers to manage the designs and construction of the DNA tools needed for the project. The connected sequence of learning activities – lecture, workshop, project definition, project progress, researcher partnership – serves to establish an effective through-line of staff-led teaching and student-led research activity.

**UCL iGEM students connecting with staff and their research**

Synthetic biology staff members from across UCL support iGEM students through regular meetings and providing feedback on student project proposals and presentations. These interactions also provide staff with the opportunity to present their research interests to students and to facilitate connections with other UCL staff whose research interests match the students’ project. The first responsibility of UCL iGEM academic staff (including in some cases doctoral students) is to provide a safe environment for undergraduate students to participate in iGEM. This includes ensuring the outputs of an iGEM project, such as bacterial strains or web page content, are also safe and appropriate (McNamara et al. 2014). Arguably the next essential function for academic supervisory staff is to link iGEM students with relevant researchers from across UCL. Establishing these links is frequently key to iGEM success.

**Student learning through iGEM research and enquiry**

Classic teaching modalities alone, such as the lecture and the practical demonstration (Anderson and Rogan 2011), are often not sufficient for preparing students for modern research degrees and employment in research settings. Participation in iGEM brings an added dimension by virtue of the high degree of student autonomy it engenders. The very real and important sense of ‘ownership’ UCL iGEM team members have for their project can be a potent motivator for achieving these competencies. Inevitably mistakes are made along the way as deadlines approach and
the pressure students place themselves under mounts. Overall this gives iGEM students a unique opportunity to hone their research skills by proposing research, gathering data and then learning to report their data clearly.

In much conventional university teaching, a three-stage arc of learning progresses from a lecture/transmission stage, then to instructor-directed research and finally a stage when students are granted research autonomy. The following examples typify research collaborations that arise between UCL iGEM undergraduate students and UCL staff. Such collaborations improve upon the conventional learning arc in that student-led research is encouraged from the very start of the activity.

Genetic modification of microglial cells

The 2013 team ‘Spotless Mind’ proposed the use of re-designed microglial cells to address Alzheimer’s disease. Natural microglial cells patrol brain tissue and help maintain the healthy function of neuronal cells. In Alzheimer’s disease, it has been suggested that microglial cells detect and migrate to plaques (regions of damage) associated with the disease, and upon encountering plaques bring about harmful inflammation. Engineered microglial cells would be modified such that, upon arriving at plaques, they would secrete factors that suppress harmful inflammation.

Enabling this research therefore required that staff contacts be established across multiple silos of the university teaching and research organisational structures. In this case a stable microglial cell line, SV40 (Applied Biological Materials, Richmond, Canada) was identified for the project and links were established with Robin Ketteler of the UCL Medical Research Council Laboratory for Molecular Cell Biology to explore use of a Nucleofector™ device (Lonza, Amboise, France) for the team to attempt genetic modification of the microglial cells.

Gut on a chip

The 2015 team ‘Mind the Gut’ explored routes by which engineered probiotic bacteria (EPB) could be used to detect chemical signatures in the human gut that signal different mood states in the brain. Compounds that improve mood would then be produced by EPB in response to those
chemicals. The team sought to mimic the environment in which EPB would interact with human gut cells. A step towards this was to reconstruct a microfluidic device, based on the design by Kim et al. (2012), by working extensively with Ya-Yu Chiang in the laboratory of Professor Nicolas Szita.

A common dynamic in practical teaching is for context to be supplied solely by instructors. An unspoken bargain is struck between students and instructors in which students accept their de facto disenfranchisement from the context of the practical. In return for this, students’ expectations that a practical will ‘work’ (i.e. yield ample, explainable data) are given tacit approval. A less passive option, exemplified in the two examples above, is for students to be empowered to define context themselves. Throughout UCL iGEM, empowering students in this has always had an energising effect, evidenced by the time and focus given to projects. The corollary of this is that projects may not ‘work’ by the above definition. However, when the time comes to judge whether a project has worked or not, student skills have already been developed and competencies enhanced.

**UCL iGEM students learning to produce outputs**

Students must meet a number of outputs that engage a range of audiences to be eligible for iGEM assessment. They must: produce a comprehensive wiki-based website; deposit biological material and data on the Registry of Standard Biological Parts; present a research poster at the iGEM finals ‘Jamboree’ event in Boston, USA and also give a 20-minute presentation at the Jamboree; followed by a five-minute question and answer session. iGEM assessment follows a summative model in which fulfilment of a defined list of tasks determines qualification for a given iGEM medal category: gold, silver, bronze or no medal. Judges drawn from the global synthetic biology community, alongside a variety of other stakeholders in the field, assess team performance (Campbell 2005). An electronic scoring table system has emerged as the preferred iGEM scoring method since 2011, as it was assessed to be the fairest and most flexible approach. Via this scoring table a medal status is determined for all participating teams that attend the Jamboree event.

Formative iGEM assessment (Willis et al. 2002) is provided by mechanisms such as i) feedback statements from iGEM judges; ii)
reflection and discussion within the UCL supervisory team; and iii) discussion between supervisors and team members. Consensus arising from these evaluations (Nicholls 2002) informs structure and selection decisions for the subsequent iGEM cycle.

The iGEM Jamboree event – 3–4 days in Boston, USA

All iGEM teams must provide a full account of their achievements on a wiki website. Technical details of a team’s BioBrick™ plasmids must be provided on their wiki and inputted to the Registry of Standard Biological Parts (often referred to as just ‘Registry’) at the relevant profile pages for the BioBrick™ plasmids a team has deposited. Critically, technical team achievements garner zero credit unless reported on both their wiki site and the Registry.

Medal qualification is primarily based on scrutiny of a team’s wiki site, which must fulfil a set of stated criteria. Teams must also give a 20-minute presentation and produce a poster that they can competently discuss with judges and delegates. This ‘live’ interaction with judges is a valuable opportunity for students to develop the key research skills of effective presentation of data, responding to intellectual challenge from peers and public speaking.

UCL iGEM students as partners with UCL academic staff

In a conventional lecture setting, students and staff have clearly distinct roles as the transmitters and receivers of knowledge. When students participate independently in research their relationship with staff is transformed to that of ‘fellow travellers’ (Jones 2005), partners working together towards a common purpose. The process of transition from passive receivers to partners poses the challenge of helping students develop new skills and understanding, while also ensuring students experience the risks and rewards of research autonomy. These goals can diverge or converge through the lifetime of an iGEM project, depending on factors such as topic choice and prior experiences of team members and supervisory students.

This potential dichotomy between transmission-based or participation-based learning echoes the discussion by Neville (1999) of whether ‘direction’ or ‘facilitation’ is the more effective role for teachers to adopt. For instance, directing research topic choices for iGEM
can deprive students of a sense of ownership of their project, whereas facilitating the process of shortlisting projects allows students and staff to work together as authentic partners. In contrast, much time in the laboratory can be lost ‘reinventing the wheel’ if directive teaching is not provided.

UCL iGEM teams are afforded the opportunity to work closely with full-time members of academic staff, post-doctoral research assistants (PDRAs) and doctoral students throughout the period of the competition. As the research direction of the project is student-led, this provides students with the opportunity to experience research as an active, collaborative partner as opposed to a passive receiver of information.

Teams are assisted in approaching UCL researchers for their input at all stages of a project: from brainstorming and scoping, to experimental design, data capture, troubleshooting and data reporting. In this way students learn specific techniques or areas of theory, pragmatic details such as preparing and printing posters and how all these new experiences interplay and link within the lifetime of a project. Applications such as Slack (https://slack.com) and Google Docs (https://www.google.co.uk/docs/about), which work seamlessly across mobile and desktop devices, enable effective collaborative work and project management of teams whose members are widely dispersed geographically. This powerful connectivity makes it easier than ever for students to make meaningful contributions to iGEM, even if they cannot remain on campus through the summer stage of an iGEM cycle (Figure 6.1).

Developing approaches to iGEM team supervision

iGEM supervision varies across the hundreds of universities that participate in the competition each year. At UCL the principal supervisor provides scientific guidance and extensive ‘behind the scenes’ work toward securing funding and facilities. Small group work (Gaudet et al. 2010) and problem-based learning (Carrió et al. 2016) are core elements of UCL iGEM, important skills needed for success in the competition and in students’ future careers. Although different teaching styles (Jones 2005) may be appropriate for the diverse range of tasks required for iGEM (Figure 6.1), three core approaches have emerged and each is set out briefly in the following sections.
Encouraging intra-group and alumni collaboration

Experienced staff members must provide knowledge and insight for students to help steer nascent projects to realistic goals. However, this is not the only effective mode of project examination by the team. Inescapably, the presence of academic staff renders project discussions more time-limited and formal than student-only interactions. Providing a student-only space to discuss decisions that will be crucial to the mission and identity of the team is key to establishing students’ sense of ownership of their project.

Providing a cadre of student peers that includes UCL iGEM alumni means the students can still have directed and facilitated discussions, while maintaining the student-led autonomy of the project. Student peers can provide the information and also the informality that helps foster intra-group collaboration. In this way iGEM teaching is delivered by peer-supported learning (Micari and Drane 2011) as well as partnership with academic staff. Figure 6.1B details the numbers of postgraduate students and iGEM alumni involved in UCL iGEM each year. Every UCL iGEM team since 2010 has benefited from peer-support and peer-teaching in this way. Inevitably students can also benefit from access to their peers in discussion of future career choices and opportunities.

Providing a local context for team activities and deadlines

iGEM defines structure for teams via a comprehensive online content provision, including archived websites for many previous teams and competitions (http://igem.org/Previous_iGEM_Competitions). However, the fact remains that an iGEM cycle stretches across 12 months, from applying for team membership through to attending the Jamboree event. Consequently, for much of an iGEM cycle the Jamboree is distant in terms of both time and location. A real danger when context is so temporally and geographically remote is that it becomes effectively absent altogether. Such a context void, if not filled by a local framework, can siphon off student motivation. Regular meetings with team supervisors, plus presentations in semi-formal settings, help to establish a meaningful routine of in-project reviews and feedback that encourages planning and helps progress.

Embedding group autonomy

Dolmans et al. (2003) suggest the extent to which student learning is ‘self-directed’ positively correlates with attainment of learning
outcomes. This self-directed ethos is promoted within UCL iGEM by granting the team autonomy in terms of both the topic the team elects to investigate and the experiments and activities undertaken. When considering projects iGEM teams are also encouraged to address real-world problems (Balmer and Bulphin 2013), in common with many problem-based learning (PBL) approaches to teaching and learning (Norman and Schmidt 2016).

The three approaches above, tested and developed over several cycles of UCL participation in iGEM, favour partnership between students and academic staff. Perhaps paradoxically, encouraging student independence strongly enables the formation of authentic research partnerships between students and staff. When students trust that staff will defend and support their creative vision, they tend to be more open to the unfamiliar experience of working in a research partnership. This contrasts with alternative modes where research projects are defined and directed by staff and the student’s role can be limited to completion of externally set targets and goals.

**UCL iGEM students making connections across subjects and beyond the academy**

Student collaboration has been reported as being beneficial to student attainment (Scheufele, Blesius and Lester 2007; Singaram et al. 2011) and providing evidence of credible inter-team collaboration has become a formal iGEM success criterion over time. The iGEM team wiki sites also function as a medium for communication and collaboration between teams and evidence suggests that such internet-based approaches are highly effective drivers of collaboration (Collier 2010; Sampaio-Maia et al. 2014; Ostermayer and Donaldson 2015).

Core values shared by iGEM and the Connected Curriculum framework (Fung 2016) are the importance of encouraging students to be aware of their social responsibility as global citizens and to consider the ethical, social and legal implications of their work. An important feature of iGEM is the core requirement that teams make credible links outside of the academy to explore potential societal impacts of their work. This stipulation has become known as ‘Human Practices’ and has been summarised by the director of iGEM judging, Peter Carr: ‘Human Practices is the study of how your work affects the world, and how the world affects your work.’ In response, UCL iGEM teams have initiated many
compelling interactions with organisations outside academia to engage with real-world stakeholders. Two examples discussed below illustrate UCL iGEM students’ human practice activities and how they have led to the formation of connections with wider society.

Biohacking and the laptop laboratory

The 2012 team, ‘Plastic Republic’, explored the feasibility of designing a bacterium capable of persisting in the world’s oceans and degrading waste plastics. As part of the project students initiated contact with members of the public who use the ‘London BioHackspace’ community laboratory in Hackney, East London. This collaboration represents somewhat of a landmark in synthetic biology (Borg et al. 2016) as it led members of the BioHackspace to design and assemble their own BioBrick™ (serial number BBa_K729016), which became the first ever BioBrick™ submitted to the iGEM Registry of Standard Biological Parts by members of the public.

The do-it-yourself ethos of the BioHackspace led a group of 2012 UCL iGEM alumni to found the company Bento Bio (https://www.bento.bio), which has developed a laptop-sized molecular biology laboratory for retail to the general public. Bethan Wolfenden and Philipp Boeing were 2012 UCL iGEM team members and used the 2013 iGEM Entrepreneurship (iGEM-E) competition to take the first steps in founding Bento Bio, then known as Darwin Toolbox. Like other UCL iGEM alumni, Philipp and Bethan have been closely involved in the design and implementation of subsequent UCL iGEM cycles, partnering with team members and supervisors to develop iGEM training and teaching. They also contribute a guest lecture on the UCL Bachelor of Arts and Sciences course, BENG3071 Open Source Synthetic Biology, presenting case studies drawn from their experiences with Bento Bio, synthetic biology and iGEM.

Mental health and medicine: Open Mind Night

The 2015 project, ‘Mind the Gut’, dealt with issues of mental health and featured the design of a genetic circuit within a probiotic bacterium that could help decrease the negative side-effects commonly experienced by patients taking certain classes of sedative. To explore how mental health is treated, and the impacts of mental health medication, the team established links with the mental health and arts charity,
CoolTan Arts (www.cooltanarts.org.uk). An event was co-organised with CoolTan Arts to exhibit artwork produced by people suffering from mental distress and to discuss synthetic biology approaches to addressing mental health.

The team also worked with the Mental Fight Club (http://mentalfightclub.com), an organisation that explores creative routes to addressing the challenges of mental health and ill-health. Interactions with Mental Fight Club, CoolTan Arts and others inspired the team to host a public ‘Open Mind’ event which mixed performance, such as singing, poetry and stand-up comedy, with honest and open narratives of mental illness. Frank accounts of mental health challenges, provided in a remarkably brave manner by members of the public, served to highlight the real human connections between research and research impact.

Why connecting beyond the university can improve the student experience

The ‘human practices’ element of iGEM invites students to expand their definition of what a project is, to see it as something more than the process of gathering data for discussion exclusively with academic staff. Projects such as ‘Mind the Gut’ and ‘Darwin Toolbox’ typify the passion and commitment displayed by UCL iGEM students taking their own projects to authentic stakeholders outside of the academy. During the process of planning and delivering these engagement activities students tend to develop a much richer and more expansive sense of what is possible and just how ‘real’ research can be. Research is no longer merely a different form of assessment in a narrow educational context, but a basic human activity with the potential to engage and impact communities.

Principles that have emerged from UCL iGEM 2009–2016

Trusting students to decide their own research directions, encouraging interdisciplinarity and expanding scope beyond the university, can all improve learning in multiple different disciplines and settings beyond iGEM and synthetic biology. Student experience should be prioritised, even if this means students may experience frustration and disappointment as well as excitement and curiosity. Keeping student experience at
the heart of a student-led, research-led, team activity is not always easy. Organisations that can keep student experience at the heart of their connected curricula will find that the resulting enhancement of learning enriches not only the immediate cohort of students, but also their peers, alumni, the institution’s teaching and research culture, and the wider community.