Imperial College London

Innovative teaching for world class learning

Learning and Teaching Strategy

Contents

Foreword

Imperial College London is an amazing university, with talented and driven staff and students. Together, they form a community that innovates, that wants to improve every day, that produces high quality research and education, and that makes an important contribution to the wellbeing of global humanity.

However, our world is changing fast. If we want to continue to deliver graduates who are able to thrive in that evolving landscape and who are equipped to be the leaders of tomorrow, we need to innovate our learning and teaching and adapt our academic community.

Imperial is a top global university because of its cutting edge and influential research. Our students come here to learn from, and work with, the best researchers. We owe it to them to create a learning and teaching environment that is globally leading too. Our students want to make their mark in the world and they expect to learn the necessary skills at Imperial.

Students learn best when they feel part of an academic community to which they can actively contribute. Teaching, research and support staff are most fulfilled when they feel that their work positively influences people and makes a difference. Imperial can become an even more vibrant and exciting place if we nurture that sense of community and support our staff and our students' thirst for engagement. Because they are so talented, our students can be partners in this scholarly community and they can be co-producers of research, of teaching innovation, and of culture change at Imperial. In fostering that sense of community we will also be supporting our students' general wellbeing and their ability to thrive.

This Learning and Teaching Strategy will focus on four areas:

- We will review our curriculum and create more space for innovation in education, for multidisciplinary activities and for students' engagement with teachers, with each other, and with the world outside of Imperial.

- We will make our teaching more interactive, more supportive, more challenging and more rewarding for our students. We will create a 21st century pedagogy aimed at investigating and developing concepts and going beyond retaining information. We will use the existing literature on evidence-based higher education and will build on the many examples of good practice presently available at Imperial. We will move away from primarily lecture-based classroom sessions and move towards more interactive teaching.

- We will foster an inclusive and diverse community where different backgrounds and cultures in staff and students are cherished and celebrated, and their different cultural experiences and identities are embraced in order to better prepare all students for an increasingly diverse and complex future work environment. We will foster a culture that understands and embodies the values of diversity and inclusivity, ensuring this is reflected in campus life, in the curriculum, and in the application of knowledge to real-life problems in a global context.

- We will develop online and digital enhancements to our curricula, our evidence-based pedagogy, our community building and our focus on teaching global challenges. We will use digital and online technology to enhance a sense of collaboration and community between students on campus, to better apply interactive teaching techniques, and to expand possibilities for creating an international classroom. We will adapt the physical spaces on campus to make them well equipped for new learning and teaching, and for building an inclusive scholarly community.

To make sure we do it right and achieve our goals, we will evaluate and research our innovations in education. We will publish those outcomes and will thus contribute to the growing body of knowledge on innovation in global higher education.

We will build a culture which values learning and teaching highly, rewards staff for their teaching and moves towards greater parity of esteem. In an environment in which teaching and research are equally valued, students and staff will experience a stronger sense of academic community. We will ensure that, as a College, we support the academic staff that are most engaged in teaching. We will visibly recognise their efforts to innovate our education and to create even more high quality and pioneering teaching environments. Our strategy will be most effective when our teaching staff are empowered to act courageously and feel embedded in this important change.

I have no doubt that we can achieve all the goals that we set out in this Learning and Teaching Strategy. We have an excellent starting point, with many great examples of innovation, with engaged and enthusiastic academic and support staff and equally talented and amazing students. There is a clear enthusiasm for being innovative, for taking our learning and teaching to the next level and for being leading in cutting-edge pedagogy. I have huge faith in our staff and students to do an excellent job of reaching new heights in our achievements in education. If we act together across the College, create a supportive learning and teaching environment in which we can experiment, make mistakes and subsequently improve, then within a few years we can be globally-leading in innovative, evidence-based education. We will build an academic environment in which all students and staff learn from each other, maximally use their talents and can feel proud because they truly make a difference in the world.

Professor Simone Buitendijk, Vice-Provost (Education)

1. Introduction

More than ever before, students in higher education will apply what they learn in university to professional careers that don't yet exist. To become global leaders and valuable citizens of today and tomorrow, our students must learn to be independent critical thinkers, to be societally and ethically responsible, and to have a broad understanding of the world.

An Imperial education should optimally prepare our students for their future careers. As active contributors to our collaborative, inclusive and diverse academic community, Imperial students will gain skills that prepare them to succeed in the modern world and that equip them to be future leaders.

Our aim for our graduates is that they will:

- Demonstrate deep conceptual understanding of their chosen discipline
- Work effectively in multi-cultural, international teams and across disciplinary boundaries
- Approach challenges with curiosity, critical thinking and creativity
- Innovatively apply their skills to tackling complex real-world problems
- Understand and value different cultures and perspectives
- Have developed into independent learners with high self-efficacy
- Display a strong sense of personal and professional identity

Imperial will offer all its students a world-leading, rigorous, evidence-based, modern educational experience embedded in a vibrant research environment.

Imperial College London aims to be:

- Recognised as globally outstanding in science, engineering, medicine and business education
- Acknowledged as a leader in technology-enhanced, innovative higher education practice
- Known for combining evidence-based pedagogy with a strong focus on community building, working with students as partners, focusing on global challenges and teaching students 21st century skills
- Renowned for applying the evidential rigour of our research to the evaluation and enhancement of our education practice
- Sought out by the world's leading educators as a source of inspiration, aspiration and collaboration

2. Our Strategic Context

2.1 Strong Foundations for Greater Success

Our Learning and Teaching Strategy builds on foundations already in place at Imperial and is directly connected with our overall strategy. Imperial's focus on science, engineering, medicine and business provides an educational environment which is unique to the UK. Our world class academic achievements set a high standard for student aspiration. Our rigorous academic programmes are designed to stretch and challenge our excellent students. Our international community of students and staff provides a dynamic and stimulating environment. Our culture is ambitious. We are willing to take calculated risks and we already have a track record of innovation in learning and teaching .

We must match the boldness of our ambition with the agility to implement change. We are already well placed to act courageously and collaboratively to invest in the creation of a College-wide innovative approach to enduring educational excellence. We are aware of what needs to be done, we are motivated and we have a proven zeal for innovation. We are well-placed to match innovative pedagogy with cutting-edge online and digital technology and to become world leading as a result.

We already have stable foundations for building change:

- We already have proven examples of implementing the best practices in higher education from around the world
- We have a talented and globally diverse population of students that can contribute a rich set of perspectives and initiative as partners in improving education at Imperial
- Our dedicated and talented educators are committed to their own professional teaching development
- Our network of support staff is experienced in supporting students in their professional and personal development
- We have the knowledge and innovative spirit to take our teaching to the next level in quality and in quantity, by developing existing evidence of best practice, making it our own and implementing it across the whole College
- We are committed to working in partnership with our engaged and talented students
- We share an ambition to build a community that is supportive, inclusive and diverse
- We have identified the opportunity to combine modern higher education pedagogy with online and digital innovation

[1] *For just a few examples of innovation in learning and teaching that are already taking place at Imperial, see our case studies on Innovations in learning and the Student Academic Choice Award winners for Best Innovation.*

2.2 Higher Education in a Fast-Changing World

The accelerating pace of change (Schwab, 2016) of almost every aspect of our lives – work, technology, interconnectedness, environment – is placing new demands on our students. They must be ready for the future, better equipped to solve complex multidisciplinary problems, able to bring fresh perspectives to global challenges, and motivated to become leaders in their chosen field.

Higher education in the 21st century is about more than acquiring knowledge from a single discipline. Higher order skills, such as critical thinking, creative problem solving, teamwork, and communication, are becoming even more fundamentally valuable. As information and facts proliferate, the ability to navigate across a wide range of disciplines and to critically evaluate, extract and communicate meaning have become essential attributes for success in modern society. Increasingly, the most important element of modern pedagogy in higher education is not simply the teachers' transmission of information and the students' retention of facts. Now we must teach students how to handle and interpret concepts, evidence and ideas, how to think and act as experts and, ultimately, how to produce original insights and valuable knowledge for the benefit of society.

As a result, higher education is entering a new and exciting period. Leading universities understand that they need to change pedagogy from fact-based traditional lecturing to interactive teaching with the aim of fostering durable skills such as critical thinking, developing and expert mind set, and problem-solving. Imperial can learn from this to improve our own students' experience and can be at the forefront of global development in higher education.

Our students have a wealth of information at their fingertips. An education at Imperial will give them insight and guidance into how they progress from a superficial engagement with this information to a deeper understanding. We will teach students how to process information in a way that extracts meaning, connects concepts and derives insight. Mastery of their chosen discipline requires them to develop conceptual and practical skills and practically apply this as they process knowledge and information. Imperial academics are world leaders in their respective disciplines and areas of research, so are well placed to guide students in this understanding and development.

2.3 Leading the Way with Evidence

Top universities around the world are realising the need to increase investment in their education. Imperial College has the opportunity to be at the forefront of innovation if we act now. We will look to evidence in order to understand international best practice and to discover the range of opportunities to enhance our education and to innovate across the College. This will help us to create a community of excellence in teaching and providing all our future graduates with an optimal learning experience.

Interactive teaching environments

There is a large and growing body of evidence on effective learning in higher education, specifically in STEM (Deslauriers, Schelew and Wieman, 2011). This research clearly shows that traditional, primarily lecture-based teaching does not yield the best results in terms of learning gains, 21st century skills and student success. Educational techniques that best enable learning are more interactive, engage the students at different levels, increase their sense of personal and professional identity, improve all students' learning and create a stronger sense of community.

A number of departments and teachers at Imperial already employ many of the emerging, evidence-based techniques. This strategy will build upon this foundation to introduce interactive, digitally enhanced teaching across the whole university.

***Find out** how Earth Sciences and Engineering uses interactive teaching*

Building an active learning experience

In the interactive mode of teaching, students will be more equal participants in research based teaching and, hence, in the process of discovery, innovation and learning through and from mistakes. One of the effects is that they will learn to act and think as experts and will have a better notion of professional identity (Holmes, Wieman and Bonn, 2015). This will provide them with a higher sense of agency and purpose as they are going through the curriculum.

***Find out** how Professor Joshua Edel helps students to develop their problem-solving skills in Chemistry practicals*

There is strong evidence that active learning methods enhance the effectiveness of teaching and instruction (Freeman *et al.*, 2014) in a way that imparts deep understanding of concepts. We will embrace these methods across the College to enable students to succeed and to fulfil their potential. A transformation to active learning (Talbot *et al.*, 2016) will allow students to spend a significant portion of their class time on activities that require them to interrogate information in a variety of ways, from using electronic clickers to answer questions, to completing worksheet exercises and exploring problems through discussion with fellow students. Such interactive techniques also make learning more engaging, challenging, authentic and satisfying, whilst leading to better retention of learning outcomes.

In the context of a lecture, the level of transformation will be determined by the topic and the desired learning outcomes. An active session could include the introduction of a few carefully designed clicker-based provocations by the lecturer in real time, allowing a gauge of understanding and engagement while teaching. Alternatively, a highly interactive lecture might require students to engage with online materials prior to arrival and to respond to a quiz that assesses their understanding or enables them to highlight content they found most challenging, then the lecturer and teaching assistants can focus instruction in these key areas. At the start of the lecture challenging questions could be posed intermittently for voting individually via clicker or smartphone response, and then posed again after facilitating discussion of these initial responses in small groups. Data collection from these responses could then inform follow-up personalised tutorial support or other interventions.

In the context of the laboratory, the transformation to more active sessions will entail replacing traditional didactic experiments in which students follow a series of pre-determined steps in order to reproduce a given outcome. Instead, students would experience open-ended enquiry-based labs, allowing them to engage in their own experimental design. A move from labs that resemble cooking recipes to those which embed authentic problem-solving and group work will demand the development of higher order thinking skills and recognition that the answers to real world questions are often not known or predetermined.

Such approaches invite students to discover that conclusions are rarely final and definitive but need to be qualified.

Active learning requires high quality interactions between the student and the academic, and between the student and their learning material. Our Learning and Teaching Strategy will

ensure students are empowered with:

- guided preparation for learning interactions, so contact time with academics can be spent effectively on application of concepts and knowledge
- structured reflection time following contact time with academics to consolidate and further contextualise their learning
- blended learning techniques that diversify the delivery of discipline-specific content material, allowing directed development of problem solving and peer learning ability
- increased emphasis in every academic interaction on the application of concepts and knowledge to novel and contextually authentic situations
- recognition that obtaining the 'wrong' answer, although intellectually uncomfortable, can be a necessary and positive step in progression to sustainable learning
- understanding that an active approach to learning requires additional and different measures of attainment, encompassing a strong emphasis on what they can do as well as what they know

Evidence also shows that active learning supports positive learning outcomes by accommodating a range of student starting points, whether that is due to variation in existing knowledge or differences in language or culture. Its participative nature provides more opportunities to correct misconceptions, to provide timely feedback, and to allow integration of perspectives by peer discussion and discovery. As responsibility for learning is shifted towards the learner, these methods can accommodate rotation of teachers between modules, individual teaching strengths of instructors, different academic disciplinary boundaries as well as variance in career pathways, trajectories and aspirations of students (Deslauriers, Schelew and Wieman, 2011; Hoellwarth and Moelter, 2011; Freeman *et al.*, 2014; Von Korff *et al.*, 2016).

To achieve a broad based adoption of active learning across the College, we will make fundamental changes to all aspects of teaching in undergraduate and postgraduate programmes. The details are set out in the Strategic Approach and Objectives.

Active learning communities

Modern pedagogy in higher education regards students as active participants in the shaping of the learning and teaching environment, not as passive absorbers of knowledge. Imperial students are bright and driven, and we believe they are superbly placed to be co-creators of our research and teaching innovations. They can actively shape and enhance their own experience and that of their peers and be partners in our academic community. We will involve students in their own learning journey and empower them to develop practical skills and deep knowledge using interactive teaching methods.

***Find out** how students in Life Sciences help each other to become independent learners through peer support*

If students feel part of a community that they can contribute towards, this leads to more effective learning (Smith *et al.*, 2005); but a sense of belonging and an inclusive community are also central to our students' general wellbeing. Students at top universities such as Imperial are highly motivated and driven. They want to succeed and to receive a challenging education. However, there is a risk that the competitive culture may lead to isolation and high levels of stress through too much focus on studying only to pass exams and to outperform others.

In active learning environments students learn to work in groups, they contribute to and are supported by a community and are encouraged to focus on broader goals beyond successfully passing tests. This benefits their mental health and wellbeing, decreases the risk of social isolation and increases their resilience.

Innovative learning technologies

Digital and online technology can fundamentally redefine the nature of the classroom. If delivered appropriately and to a high standard, courses that blend pedagogically-sound learning technologies can be highly effective, and participating students derive high levels of satisfaction (Tamim *et al.*, 2011). Classroom and laboratory time can be more interactive when study materials are available online before classes; teachers can get real-time information about students' learning; space and place can become flexible concepts, enabling participation from across campuses and across geographies; and international perspectives can be brought directly into the classroom.

***Find out** how Professor David Dye uses a flipped classroom to improve students' understanding and performance*

Blended and online learning environments can stimulate, enhance, and amplify interactive and participative learning and if applied well, enhance a sense of community and participation. Imperial is superbly positioned to innovate both in pedagogy and in digital technology and to create true synergy between these two approaches in order to better deliver our educational goals.

Evaluating innovations in education

Rigorous evaluation of innovation in higher education is key to its sustainability and success. It is crucial that when universities transform their teaching, they also study the effectiveness of their methods and share the outcomes of this evaluation with colleagues internally and externally. Our large group of Teaching Fellows are well-placed to lead in this endeavour at Imperial. We plan to contribute to global knowledge on change in higher education teaching and be instrumental in taking it to the next level.

We will evaluate our education; incorporating, for instance, an investigation of how self-efficacy can be nurtured in the context of discipline, as well as professional and ethical identity (Strasser and Hirsh, 2011).

***Find out** how an innovative approach to learning is helping our medical students to see themselves as doctors*

Fostering educational diversity and inclusivity

A growing body of literature shows that students work and learn better in an inclusive teaching environment with respect to teachers' attitudes, curriculum content, interactive classroom communities, appreciation of the value of different backgrounds and opinions, and social culture on campus (Gurin *et al.*, 2002; Easterbrook and Parker, 2006; Ippolito, 2007; Scudamore, 2013; Murphy Paul, 2015). Our students are diverse in their cultural backgrounds, nationalities and orientations; Imperial can make its learning and teaching environment even more inclusive for students. We can ensure that different cultural backgrounds and perspectives are an integral part of our learning and teaching environment and that students are part of an academic community that treats its members with respect and creates equal opportunities for everyone to succeed, regardless of gender, sexual orientation, ethnicity, cultural background or disability. Our students will be even better prepared for the global job market by learning to work in diverse groups and applying their knowledge across cultures and with a respect for different values and human experiences.

***Find out** how students work in inclusive teams to tackle Global Challenges as part of the Horizons programme*

3. A World-Class Educational Experience

3.1 Research-based

One of the most distinctive elements of an Imperial education is that our students join a community of world-class researchers. They learn alongside leading experts, discussing cutting-edge developments and actively engaging with research and discovery in their chosen field. They move swiftly from exposure to current research into conducting their own well-designed experiments. They build awareness and contextual understanding of higher order research and stimulate development of reasoning skills.

A research-based education enables our students to become independent learners with the curiosity and drive to continue learning throughout their lives. It shows them to look for evidence before they act, work together across disciplines, manage ambiguity, accept that making mistakes is a crucial part of innovation, understand there are no simple answers to big problems, be confident in the face of uncertainty and understand that positive change frequently requires a challenge to the status quo. These highly applicable skills and attributes are valued by employers and will benefit students in any future career.

Our strategy will engage our students in active research experience. As co-producers of research, students will learn how to tackle questions that have no 'right' answer, they will see how to deal with uncertainty and they will gain valuable academic and professional skills. Throughout their studies we will support them to develop personal strategies for learning from error and to help them find ways to use that learning in creating progressive solutions.

Our ambition is therefore that all undergraduate students will undertake research as part of their degree at Imperial, under the supervision of an active researcher. This will involve exploring a research question or area that has the potential to add to their discipline. To prepare them to become creators of original knowledge, our students will develop deep disciplinary knowledge, understanding of research methods and design of experiments, and appreciation of the ethical and societal implications of their work.

Research projects will develop and test students' subject understanding while allowing them freedom to follow their curiosity and explore a topic of interest in detail. We will encourage research projects in multidisciplinary teams.

Students will also learn to communicate their research findings to an academic audience, for example through academic posters and journal article-style reports. They will also have the opportunity to communicate their work to a broader audience, and in doing so they will learn how to share their knowledge, be persuasive, and explain the significance of their ideas to industry and society. In these ways they will make a clear contribution to our engagement with wider society and will listen to new perspectives from non-academic communities.

Find out *Find out how students in Chemical Engineering develop their broader skills through active engagement with research*

3.2 Student-centred

Our students work most effectively when they feel part of a community where everyone has the opportunity to be themselves and to learn from each other, and where difference in background and culture are celebrated. We will work together in partnership with our students to create a learning environment that is stimulating and caring, where students are engaged as co-creators of research and benefit equally from new ways of learning and teaching. This means working with students to understand their feedback and implement their recommendations accordingly, as part of a process of evolution and enhancement of our education.

Student-centred education also means giving students responsibility for their own learning. They will participate in setting their own goals, manage their own learning process and have the freedom to find their own direction in their education. They will become independent thinkers by developing the strategies and the confidence to learn by discovery, rather than simply memorising factual information.

This will help students to put disciplinary information into context and it will give authenticity to the teaching and the research context. Our students will develop lifelong learning skills that will enable them to tackle 21st century problems and to compete in the global job market.

Creating opportunities for students to actively shape innovation in learning and teaching also puts them at the heart of our strategy. We will develop novel ways to work in partnership with students, enable them to co-create innovative teaching practices, and employ them as teaching assistants in classrooms and in online and digital education communities.

In redefining our curricula, we will implement a modular structure that enables our students to have greater choice and flexibility within their discipline programmes and gives them the opportunity to access modules from other disciplines. In this way all students can broaden their knowledge beyond their own discipline. A review of all programmes will reduce curriculum content and volume of assessment, therefore creating time and space for students to reflect on, and integrate, their knowledge. Core learning outcomes will be defined for every programme. We will ensure the creation of clear learning pathways that deliver the core learning outcomes of each programme.

Find out *Find out how Giskin Day encourages students develop creativity and to learn through play*

3.3 Evidence-based

Our community of world-class researchers use evidence-based thinking and decision-making every day in their work. We will apply the evidential rigour of this practice to our curricula, pedagogy, learning environment and educational technologies. New forms of pedagogy at the College will draw directly upon the substantial body of evidence (Freeman *et al.*, 2014) that shows how active learning methods produce better learning outcomes for students.

As we innovate our teaching methods, we will evaluate the impact and effectiveness of our learning and teaching on the staff and the student experience, and on our students' study success and learning gains, to form our own evidence base, publish our results in peer reviewed journals and contribute to the 'second generation' of global evidence on interactive teaching.

We will use established departmental expertise to build capacity in educational research within each discipline. By evaluating the effectiveness of our learning and teaching innovations, and then adjusting our teaching methods based on the evidence we have collected, we will continuously enhance our education. In doing this we will reinforce existing pedagogic research activity. We will also build a stronger external profile as a centre for evidence-based teaching that others look to for collaboration and inspiration.

Our expertise in data science and the possibilities of learning analytics will allow us to study the effects of digital and online technology on students' learning. Leading international universities such as Harvard and MIT have thus far been in the forefront of this research (Biemiller, 2014), but the strength of data science and the new approach to STEM-teaching at Imperial will make us uniquely positioned to develop new knowledge that can benefit both our own students and the international academic community.

3.4 Inclusive and diverse

Half our students are from outside the UK and we have over fifty different nationalities on campus. Imperial has a diverse academic community, but we can do more to attract and support students from a broad range of backgrounds and we can create a more inclusive environment for all by being aware of the barriers faced by under-represented groups. When students don't feel included, they do not thrive and do not reach their academic potential. The relationship between sense of belonging and educational success has led a number of high ranking US institutions of higher education to adopt the concept of 'Inclusive Excellence' to drive change, especially in STEM education[2]. A positive climate in classrooms and on-campus, alongside interactive teaching, can improve students' persistence in learning, their academic and emotional development, and their future professional engagement.

[2] *See for example the Cornell Inclusive Excellence Academy*

Bias in academic environments can lead to students underperforming and being less visible and less actively engaged. For instance, bias against women in engineering leads to them taking on lesser roles in group work and even being discouraged from pursuing a career in the field (Seron *et al.*, 2016). Similar effects have been documented for black and minority ethnic students and for first generation students. Our new Learning and Teaching Strategy will encourage teaching staff to become aware of their own unconscious biases, for instance towards women and minorities in STEM, and we will provide staff and students with the tools to minimise the effects (Killpack and Melón, 2016). We will identify the barriers faced by underrepresented student groups by commissioning social science research and giving all student groups a voice. We will develop institutional measures and policies and will align this work to our evolving programme of work in widening participation and in equality, diversity and inclusivity College-wide.

***Find out** how Team Based Learning is being used in a structured approach to interactive teaching in Life Sciences*

Making our learning and teaching more inclusive means:

- Creating equal opportunities for our students to succeed, regardless of their gender, sexual orientation, ethnicity, cultural and socio-economic background or disability
- Recognising and harnessing our students' diverse cultural backgrounds, identities and experiences by creating opportunities for them to learn from each other and to make their different backgrounds an asset
- Facilitating all students' sense of personal and professional identity and sense of belonging within a field, so that their background can contribute to their success
- Designing a diverse range of teaching, learning and assessment approaches that recognise and support the needs of students both as individuals and as members of a learning community
- Removing barriers to learning and creating a more equitable experience to assist all students, regardless of health issues or language support needs
- Counterbalancing the effects of unconscious bias in individuals and in institutional structures through creating and implementing evidence based policies
- Using lecture capture and captioning, as well as by making comprehensive lecture notes available in advance

When applied well and sensitively, interactive teaching can counterbalance some of the negative effects of being part of an underrepresented minority, including for students with disabilities (Sharpe *et al.*, 2006). The use of more active learning, for example group-based learning, can initially be challenging for students. There may be particular initial difficulties for those who are introverted, lack confidence or are culturally trained not to speak up in class, however structured approaches to interactive and group learning can help all students to feel included.

Culturally mixed team-working will be incorporated to enable students to practise intercultural communication and collaboration and to build a sense of community amongst the cohort. When considering how best to construct diverse teams, we will also take active steps to combat the potential effects of stereotyping and implicit bias that can be an issue in group work.

When reviewing and redesigning curricula, an appreciation of the differences in background and in the personal and professional identity of our students will be central to our approach. We will design more inclusive curricula to recognise that diversity in backgrounds and cultural perspectives can be an asset in teaching that involves application of concepts to real-life situations. Ensuring that all of our students are seen and heard, this work will be undertaken in partnership with students and teaching assistants from a broad range of backgrounds.

The international community of students and staff at Imperial is essential to our dynamic education and research environment. We are committed to continuing to recruit the most talented students and staff from across the globe, to increasing diversity and enriching our community.

3.5 Outward-looking

Our students will develop the ability to look outside the classroom and laboratory and to think about how their learning can be applied to respond to global challenges and for the benefit of society. We will ensure that the content of our curricula remains relevant and is informed by regular dialogue with employers, accrediting bodies and with our alumni. We will use authentic, real life examples and make clear the relationship between our students' learning and their world beyond the classroom. We will encourage and facilitate opportunities for students to engage in work based learning.

We will teach our students how to engage the public with their research. They will learn how to create a dialogue about the ways in which their discoveries could benefit society. We will make space within our curricula for all students to engage with outside, integrative, challenging activities for credit, which will enable them to apply their disciplinary knowledge in a new context, driving transformation of understanding and identity. This might include engaging schools, hard to reach groups and local communities with our science; involving patients and other research end-users; and sharing our research with the public more broadly. It could also involve student led projects and entrepreneurship, as well as existing options within the Horizons programme.

***Find out** how the Imperial College Advanced Hackspace is helping our students to turn their ideas into reality*

***Find out** how postgraduate students in Bioengineering are developing their entrepreneurial skills in an innovative programme*

3.6 Technology enhanced

Our future students are growing up in a societal context that is very different even from recent memory. They are more connected to each other and the world and they have access to more information from more sources than ever before. They expect personalised, digitally augmented, and meaningful interactions in all aspects of their lives.

Yet, not all people thrive in the digital age, not all aspects of our lives benefit equally from digital technologies and not all students or staff are digital natives. Though an abundance of information is readily available, we know that it is far harder to acquire the contextual knowledge and insight to use that information well. It is important that we use online and digital technology carefully in our learning and teaching environment, considering how it can most effectively be used to build a supportive, connected academic community.

***Find out** how technology is being used to build a sense of community for students on our Global MBA*

We will apply digital innovation wisely. We will work together with our students to innovate, but we will also study and test any positive and negative attributes of this innovation, and make adjustments where necessary. Working together we will make our online and digital technology more conducive to effective learning and to community building on-campus and off-campus. This approach will also provide our students with valuable insights into the potential for online innovation and digital connectedness as a force for the good, as well as into the ethical, societal and human limits of technology. These are valuable skills for the 21st century workplace.

Digital and online innovations will be used to support and enhance more interactive ways of teaching. With blended learning, online and digital technology can replace lectures and classroom time can be used for interactive education experiences. Emerging evidence shows that together interactive learning and digital technology innovation are particularly successful in improving students' learning (Ghadiri *et al.*, 2013; Klochan, 2015).

Opportunities for innovation in the use of technology to further enhance our education include real-time, two-way feedback between students and teachers; this allows teachers to become aware of areas that students are finding challenging just before or during the delivery of a course so that they can adapt accordingly.

The use of blended learning, which combines the use of online material with face-to-face learning, can be used to free up time in the classroom for more interactivity. Students can be asked to study online materials before coming to class and will be better prepared for the actual, interactive classroom teaching. This has the benefit of enabling smaller group teaching and increased opportunities for students to interact directly with staff. Changing the balance of activity within the classroom creates space for real-time assessment, enabling students to check their progress and helping staff to know how to focus their efforts most effectively. We can use group level online data to evaluate our education, change our teaching methods and improve learning outcomes. The availability of high quality online materials also helps to create an inclusive educational experience, which is equally accessible to all students.

Online and digital technology can be used to improve learning and education beyond the classroom, such as with fieldwork. It can help support community-building within our student body. It allows us to create international classrooms by mixing Imperial students with peers in other parts of the world online, and by creating multi-site classrooms with students based on different campuses.

Using the existing strengths of the Imperial community, we will find new ways to use digital technology that enhance research-based learning and teaching, foster a sense of community by connecting students both on campus and with their global counterparts, and enable more interactive teaching methods. We will use technology to support, enable and deliver education both on campus and in the broader, global community. We will also use online technology to create opportunities for our own students to be innovative and entrepreneurial.

This investment will build a learning innovation system across the College, including the development of Massive Online Open Courses (MOOCs), Small Private Online Courses (SPOCs), online Master's programmes, and Continuing Professional Development (CPD). These innovations will build a community of scholars who are able to develop and deliver world class online and digital content to our own students. Outside the College, they will allow us to build

stronger relationships with alumni, provide a global body of learners with exposure to world-class teaching, strengthen collaboration with partners across the globe, improve Imperial's global brand recognition, and provide an opportunity to strengthen and diversify our revenues (see the Digital Learning Strategy in Appendix One).

Our ambition will require a comprehensive review of existing systems and investment in order to implement new solutions. Investment in this area will prioritise the need to build capacity, including in our supporting infrastructure; this will include employing the advice of learning technology specialists and instructional designers, developing on-site recording facilities and seeking high quality technical support.

4. Investing in change

There are many examples of great learning and teaching at Imperial already. We will build on these solid foundations as we work with different departments to apply these approaches to all programmes using methods that are most effective in the context of the individual discipline. Using an evidence-based approach we will identify the most effective pedagogies and assessment methods to suit specific learning outcomes and particular disciplinary needs.

We will also adopt a subject-specific approach in innovation, recognising that best practice often depends on disciplinary context. Departments will determine the implementation approach that suits them best and the strategy allows for variation depending on the starting point. Staff will set priorities and the pace of change, and we will encourage departments to collaborate on building successes.

A process of curriculum review and the introduction of new ways of teaching and assessment will take time, careful thought and effort. It will be a facilitated, collaborative process led by academic staff with the active engagement of our students.

The implementation of change will be an ongoing and evolutionary process, which will require investment across many different areas of staff resources and infrastructure over the next five to ten years.

The change we are aiming at implementing is substantial. Faculty will need training, time and incentives to engage. We also need to be aware of two potential barriers to change that are perhaps more at the level of emotions, but also important. The first is related to the fact that even though the argument that interactive teaching is more evidence-based should be compelling to academics, for some, the message may appear to be that they have been 'doing it wrong' for a long time. That can lead to resistance to the proposed changes. The second factor relates to the phenomenon that academic staff often derive their identity more from research than from teaching. For the successful implementation of our Learning and Teaching Strategy it is crucial that innovation in education is valued by the College and that faculty pride and identity can be derived from being an education innovator as much as from being a successful researcher. Research faculty sometimes don't dare 'come out' as education innovators (Brownell and Tanner, 2012), for fear that it will hinder their career. Careful change management and communication will be needed. Both types of subtle resistance can be overcome if leading the change is perceived as prestigious enough and if a substantial number of departments and faculty will engage and feel supported by the central leadership.

4.1 Funding for departments to review and re-design their curricula

All departments will be supported to review their undergraduate and postgraduate taught curricula in line with the Learning and Teaching Strategy. Additional staff resources will be available to enable departments to undertake this process, including to backfill for existing staff. Facilitation for this process will be supplied by the Educational Development Unit (EDU), working alongside the Centre for Languages, Culture and Communications (CLCC), Centre for Academic English (CfAE) and Careers Service.

4.2 Funding for department-wide pedagogic transformation

All departments will be invited to bid for funding to transform their teaching methods. The process of bidding is designed to ensure that funding is made available based on commitment and buy-in from the senior and top leadership within departments. Funding will be available to fund all high quality bids. Resources will be available to backfill for existing staff to lead on the change process and to employ additional discipline specialists where necessary. We will invest in training for all staff who teach, along with Graduate Teaching Assistants and Undergraduate Teaching Assistants, to support these changes.

Departments will be encouraged to work together on bids in pairs or small clusters. In doing this we will learn from approaches that have been successfully implemented elsewhere[3]. We expect that a holistic approach will combine changes in teaching with the use of technology and the transformation of teaching spaces.

Faculty will need to adjust their expectations of teaching, and staff will benefit from taking an active interest in the development of blended learning and interactive pedagogy. Although not every teacher or department will make substantial changes or implement new ways of teaching immediately, the College will require engagement from a critical mass across every active department. We will initially create a large community of educators who will drive change, learn together and develop a sustainable culture for others who follow.

4.3 Funding for innovative projects

We will establish a new scheme that awards grants to students who work with staff to determine priorities and to implement change within their departments. The Excellence Fund for Learning and Teaching Innovation will continue to provide separate small grants to staff.

[3] *See for example Cornell University's call for proposals to departments, 2016, 'Catalyzing creativity and sustainable innovation in teaching'.*

4.4 Funding to build capacity in evaluation and research

We will support studentships for PhDs in education across each of our main discipline groupings. We will appoint a full Professor of Education to provide strong connections into social sciences theory and practice of higher education. In the future, we will aim to appoint full Professors of Education in science, engineering, medicine and business, respectively. We will also evaluate and research the equality and diversity impacts of curriculum design, delivery and assessment, as well as the learning outcomes of online and digital offerings.

4.5 Funding for education infrastructure

We will fund new flexible resource-rich learning spaces for staff to implement different teaching techniques including digitally enhanced physical spaces and online education delivery platforms. We will invest to support the new Digital Learning Hub, which is designed to support departments and individual academics in creating online content, in using flipped classroom models to support active learning, in building a learning community of students in different physical locations, in building our capacity in online and digital production, and in increasing knowledge of the opportunities afforded by online courses and the pedagogy and technical features of their development.

4.6 Funding to support our students

In line with the recommendations of the Future of Student Services review and the Personal Tutor Working Group, we will strengthen support for our students in departments and faculties, create modern, professional and comprehensive central student services and provide independent advice and guidance through Imperial College Union. We will also invest in new initiatives to embed equality, diversity and inclusivity in the campus community.

5. Strategic Approach and Objectives

To achieve a broad based adoption of active learning practices, we are making fundamental changes to all aspects of education at Imperial, across all undergraduate and postgraduate taught programmes.

Curricula and assessment

We are changing what is learned, the order of teaching, and how knowledge and skills develop towards mastery, thinking like an expert and the desired graduate attributes. We will measure how students' learning is progressing, and ultimately the full abilities of each student.

We aim to achieve a shift towards more authentic, active learning, and create educationally productive spaces for our students to use as they integrate their knowledge into practical discipline mastery and expertise. We aim to deploy a variety of assessments to evaluate the full range of our students' achievements and skills with tailored, authentic assessment. We will actively seek feedback that boosts learning attainment.

Pedagogy

We are evolving how we deliver learning and what methods we use in teaching.

We aim to augment lectures with active content and similarly transform our laboratory classes to become increasingly enquiry based and interactive; applying the evidential rigour of our research practice to how we teach.

Our educational culture

We are adapting to work together as a diverse academic community, improving the ways in which we include and inspire our students, and redefining how we develop and use physical and digital learning environments.

We aim to establish an inclusive culture in which students are partners and where diversity and collaboration facilitates a world leading educational experience.

5.1 Curricula and Assessment

We will carefully and strategically redesign and improve our curricula across all taught programmes. We will provide better, more flexible assessment and feedback opportunities that promote deep knowledge and practical skills across all our programmes.

Curricula

We are prioritising the review and redesign of our curricula using a consistent approach. Acknowledging that all our programmes are unique, we understand that our curricula have often developed organically in response to disciplinary changes, changing faculty expertise and interests, and pragmatic management of resources. This natural evolutionary growth has resulted in curricula that are not always sequenced in a way that is most logical for learning, which are sometimes overloaded and thus difficult to navigate by both students and faculty. Meanwhile developments in digital and online technology have been revolutionising the way students can acquire knowledge, and creating new possibilities for how classroom time can be used.

We recognise that distance from the College and experience of the working world is useful to the evaluation of the learning experience at Imperial, so we will consult with our alumni and outside professional bodies on which elements of Imperial education are valued most in professional life. This will give us the pulse of the marketplace and enable us to align our priorities with the fast-changing needs of society.

Experience of departments that have already made changes like these has shown that a fully effective redesign will take substantial time and effort, so we will take the time to do this well, aiming to have completed most of this work during the next two academic years.

We will establish a consistent approach to change by:

- Mapping the entire curriculum, capturing its current content as well as how it develops and assesses skills development at the level of intended learning outcomes, with the aim of showing alignment for all possible learning pathways
- Developing a balanced set of learning outcomes at programme and module level, focusing on: discipline-specific abilities, discipline identity, fundamental skills development and Imperial graduate attributes
- Amending and reshaping each curriculum to create time for more integrative and more interactive learning
- Considering what existing data and new research is needed to establish a robust baseline against which to evaluate the efficacy of any future curriculum development
- Including a research project in all undergraduate degree programmes to provide students with active engagement in discovery, with supervision by an active researcher
- Implementing a consistent, College-wide approach to the availability of Horizons within all undergraduate programmes
- Launching for-credit modules that offer broader, integrative activities to apply disciplinary knowledge in a new context, driving transformation of students' understanding and identity. These might include engaging schools, hard to reach groups and local communities with our science; involving and engaging patients and other research end-users; and sharing our research with the public more broadly. It could also involve student led projects and entrepreneurship, as well as existing options within the Horizons programme
- Consulting widely with employers, accrediting bodies and with our alumni, making use of our strong network of Industrial Liaison and Advisory Boards
- Allowing space and time for effective implementation of redesign and using evaluation of curriculum changes to inform continued improvement

We will be able to evidence:

- Learning outcomes that:
  - represent state of the art for each discipline
  - benefit from the latest guidance of relevant professional bodies and resonate with employers
  - capture the fundamental knowledge, skills and attitudes of the discipline
  - reflect disciplinary identity, professional expectations and Imperial graduate attributes
  - empower curriculum designers and teachers with a range of learning approaches and materials
  - link with a range of student identities and possible onward trajectories
  - capture the essence' of the course identity
- Modular structures that:
  - allow increased multidisciplinary study and connectivity between related disciplines
  - add flexibility and choice for staff and students
  - provide disciplinary breadth without overloading our curricula, our students and our faculty
- Emphasis on foundational concepts and discipline mastery as well as acquisition of facts
- Redistribution of student workloads allowing them to reflect on learning, achieve deep understanding and integrate concepts into practically applicable skills
- Research-based skills development
- Integration of professionalism alongside a progressive and ethical approach to learning, teaching and research throughout every programme
- Student engagement with authentic, integrated learning and assessment that applies disciplinary knowledge within a context and demands higher order analysis, evaluation and reflection
- Student engagement with at least one online module rated as a disciplinary gold standard against global comparators
- Availability of dedicated resources to support staff in curriculum review and redesign, building on a broad range of available experience and expertise

Assessment and Feedback

The nature of assessment and feedback to students has been a consistent theme in their evaluation of the educational experience at Imperial[4]. The volume of assessment is considered to be problematic, as is the quality and timeliness of individual feedback. Concerns have also been raised about an exam-passing culture and the associated competitiveness that assessment practices may amplify. As a consequence, our students too frequently adopt strategies to solely memorise facts in the short term, rather than engaging with an integrated study of the discipline. We will continue to set high standards for attainment, but we will assess this in a more effective and less intensive way. We will make use of dual-purpose assessment wherever possible to boost learning.

[4] *See for example the 2014, 2015 and 2016 Imperial College Union responses to Imperial's National Student Survey results.*

We will establish an enabling approach to change by:

- Developing a baseline understanding of the assessment load on every programme, and across all modules being studied concurrently
- Establishing norms and standards that enable students to better gauge the effort required for assessments (e.g. use of word caps), focusing effort on fewer, better assessments methods
- Deploying tools that allow frequent self-diagnosis by each student on every module to identify their relative attainment of knowledge and skill (e.g. instant feedback online quizzes before each learning event)
- Communicating clearly the ways in which every assessment aligns with module learning outcomes and how these relate to programme outcomes; and aligning feedback strategy for support
- Actively building recognition amongst students that making mistakes is a helpful part of learning, and supporting students to develop personal strategies for learning from errors that enable the development of creative, progressive solutions
- Drawing on best practices locally and globally to increase the authenticity and inclusivity of assessment
- Investigating new assessment practices, in the longer term, to promote and test integrated learning. These will measure attainment at programme level, including skills such as abstract reasoning, cognitive curiosity, effective team work and ethical professional behaviour

We will be able to evidence:

- All assessments have clear alignment to module learning outcomes, contextualised within programme learning outcomes
- Increased emphasis on authentic, inclusive assessment that shows what students are able to do in practice, as a consequence of their learning
- Significant reduction in assessments based on memorising of accumulated facts
- Balanced student workloads for assessment and for integrating feedback within modules and across programmes as a whole
- Increased self-assessment and self-diagnostic opportunities for students to discover their own gaps, and to calibrate progress against peers
- Use of active learning mechanisms that ensure every student gains from every assessment point
- Availability of marking schemes and past exam papers for all coursework and exams
- Availability of model solutions for all coursework and for all exam papers shortly after completion
- Reduced aggregate load of assessment for credit
- Availability of dedicated resources to support staff in design, implementation and evaluation of new assessment strategies

5.2 Active Learning Pedagogy

We will introduce new methods to create an active learning and teaching environment across all taught programmes.

The adoption and introduction of active learning methods requires the transformation of current practice at all levels on a case-by-case basis. The methods and techniques introduced will closely reflect specific learning outcomes of individual programmes, modules and classes. Our comprehensive review and overhaul of curriculum delivery will encompass bespoke use of the full range of validated active learning techniques, and the integration of blended digital content. We will be able to innovate, to develop and adapt known methods, and to introduce entirely new active teaching methods while evaluating their effectiveness in the context of Imperial. Active methods in particular will be deployed to develop fundamental skills, like critical thinking, problem solving, group work and communication in the context of a specific discipline.

We will establish a supportive approach to change by:

- Freeing up time of key academics who lead the transformation of specific modules, so they have the space to identify learning outcomes, to map these to optimal delivery methods, then to develop and deploy these within an active learning framework
- Closely involving Teaching Fellows and learning technologists who will bring deep pedagogical expertise to help unlock maximally effective delivery of complex disciplinary content
- Allowing at least three academic sessions to complete an initial observation and planning phase, an implementation phase, and an evaluation and iterative refinement phase
- Helping faculty to turn heterogeneous student levels, languages and cultures from a challenge into an opportunity for learning where different perspectives offer an authentic, inclusive and integrated teaching experience
- Supporting students to engage effectively with an interactive approach to study with an appreciation of their differences in background, culture and pre-entry educational experience, as well as different levels of linguistic and communicative competence
- Encouraging students to become responsible for self-directed learning that bridges their individual learning gaps
- Developing interactive teaching tools that deliver fine grained, timely, dialogic feedback
- Being sensitive to teachers' inhibitions (Brownell and Tanner, 2012) while ensuring staff do not innovate in isolation and that they understand the underlying concepts of interactive teaching
- Enhancing our provision of training and support for all our instructors
- Creating new opportunities for students to collaborate and support their peers, for example through peer assisted study skills[5] and using this network to communicate the educational rationale for active learning to all other students.

We understand that many teachers believe that providing facts and answers is an important part of their role and crucial to their professional identity. It can be a challenge to step back and facilitate learning that allows students to discover for themselves. Focusing more time and effort on teaching in a culture that rewards research excellence can be an additional challenge. Yet these changes are crucial to the success of the strategic transformation at Imperial. If new techniques are being applied partially and/or without fundamental knowledge of the principles behind the new pedagogy, the results will likely be disappointing, both from the students' and from the teacher's perspective. That is why we aim for a College-wide community of educators who will introduce new teaching in a measured, sustainable way that is based on evidence.

In making this broad-based shift we will pursue three mutually reinforcing priorities:

1. Increasing use of active methods: teacher practices, teaching methods, students' learning by doing
2. Ensuring evidence-based matching of method to the discipline and the topic, as well as the desired learning outcome, e.g. if traditional chalk board presentation is the best learning method, then this will be used
3. Making the educational design and learning intent explicit to all students and staff involved, providing training and support as we make changes to the pedagogical approach. This will allow teachers to learn new methodologies in collaboration with students (Mulnix, 2016)

[5] *See for example the Peer Assisted Learning scheme in Life Sciences and Peer Assisted Study Sessions at Manchester.*

We will be able to evidence:

- Increased use of active learning in classroom interactions
- Teaching methods that are carefully selected based on the nature of learning outcomes
- Inclusive methods used in every learning and teaching interaction that provide opportunities for all students to fulfil their potential
- Learning interactions that are clear in their purpose and desired outcomes, and are made explicit to the students
- Materials and activities for learning interaction that directly contribute to intended learning outcomes and are informed by relevant research
- Use of technology to enhance learning interactions
- Teaching practices of individual academics that are informed by research and successes of other College staff
- Collaboration with leading educators worldwide to innovate teaching methods and research their outcomes
- Availability of dedicated resources to support staff in adopting more active teaching methods

5.3 Our Educational Culture

We will establish an inclusive culture for all staff and students across all our infrastructure and programmes.

Our strategy will be a success when we create a supportive environment for staff and students that rewards and recognises innovation and improvements, whilst encouraging student engagement in positive change. It will depend on the creation of world class learning spaces, the use of high quality data and the implementation of research evidence to inform decision making and evaluate education.

5.3.1 A supportive and inclusive scholarly community

Consistent, high quality support is essential to the wellbeing and success of our students and staff. We recognise that a supportive environment is key to fostering a sense of community and we will work to enhance this throughout the College.

We will establish an understanding approach to change by:

- Ensuring that staff in all roles across the College are supported and recognised
- Creating new opportunities for student-staff integration to build mutual understanding and co-operation
- Implementing the recommendations of the Personal Tutor Working Group, we will strengthen our personal tutoring system, providing support for Personal Tutors and Senior Tutors to help them support their tutees' personal and professional development and building a culture where personal tutoring responsibilities are valued and rewarded
- Applying recommendations of the Future of Student Services review, we will strengthen our student services in terms of physical space, communications and marketing, management and the use of systems and data. Meeting students' needs will be a constant driving force for improvements within and between our range of student services
- Supporting all students to help them make the transition to study at Imperial, by managing expectations and ensuring that everyone has the opportunity to play an active part in our academic community
- Providing advice for students which helps them to map their route through our more flexible programmes
- Exploring how to increase the use of online resources that support our students in the transition to university
- Creating new initiatives to embed equality, diversity and inclusivity in the campus community
- Maintaining and enhancing shared spaces, such as departmental common rooms and social spaces, emphasising the need for consistency in environment quality for all students across every department and campus
- Communicating the reasons for the use of different pedagogies within our programmes

We will be able to evidence:

- Students and staff feel part of an inclusive scholarly community
- Students and staff can perform to the best of their abilities irrespective of their gender, ethnicity, sexual orientation, cultural and socio-economic background or disability
- Students have high quality learning resources to draw on at their own pace
- Students and staff feel more supported by services across the College

5.3.2 Staff reward and recognition

Our strategy will be realised by establishing a culture that values learning and teaching as highly as research, thus rewards staff for their teaching. We will seek to establish robust and transparent structures to ensure that teaching faculty are consistently recognised for their achievements. We will strive for greater parity of esteem for teaching as a core activity at the same level as research.

We will establish a motivating approach to change by:

- Ensuring that processes for recruitment and promotion recognise contributions to the College's educational mission
- Recognising and valuing time spent on educational transformation, for example innovating curricula and pedagogy

- Developing and defining career pathways for staff whose primary focus is learning and teaching
- Increasing the visibility and recognition of staff who deliver great teaching
- Reviewing our existing mechanisms for evaluation of lecturers and modules to provide formative and constructive feedback for staff
- Acknowledging that teaching innovation can initially reduce student satisfaction expressed though survey results and ensure that staff are not penalised for this
- Appreciating that a focus on learning and teaching innovation may reduce staff contribution in other academic areas (e.g. research, mentoring and citizenship)
- Creating a community of teachers who innovate and research teaching methods, so that they can support each other, learn together and can become mentors to others
- Being sensitive to staff perception that changing our pedagogy indicates they have not been teaching 'in the right way' for many years
- Being sensitive to the fact that some staff identity centres more around research than around teaching

We will be able to evidence:

- Staff recognition through academic promotions for contributions to education
- Enhanced career progression for staff in Learning and Teaching roles
- Positive contribution of lecturer and module evaluation to educational improvement
- Staff feel that their contribution to education is valued
- An active community of innovative teachers and scholars

5.3.3 Support for staff to innovate and improve

- We will establish a constructive approach to change by:
- Creating time for some staff to step back from existing workloads and recognising their contributions consistently across the College
- Distributing workloads that recognise the contribution made by members of staff in reviewing and innovating curricula and pedagogy
- Adopting transparent departmental workload models, which include teaching and student support, is therefore recommended as good practice for all departments
- Allocating additional funding to departments to provide backfill for colleagues who are engaged with implementing change. It will be for departments to determine how this additional resource is best used.
- Investing in additional members of staff who will work with departments in facilitating curriculum review and provide support for staff to innovate their teaching
- Providing practical support on a one-to-one basis and across departments through the development of an Imperial pedagogy toolkit
- Giving educational technology support to help staff develop and deliver online learning innovation
- Funding ways to provide support for our staff in implementing more inclusive teaching approaches; for example, in supporting culturally mixed team working and in creating more inclusive curricula

We will be able to evidence:

- Opportunities and time are given to staff who enhance and refine curricula, innovate teaching methods and practices, and improve quality of assessment
- Implementation of transparent workload models across all departments to include time for education innovation and individual's teaching practice
- Availability of practical support and resources to staff to transform teaching
- Development of a community of practice for teaching staff, particularly those tasked with implementing innovation

5.3.4 Student engagement in positive change

We will establish an engaging approach to change by:

- Ensuring that students who actively contribute to these changes are supported and recognised.
- Establishing new ways for our students to contribute to their own and to their peers' educational experience, including in the online and digital space
- Strengthening existing feedback structures and build on their foundations for consultation, participation and collaboration with students
- Creating a series of new grants that support our students to work with staff in determining priorities for change and recommending improvements. These will enable students to engage in the implementation of relevant changes within their own departments
- Funding a series of projects that create an opportunity for staff and students to work together in addressing shared issues of concern, creating a partnership approach that is supported locally and centrally within the College

We will be able to evidence:

- Students participation in peer learning and assessment as part of their programme
- Opportunities for students to contribute to improvements in their discipline curricula, pedagogy and assessment
- Funding of student-led education improvement projects in each department

5.3.5 World class learning spaces

New forms of pedagogy require high quality, digitally-rich and multi-functional teaching spaces. Trends towards shared space for learning and teaching highlights the continuing need to provide social spaces within departments that enable students to meet and foster a sense of community. Library spaces must include a variety of learning, teaching, study and social spaces that are open to everyone across the College. The provision of spaces for study, collaboration and social activities should correlate to modern modes of office working. The need for increased flexibility is also driven by the differing requirements for students at different sites and the changing needs of our community throughout the year, e.g. more group working is needed at certain times while more individual study occurs during exam period. This presents opportunities for us to transform our existing spaces and to create new spaces.

As we move towards a holistic approach to space usage across campuses, we will take action to address existing disparities in the quality of space. These will be increasingly important in attracting and retaining the best students and staff. We will work in partnership with students and staff who teach and support teaching at an early stage throughout all these works, and will carry forward changes through the Operational Excellence (OE) space programme.

We will establish a future-looking approach to change by:

- Creating flexible flat spaces that can be partitioned and can use technology and furniture with maximum flexibility
- Providing new learning spaces for each faculty to accelerate and enable innovation by offering an adaptable, resource-rich 'sand box' for staff to experiment with new teaching techniques
- Embedding a new, overarching space policy framework that will facilitate greater sharing and drive increased utilisation
- Developing a modern, well-equipped undergraduate teaching laboratory and shared idea generation space to enable the development of highly innovative and world-leading interdisciplinary aspects to our teaching, with cross-fertilisation of ideas and experience between all Imperial staff and students
- Maintaining and enhancing departmental common rooms to ensure a consistently high quality experience for all students across departments and campuses
- Creating spaces which support our students and staff to engage with ideation and prototyping.
- Ensuring that library spaces are flexible and fit for the next generation, including adequate provision of power and data, as well as collaborative and bookable spaces.
- Planning Library study space within the context of the wider provision of study space across the College
- Mitigating pressure on the library, particularly at peak times

We will be able to evidence:

- Active student and staff engagement in design and delivery of new learning and community building spaces
- Equal access to quality physical space suited for reflective learning, and for discipline cohort building
- Distribution of physical learning innovation hubs across campuses
- Evaluation of the effect of physical environment on learning outcomes
- Modern, interoperable digital augmentation suited to the pedagogies are delivered in all physical learning spaces

5.3.6 Use of data and analytics to understand success

Data is critical to enabling the process of evaluation and to educational research. Improving the availability and quality of our data will better inform decision making for our staff and for our students. For example, we have already seen that the new interactive curriculum mapping tool used by the Imperial College School of Medicine, "Sofia", supports students and educators in viewing specific learning and teaching outcomes in the wider context of their programme. For the first time we are able to carry out cohort studies that explore student outcomes, measure the impact of course changes and see the efficacy of educational interventions.

We will establish a data-focused approach to change by:

- Mapping and monitoring data about our curricula and assessments to provide a clear picture of the content and workload across each programme
- Giving students clear, detailed information and advice about possible pathways through optional modules in order to inform their choices
- Learning from, augmenting and aggregating data to follow individual students' trajectories through Imperial and potentially beyond
- Incorporating social sciences data analytic techniques into our evaluation, and web-based analytics into research of online learning
- Using our online and digital spaces as a 'laboratory' for rigorously testing different pedagogies in a controlled environment, for instance by simulating randomised controlled trials in a digital environment

We will be able to evidence:

- Students' digital interaction with the College is integrated, flexible and personalised and they are active participants in the evaluation of the methodologies
- Collection of data that provides information at the individual and the group level
- Availability of high quality data about the characteristics of learning interactions[6] in classrooms and online
- Data science approaches to evaluating our education
- Availability of data about programmes, modules, pedagogies and assessment outcomes that enable comparison and evaluation within and across disciplines
- Consideration of learning analytics approaches and design into curricula where useful

5.3.7 High quality evaluation and research

New understandings of the brain (Bransford, Brown and Cocking, 2000), and new learning models (Ambrose *et al.*, 2010) have created a significant opportunity to conduct impactful research and evaluation into higher education learning and teaching practices. Analytics on learning from online datasets also create novel opportunities for research into higher education, allowing the development of innovative ways to research integrated, authentic, contextual research-based learning and how they transform student cognitive understanding and identity. In the short term our use of data will put emphasis on the rigorous evaluation of our own learning and teaching practices.

[6] *Including environmental factors like room, temperature, duration, time of day, etc; and for online data about time of day, duration, dwell time by topic, etc.*

We will establish a data- and research-based approach to change by:

- Drawing on existing evidence and collaborating with leading higher education experts to determine the research questions that are important for Imperial as we evaluate changes to our learning and teaching
- Establishing a baseline against which our learning and teaching innovation can be evaluated – this will focus on Imperial graduate attributes
- Using information from our own practice to contribute to the global body of knowledge on active learning
- Taking the research questions to the next level and being globally leading in cutting edge interactive learning and education research
- Ensuring our decisions about curricula, pedagogy and assessment of attainment are evidence-based and research-base

Over the longer term, we envisage this will lead to:

- Studentships that support PhDs in educational research within each of our main discipline groupings
- Recruitment of a full Professor of Education with strong connections to the social sciences theory and practice of higher education, and translation of that theory into impact at Imperial
- Development of an original Imperial College London body of knowledge that rigorously evaluates how we educate, and creates useful transferable techniques and insights to foster innovation
- Recruitment of a Full Professors of Education in science, engineering, medicine and business faculties, who offer academic focus on education practice in their disciplines, setting a research and evaluation agenda accordingly

We will be able to evidence:

- Baselines against which learning and teaching can be evaluated for all programmes
- Plans that evaluate and inform learning and teaching improvement on all programmes
- Social science research commissioned to understand the barriers faced by underrepresented student groups
- Equality and diversity impacts of curriculum design, delivery and assessment
- Quantitative evidence of the impact of our widening participation programmes on student access, success and employability, though tracking of individual students through to admission, continuation, degree result and destination
- Rigorous research on the effects of cutting edge innovation and changes to curricula and pedagogy
- Appointment of professors of education in science, engineering, medicine and business faculties

Bibliography

Ambrose, S. A., Bridges, M. W., DiPietro, M., Lovett, M. C. and Norman, M. K. (2010) *How learning works: seven research-based principles for smart teaching*. Jossey-Bass.

Biemiller, L. (2014) *Harvard and MIT Release Visualization Tools for Trove of MOOC Data – Wired Campus, The Chronicle of Higher Education*. Available at: http://www.chronicle.com/blogs/wiredcampus/harvard-and-mit-release-visualization-tools-for-trove-of-mooc-data/50631?cid=gn&utm_source=gn&utm_medium=en (Accessed: 10 April 2017).

Bransford, J., Brown, A. and Cocking, R. (2000) *How people learn: brain, mind, experience, and school*. National Academy Press.

Brownell, S. E. and Tanner, K. D. (2012) 'Barriers to faculty pedagogical change: lack of training, time, incentives, and...tensions with professional identity?', *CBE Life Sciences Education*. American Society for Cell Biology, 11(4), pp. 339–46. doi: 10.1187/cbe.12-09-0163.

Deslauriers, L., Schelew, E. and Wieman, C. (2011) 'Improved Learning in a Large-Enrollment Physics Class', *Science*, 332(6031), pp. 862–864. doi: 10.1126/science.1201783.

Easterbrook, D. and Parker, M. (2006) 'Engineering Subject Centre Mini-Project: Assessment Choice Case Study', *Higher Education Academy*. Available at: https://www.heacademy.ac.uk/system/files/assessment-choice-case-study.pdf (Accessed: 10 April 2017).

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H. and Wenderoth, M. P. (2014) 'Active learning increases student performance in science, engineering, and mathematics.', *Proceedings of the National Academy of Sciences of the United States of America*. National Academy of Sciences, 111(23), pp. 8410–5. doi: 10.1073/pnas.1319030111.

Ghadiri, K., Qayoumi, M., Junn, E., Hsu, P. and Sujitparapitaya, S. (2013) The Transformative *Potential of Blended Learning Using MIT edX's 6.002x Online MOOC Content Combined with Student Team-Based Learning in Class*. Available at: https://www.edx.org/sites/default/files/upload/ed-tech-paper.pdf (Accessed: 10 April 2017).

Gurin, P., Dey, E., Hurtado, S. and Gurin, G. (2002) 'Diversity and Higher Education: Theory and Impact on Educational Outcomes', *Harvard Educational Review*. Harvard Education Publishing Group , 72(3), pp. 330–367. doi: 10.17763/haer.72.3.01151786u134n051.

Hoellwarth, C. and Moelter, M. J. (2011) 'The implications of a robust curriculum in introductory mechanics', *American Journal of Physics*. American Association of Physics Teachers, 79(5), pp. 540–545. doi: 10.1119/1.3557069.

Holmes, N. G., Wieman, C. E. and Bonn, D. A. (2015) 'Teaching critical thinking.', *Proceedings of the National Academy of Sciences of the United States of America*. National Academy of Sciences, 112(36), pp. 11199–204. doi: 10.1073/pnas.1505329112.

Ippolito, K. (2007) 'Promoting intercultural learning in a multicultural university: ideals and realities', *Teaching in Higher Education*, 12(5), pp. 749–763. doi: 10.1080/13562510701596356.

Killpack, T. L. and Melón, L. C. (2016) 'Toward Inclusive STEM Classrooms: What Personal Role Do Faculty Play?', *CBE Life Sciences Education*. American Society for Cell Biology, 15(3), p. es3. doi: 10.1187/cbe.16-01-0020.

Klochan, Y. (2015) Highlights from '*Blended Learning on MIT's Campus'; Nov 16 xTalk | Office of Digital Learning*. Available at: https://odl.mit.edu/news-events/blog/highlights-blended-learning-mits-campus-nov-16-xtalk (Accessed: 10 April 2017).

Von Korff, J., Archibeque, B., Gomez, K. A., Heckendorf, T., McKagan, S. B., Sayre, E. C., Schenk, E. W., Shepherd, C. and Sorell, L. (2016) 'Secondary analysis of teaching methods in introductory physics: A 50 k-student study', *American Journal of Physics*. American Association of Physics Teachers , 84(12), pp. 969–974. doi: 10.1119/1.4964354.

Mulnix, A. B. (2016) 'STEM Faculty as Learners in Pedagogical Reform and the Role of Research Articles as Professional Development Opportunities.', *CBE Life Sciences Education*. American Society for Cell Biology, 15(4). doi: 10.1187/cbe.15-12-0251.

Murphy Paul, A. (2015) *Are College Lectures Unfair? – The New York Times*, *The New York Times*. Available at: https://www.nytimes.com/2015/09/13/opinion/sunday/are-college-lectures-unfair.html?_r=1 (Accessed: 10 April 2017).

Schwab, K. (2016) *The Fourth Industrial Revolution: what it means and how to respond*, *World Economic Forum*. Available at: https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/ (Accessed: 10 April 2017).

Scudamore, R. (2013) 'Engaging home and international students: A guide for new lecturers', *Higher Education Academy*. Available at: https://www.heacademy.ac.uk/system/files/rachelscudamorereportfeb2013.pdf (Accessed: 10 April 2017).

Seron, C., Silbey, S. S., Cech, E. and Rubineau, B. (2016) 'Persistence Is Cultural: Professional Socialization and the Reproduction of Sex Segregation', *Work and Occupations*. SAGE PublicationsSage CA: Los Angeles, CA, 43(2), pp. 178–214. doi: 10.1177/0730888415618728.

Sharpe, R., Benfield, G., Roberts, G. and Francis, R. (2006) 'The undergraduate experience of blended e-learning: a review of UK literature and practice', *Higher Education Academy*. Available at: https://www.heacademy.ac.uk/system/files/sharpe_benfield_roberts_francis_0.pdf (Accessed: 10 April 2017).

Smith, K. A., Sheppard, S. D., Johnson, D. W. and Johnson, R. T. (2005) 'Pedagogies of Engagement: Classroom-Based Practices', *Journal of Engineering Education*, 94(1), pp. 87–101. doi: 10.1002/j.2168-9830.2005.tb00831.x.

Strasser, R. and Hirsh, D. (2011) 'Longitudinal integrated clerkships: transforming medical education worldwide?', *Medical Education*, 45(5), pp. 436–437. doi: 10.1111/j.1365-2923.2011.03939.x.

Talbot, R. M. l., Doughty, L., Nasim, A., Hartley, L., Le, P., Kramer, L. H., Kornreich-Leshem, H. and Boyer, J. (2016) 'Theoretically Framing a Complex Phenomenon: Student Success in Large Enrollment Active Learning Courses', in 2016 *Physics Education Research Conference Proceedings*. American Association of Physics Teachers, pp. 344–347. doi: 10.1119/perc.2016.pr.081.

Tamim, R. M., Bernard, R. M., Borokhovski, E., Abrami, P. C. and Schmid, R. F. (2011) 'What Forty Years of Research Says About the Impact of Technology on Learning: A Second-Order Meta-Analysis and Validation Study', *Review of Educational Research*, 81(1), pp. 4–28. doi: 10.3102/0034654310393361.

Appendix One

Using cutting edge digital technology to support **interactive teaching**, create a **stronger academic community**, develop an **inclusive culture of diversity** and apply **the latest innovations in learning**.

Digital Learning Strategy

This Digital Learning Strategy will support the delivery and implementation of both the Learning and Teaching strategy and the overall College Strategy.

Online learning and digitally-enhanced teaching create enormous opportunities for Imperial to deliver innovative education that is as excellent and world-leading as its research, to find a niche, and to lead globally. Many top universities ventured into the online learning space before Imperial, but very few, if any, have coupled their digital innovation with far-reaching, university-wide education innovation. If Imperial moves in a bold, but strategically savvy way, it can evolve to meet 21st century education requirements, improve students' broader experience on-campus, and enhance their learning. From here we can do the same for even larger cohorts of learners globally.

Four priorities of the Digital Learning Strategy

1. To enhance the experience of our on-campus students

The Digital Learning Strategy will support more interactive classrooms and laboratory spaces. Digital technology can be used to deliver lectures and other course materials online, before physical classes take place. This frees up classroom and laboratory time for more in-depth discussion, for group work and further engagement with the materials. In the interactive classroom, technology can be used to guide discussion, to engage students actively with one another and with the teacher, to provide students and the teacher with real-time feedback on individual and group assignments, to enhance group discussions. It can live-stream teaching to groups of students at another Imperial campus or in other parts of the world. During class, teachers can get a much better impression of their students' level of understanding and can adjust their teaching during the module or even on the spot.

Using advanced technology, students can grade each other's work, produce group assignments in a digital space, analyse real datasets in virtual research environments, and become actively engaged with their scholarly community. They can collaborate on projects with other top universities that are active in the online space, creating a vibrant, international learning environment for Imperial students in which they can be co-creators of teaching innovation. Imperial would be the first university to strategically combine evidence-based active learning methodologies in synergy with digital and online innovation across all areas of learning and teaching.

2. To increase Imperial's global footprint in education

As leading universities are producing more open and available online courses, learners around the globe can choose university courses in a particular topic without having to move to live on campus. Increasingly, such courses from top universities are being provided for credit. This technology caters to many bright young people who cannot afford to physically go to a university and live on campus as they get a degree. Similarly, it provides for life-long learning, which is being recognised as a necessity for working people to stay up-to-date with fast developing technology and research developments. Our students develop into lifelong learners and as alumni will continue to benefit from access to our education. Yet these changes are disruptive to universities that have long catered to large groups of students who come to their campuses for a number of years.

Imperial can develop online teaching for large groups of learners across the globe, and in the UK, reflecting the areas of our research strengths via digital platforms and methods. Those offerings should be our standard level of pedagogical excellence and should be taught by the same top researchers as the on-campus offerings. These courses can create a global community of actively engaged learners and loyal ambassadors for Imperial. If used for outreach, these courses can be used to train and attract secondary education students to Imperial. The choices of courses can range from single small online courses, to (combinations of) Massive Open Online Courses (MOOCs) and fully online degrees.

The focus will be on topics that are most in demand globally and are research strengths of the College, such as public health and medicine, global challenges, computer science and business. In five to ten years' time the College will thus serve two communities: one on-campus and one global. The latter will have much higher numbers and a larger spread in student ages.

The topics and courses that Imperial will cover online will ideally blend offerings for sustainable new revenue (see below) and offerings for the benefit of society, which increase our impact in education and in research. There may be instances when Imperial chooses to produce courses for free or sponsored by philanthropy, for example in a time of global epidemic or if catering to a group of health workers or other learners who cannot afford to pay.

Much of the potential for cutting edge research in learning analytics and online learning has not been fully explored, but these are growing fields in educational research. Imperial can be ahead of the game globally if we combine our expertise in data science and our existing expertise in higher education pedagogy with a clear focus on researching and evaluating the education innovation that is being planned.

3. To create global citizens who optimally use digital technology in professional environments

Global availability of technology is increasing at enormous speed. Businesses and organisations who know how to employ digital tools, use them well, create global online communities and innovate are thriving. Yet there are limits to what humans can responsibly do in online spaces, and it can be difficult to grasp these issues of technological constraints, ethics, inclusivity, safety, big data and infrastructural developments. Not all students are digital natives, or will know how to use online technology to improve human interaction and the human condition.

Imperial students will have valuable graduate skills to bring into the global work place if they are used to interacting with digital technology in their classes, if they are used to being part of a community that partly meets in person and partly collaborates in an online space, if they have been co-producers in finding optimal digital and online solutions for human learning, business and interaction. Ideally the Imperial online learning space will be international and innovative so learners from other parts of the world will interact with our on-campus students for learning and research. Imperial students can be participants in the classroom, teaching assistants in online courses and entrepreneurs in online technology. They will be fully accomplished at learning and working in a truly global online environment.

4. To create revenue for the College

Part of the online offerings mentioned above can be revenue generating, with different models of payment and income for the College. Many analysts are predicting that within the next few decades, on-campus offerings will be a substantially smaller part of the global university picture and that a large percentage, or even the majority of the higher education, will be offered in the online space. If that is true, there is no doubt that the dominant providers will be universities with a strong global brand name and an excellent reputation for research and pedagogy, which provide a large, quality suite of technically strong online possibilities. Imperial can be in that arena and can have a business model that reflects its attractiveness to a large global population.

Innovation in online teaching

For our strategy to be successful, Imperial needs to offer a broad range of online courses. Large, open courses are an important part of this portfolio, because they can be test cases for high quality educational offering. Potentially the whole world will be watching and learning from our innovation, so these courses need to be technically superb, within research topics for which Imperial is globally renowned. It needs to be pedagogically sound, evidence-based and preferably taught by top researchers in the field. The knowledge that flows from producing these courses will spill over to innovation in on-campus learning, both in terms of novel pedagogy, in ways of assessing and testing, in earning analytics and new ways of rigorously testing novel pedagogies, in building and supervising the online learning community and in many other ways. Top researchers who have produced successful MOOCs will be more interested in teaching than they have ever been before, and the fringe benefits of that increased enthusiasm are significant. Producing top-level courses for the world will change on-campus teaching in profound ways.

In order to reap these benefits, it is important that the Digital Learning Strategy is centrally defined before it is delivered locally or at department level. It is important that the full strategy

is supported by a central team who can stay on top of the fast developing field of online education, can negotiate with platforms and providers at a central level, and can ensure the highest level of quality and efficiency both in content delivery and in learning analytics and research. The Digital Learning Strategy should also ensure financial sustainability of the programme in the middle to long term, as well as its flexibility in the face of future technological developments and its continued alignment with the overall College strategy.
Professor Simone Buitendijk, Vice-Provost (Education)

By setting out a Digital Learning Strategy we will foreground the importance of implementing digital technology throughout our learning and teaching practices.

Our Online and Digital Approach

Getting the most from digital and online technology

The new, interactive way of teaching outlined in our Learning and Teaching Strategy lends itself very well to use of digital and online technologies that require blended learning methods. We will ask departments to transform their pedagogy, to be innovative in their use of technology, and to enlist the help of learning technologists in their specific discipline.

The centrally-led Digital Learning Hub will help them to decide how to best employ technology to support broader goals; field work, laboratory work or classroom teaching will require different uses of digital technology and some solutions will be specific to mode and format of delivery. Our Digital Learning Hub will be knowledgeable about the possibilities available and will be able to advise whether bespoke solutions need to be developed and tried, or whether off-the-shelf possibilities are available. When requests for help are voiced to the Digital Learning Hub, the use of digital innovation will be more cost-effective and of higher quality.

We will build on the pedagogical goals outlined in our Learning and Teaching strategy and we will evaluate all innovative digital technology against those goals, in close collaboration with our students. Digitalisation can be very effective in building a community and in enhancing learning. Evidence suggests that blended learning can yield better outcomes in teaching[7], but it is pivotal that we research the effects of the technology and quickly identify unwanted side-effects or barriers to effectiveness. We will use established research methodology and develop our own assessment of online and digital pedagogy. We will work closely with international experts on this; because it is not a very large research field, collaboration and building on others' expertise will be important. Online learning through analytics, online randomisation and big data science is an exciting and promising research field, which offers novel possibilities for rigorous study in which Imperial can play a lead role.

Increasing the global education footprint

We will start producing online courses that are open and aimed at large audiences (MOOCs) and that are closed and aimed at smaller audiences (SPOCs). As much as possible we will try to use the online materials in multiple ways. For example, MOOCs and SPOCs that deal with the same topic can be developed alongside one another and be used for different but connected target groups.

In the choice of MOOCs we will first focus on Imperial's research strengths and on topics that are in-demand but not yet covered. We will produce courses on EdX and on Coursera, the two globally leading platforms. It is important for our reputation that we produce high-quality MOOCs, which feature our leading researchers. All faculties should be visible in our MOOC offerings and they should enhance Imperial's global reputation. A Committee (the Online Learning Innovation Group) with representatives from all faculties will define rules and choose which MOOCs can be produced. The Digital Learning Hub will subsequently offer the technical and pedagogical support needed for production.

We will produce smaller, closed community courses for use on-campus, for student communities that work in different places (e.g. the Medical School or the Chemistry Department). In doing so we will create international classrooms with Imperial students and external students in other parts of the world (e.g. Lee Kong Chian School, MIT, or developing countries), or we can mix Imperial students together with professionals.

Developing responsible digital innovation

In close collaboration with our students, we will design, innovate, implement and evaluate digital and online learning technology. Our most important goal in the Learning and Teaching

[7] *Sharpe R, Benfield G, Roberts G et al, 2006, 'The undergraduate experience of blended e-learning: a review of UK literature and practice', Higher Education Academy. https://www.heacademy.ac.uk/system/files/sharpe_benfield_roberts_francis_0.pdf*

Strategy is perhaps the ambition to build inclusive diverse communities that stimulate interaction between students and academics. Online technology can greatly enhance a sense of belonging, it can increase effective communication and draw out students who find it hard to speak up in a lecture theatre. However, technology can also alienate and isolate, or expose individuals to unfair treatment and even bullying. We will not immediately know the effects of much online innovation, so it is crucial to work very closely with our students to find out what works and what does not work. They will be co-creators and co-innovators and can be employed as teaching assistants in the digitally enhanced classroom, as well as in the virtual space. If we develop technology and rigorously research it together, and if we closely monitor whether it helps or gets in the way of human interaction, we will develop responsible online innovation whilst helping our students to develop valuable skills for use in their future jobs.

Creating revenue

Soon after the launch of our online learning programme we will develop programmes or courses that can generate revenue in the near future. Concrete possibilities are fully online Master's programmes (e.g. in public health), short courses for Continuing Professional Development, or MOOCs that may be in high demand (e.g. in data science).

Our Learning and Teaching Strategy sets out the full context of our ambitions and our proposed actions in more detail.

Appendix Two

All the goals and objectives laid out in our strategy are informed by careful consultation with staff and students from across the College.

Learning and Teaching Strategy consultation

The consultation phase of the Learning and Teaching Strategy development took place in the 2016 autumn term and has now concluded.

Consultation process

There were four main components to the consultation:

1. Online consultation for students and staff

An online consultation for staff and students was open between 1 November and 16 December 2016. Overall 273 people, 131 students and 142 staff, responded to one or more of the questions.

2. Pop-up consultations with students and staff

A series of pop-up consultations took place over a two-week period in the 2016 autumn term to gain views and feedback from staff and students. Stands were located in the following areas:

- Bessemer Reception, South Kensington
- College Main Entrance, South Kensington
- Reynolds Building, Charing Cross
- SAF Building, South Kensington
- Junior Common Room, South Kensington
- Sherfield Foyer, South Kensington

The stands consisted of large consultation posters asking for comments on teaching methods, learning environment, learning resources and any other comments on learning and teaching at Imperial. Overall 260 comments were received.

Voting boxes were also available for staff and students to indicate their views on the following question: “Thinking about the ways in which we might change learning and teaching at Imperial, which of these areas do you think is most important?” 407 people voted.

3. Town Hall meetings open to all staff and students

Town Hall meetings took place on the South Kensington campus on 23 November 2016 and 8 December 2016. These were open to all staff and students; those in attendance were mainly staff who are directly responsible for delivering and supporting learning and teaching. As well as discussion during the meetings, Mentimeter was used to collect feedback from 69 attendees on three multiple choice questions.

4. Meetings with Heads of Departments and Teaching Fellows

At the Heads of Departments dinner on 10 October 2016, Simone Buitendijk presented the Learning and Teaching Strategy. The attendees then discussed the existing strengths in learning and teaching at Imperial, areas for improvement, and examples of good practice.

At the Teaching Fellows Network meeting on 2 November 2016, Teaching Fellows discussed which elements of learning and teaching are working well and should be retained, which elements should be changed, the necessary resources to implement these changes, and existing examples of good practice in learning and teaching.

Consultation outcomes

These consultations resulted in the identification of key themes which have been woven into the goals and objectives of the Learning and Teaching Strategy.

Elements of an Imperial education

- Students should develop **transferable skills** as well as completing rigorous academic programmes with **disciplinary depth** in order to prepare them for professional careers on graduation
- Learning and teaching should include **real life examples and applications**, and should focus on topics with applications that deliver **benefit to society**. Situated authenticity and case studies were often mentioned

- Learning and teaching should be **research-based**, to include: advanced modules focusing on a department's research strengths; students undertaking research projects; students having access to leading researchers in their fields; and modules including current and possible future research directions of a field
- Understanding should be emphasised as well as factual knowledge. **Problem solving and critical thinking** are key attributes students should develop during their degree
- Students should have the opportunity to **learn through failure** without losing marks, with staff trained to deliver this kind of teaching
- Teaching should be **stretching and challenging** for students, but with support available to students when they get stuck
- Students should have the opportunity to engage in **inter-disciplinary learning** during their time at Imperial

Curriculum design

- Some Imperial curricula are overloaded with factual content, whereas **a more focused curriculum** would allow students to develop deeper understanding of topics, and facilitate active learning method
- **Decreasing student workloads** can avoid the risk of superficial learning, and enable students to balance studying with extra-curricular activities, job applications and a life outside the College
- Students need to be able to synthesise material from multiple modules, so **programmes should connect** horizontally and vertically. Modules should follow a logical progressive curriculum that builds over the years, with pre-requisite knowledge (e.g. mathematical concepts) taught before material that builds on this knowledge

Learning and teaching methods

- **Small group tutorials** are one of the most helpful learning methods, allowing students to work through problem sheets, ask questions, get immediate feedback and help with areas of difficulty. Small group sizes are important to students getting the most out of tutorials, with many students and staff wanting more tutorials and a greater proportion of contact time to be spent in tutorials
- **Active learning** is a very effective. It can include problem classes, study groups, group or class discussions, problem based learning and project work. It can develop transferable skills as well as disciplinary knowledge and understanding. The best active learning methods allow students to have 1:1 interactions with teaching staff so they can ask questions and get feedback as part of the process
- **Lectures** can be very helpful in teaching theoretical content, especially when delivered by excellent communicators and structured to include interactive elements. Many staff and students feel that some content delivery can be achieved through online video resources and self-learning, with contact time being used to practice applying knowledge, to address student misunderstandings and for discussion instead
- **Laboratory, practical classes and fieldwork** can be very effective learning methods when they are well organised, synthesise material from multiple modules, and where a good number of Teaching Assistants are available to allow 1:1 discussions and feedback
- **Group work** on problem sets, discussions and projects are a useful learning method, developing transferrable skills as well as student understanding. Students prefer to work in small groups as this aids effective communication. However, students have some concerns about fairness of group work where some members are more diligent than others

Assessment and feedback

- The **emphasis on assessment through exams could be reduced**, with more focus given to coursework, vivas and innovative assessment methods that facilitate the assessment of understanding as well as factual knowledge
- **More formative assessment** would help students to learn effectively by working through problems and giving them feedback. Weekly online tests with automated marking were suggested to increase formative assessment without increasing staff workload
- Feedback is essential to student learning, with the ideal being a high quantity of **timely, detailed, personalised feedback**. This should include frequent formative assessment and feedback that tracks students' progress. While students are keen to receive feedback quickly, staff are sometimes concerned about the workload in preparing personalised feedback; giving feedback electronically could help here
- Students are sometimes narrowly focused on maximising their exam marks to the detriment of their broader learning, so we need to **consider how assessment incentivises student learning**

- Some students are keen to have access to **more past exam papers and mark schemes** to assist with their exam preparation
- Students could be given the opportunity to give feedback, and could work with staff to analyse this feedback and work out how it can be addressed. They could give formative as well as summative feedback and trained to give constructive feedback.

Features of an excellent teacher

- **Superb communication skills**, including the ability to explain complex concepts clearly
- **Ability to adapt teaching** based on students' abilities, progress and interests
- **Enthusiasm** about their subject and about sharing knowledge with students
- **Approachable nature** that encourages engagement from students with questions or misunderstandings
- **Constructive approach** to reflection and student feedback

Learning resources

- **Clearly explained and complete lecture notes**, which are particularly appreciated when made available online in advance of lectures so students can bring a printed copy to annotate in lectures. Students value reading lists as part of lecture notes. Students also suggested more e-textbooks and iBooks would be very useful for their learning
- **Panopto** allows students to revisit difficult topics and is useful for revision. Some concerns were raised that Panopto reduces student attendance at lectures, staff feel pressured into using it, that the recording technology doesn't always work, and that recordings are not always of high quality
- **Blackboard and online resources**, including lecture notes uploaded electronically, chat functions, discussion forums, videos, animations, and online material not owned by Imperial (e.g. online tutorials). However, the large investment of time required to set up online resources, difficulty in providing feedback to students in this format, and the unreliable Blackboard system are downsides of online resources
- **Teaching Assistants** are valued, especially when there are a sufficient number of TAs to allow 1:1 discussions and feedback

Learning and teaching space

- There is a particular need for more **space for group work**, for example flexible flat-floored classrooms that facilitate student interaction are required as well as smaller rooms for small group teaching
- **Better quality** project and laboratory space is required and **teaching technology** could be improved e.g. audio visual tools
- More **multidisciplinary space** is needed like the Hackspaces and the Ideas Lab
- **Social space** is important for students to build cohort identity, but this space is not currently being prioritised
- **More space for student group study** and **space for individual study** is needed, with the library requiring investment to become a more comfortable working environment for students

A culture that values teaching

- Staff need to feel that **teaching is valued by departments and the College**, and that time invested in teaching will be recognised. Some staff feel teaching is highly valued in their department and appreciate initiatives that recognise excellent teaching (e.g. the Student Academic Choice Awards)
- Many staff lack **time and incentive to invest in teaching**, believing that they will be rewarded for excellence in research but not for excellence in teaching
- **Peer review of teaching, discussion of teaching methods and staff seminars** on learning and teaching would help to build a culture where excellent teaching is given high esteem
- More emphasis could be given to teaching ability during recruitment and promotion processes
- Staff innovating in their learning and teaching should not be penalised if Student On-line Evaluation (SOLE) scores temporarily drop as a result of new teaching methods

Appendix Three

A new committee will ensure the successful implementation of our strategic goals, objectives and innovative practices.

Learning and Teaching Committee

Terms of reference

- To oversee the development and implementation of the College's Learning and Teaching Strategy, ensuring alignment with College Strategy
- To proactively identify, support and promote innovations in learning, teaching and assessment
- To consider the evaluation of various approaches to curriculum design, delivery and assessment, ensuring that the impact on different student groups is understood and that the results are used to inform future practice
- To communicate and promote the profile of learning and teaching and the student experience at Imperial College
- To engage with and recommend action as appropriate to address key themes emerging from internal and external surveys of students
- To advise on the College's Teaching Excellence Framework (TEF) assessment and contribute to the development of the TEF provider submission
- To consider responses to external consultations on matters relating to learning and teaching
- To identify best practice from across the sector that can inform enhancement within College
- To oversee the development and implementation of the Academic Standards Framework (ASF) and ensure its compliance with the QAA Quality Code and related external frameworks, as well as its fit within the College
- To ensure alignment of the ASF with the SIMP process, specifically but not limited to the Academic Programme Lifecycle (APL) work stream
- To provide oversight of 'task and finish' groups and ensure timely delivery of proposals to support the APL work stream
- To receive and consider reports from the Online Learning Innovation Group

Reports to Senate

Membership

- Vice Provost (Education) (Chair)
- Associate Dean of Programmes, Business School
- Vice Dean Education, Engineering
- Vice Dean Education, Natural Sciences
- Vice Dean Education, Medicine
- Director of Educational Development
- Director of Strategic Planning
- Director of the Graduate School
- Academic Registrar
- Head of Academic Services, Registry
- Head of Strategic Projects, Education Office
- Deputy President (Education) ICU
- Secretariat provided by QA Team, Registry