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## 2.1. The unifying role of learning across higher education

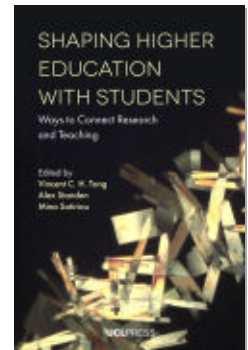
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## 2.1

# The unifying role of learning across higher education

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As a fellow scientist, from a different discipline, it is heart-warming to see a young mind thinking both laterally and globally and questioning all our previous experiences both in learning and teaching as well as in the field of assessment. Ahmet has reached a stage in his own intellectual development that is 'seeing the light' of the links between interdisciplinary research. It is connection through team learning that he passionately feels should move our institutions of higher learning towards a more integrated future. Personally, coming from the field of clinical medical science and the modern recent wave of 'evidence-based medicine', it is so very rewarding to be able to endorse a young engineer who wants to challenge and empower the youthful student experience, democratise education and challenge conventions. It gives me great pleasure to see that the R=T initiative at UCL is causing a small revolution in many younger research workers. Hopefully they will be the vanguard and continue to challenge the learning process and the status quo. Higher education is not about data and the gathering of isolated facts to be regurgitated in exams but about putting them into a knowledge base provided by the teacher. The teacher's task is then to show the wisdom of this knowledge and thus enthuse, stimulate and encourage the student to want to find new knowledge and wisdoms across their discipline for use in our modern society. I will follow Ahmet's academic career with interest, and as my mother – a dedicated and very practical teacher – always taught me: 'Pupils *may* learn. Teachers *must*'.

Professor Peter Abrahams

## 1. The antique roots

In the era of Classical antiquity, the majority of humankind had a relatively limited collection of knowledge about the universe while most phenomena were explained through myths and stories. In that particular time, the Library of Alexandria (Figure 2.1.1) was opened as a pearl of wisdom as the very first research institute ever known in the history of the world. It truly was a citadel of human consciousness, the centre of education and science in the Hellenistic world, where laws of the nature were enthusiastically sought for and taught to subsequent generations. Among the greatest minds educated were Eratosthenes (Roller 2010), a great polymath and father of geography who claimed planet Earth was spherical and calculated its circumference to a surprising degree of accuracy (1% error) about 1,700 years before any scientist, even after Magellan's circumnavigation. Aristarchus (Heath 1913) hypothesised a heliocentric solar system almost 2000 years before Copernicus (1566). The examples go on with Euclid, Archimedes, etc., indicating that for great discoveries,



**Figure 2.1.1** The Royal Library of Alexandria (third century BCE) was part of the Temple of the Muses. (Image used under Creative Commons CC0)

perhaps one does not need that much equipment beyond basic tools and paper combined with a great deal of curiosity and imagination.

The Alexandrian Library is of particular importance in exploring the systematic collection and sharing of information, as the first institution to have lectures, reading rooms, meeting offices, public halls and an extensive library. It was an early model of a university, where knowledge is learned, shared, enriched and taught so to be passed on. It was perhaps one of the earliest centres ever to integrate research and teaching. It was through the formation of influential contemporary teams, in which learning, inspiration from and imitation of great minds apparently had taken place, that a cultural evolution was able to progress. In other words, it has been possible through preliminary *memes*: ideas, behaviours and cultures spreading between individuals in a society.

The library was progressively forgotten over the following six centuries, with most of its contents either lost or burnt. It would take many more centuries until the Enlightenment to surpass level of comprehension attained there. Yet successors have adapted and flourished even more. The collection of information keeps on expanding in the twenty-first century. It is more extensive, fluid, abundant and easy to find than ever before. Yet with time becoming ever more limited, all this information is also hard to process. Accordingly, we can and will eventually find a way again of adapting to the renewed necessities of this age to prosper even further. We should not forget what brought our species to the current distinct position: the systematic accumulation of knowledge about the cosmos and its successful transfer to subsequent generations. Hence, this chapter relates specifically to the production and sharing of knowledge and even more distinctly on the human components of knowledge-generation and sharing: teacher and student. Specifically: research and teaching.

## 2. The overlapping of research and teaching

In research, unknowns are sought, while in teaching the known is taught. Importantly both share the act of learning. Therefore, any process that enhances the quality of learning should theoretically develop teaching too. Hence this section considers whether there is tangible evidence that indicates a mutually beneficial correlation between research and teaching (Breen et al. 2003).

Research and teaching are two core academic traits of modern universities and policies determine the time allocated to both. Time invested

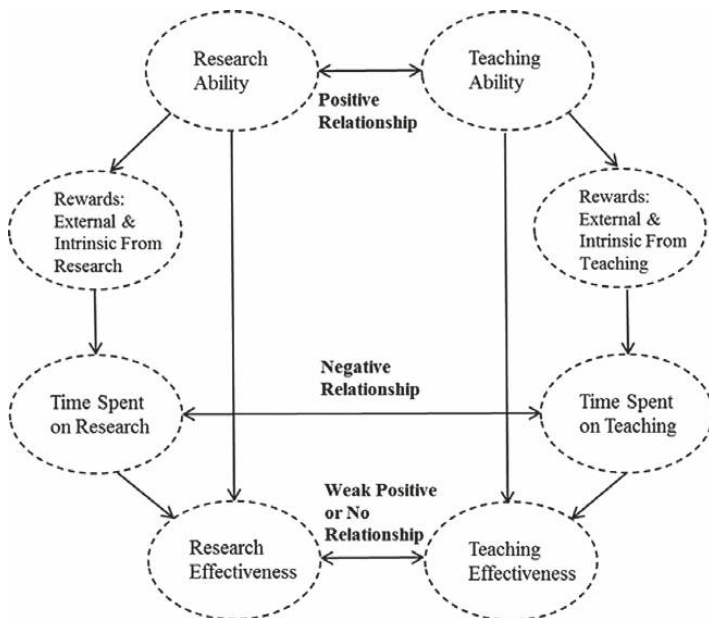
in either one is reallocated from the other – for example, teaching-focused universities do not prioritise research (Marsh 1979). Yet there are complementary insights in their mutual interaction. In many ways, learning and teaching reinforce each other. Imagine teaching a colleague. Suddenly, you realise gaps in the knowledge that was assumed extensive. It is apparent that a thorough understanding of teaching and learning are interactively beneficial to each other. A teaching person is assumed to have learnt better than a pure learner. The potential cause of this positive interaction is often explained through comparison of different teaching methods and information retention rates among students after a learning session.

Substantial changes, however, are observed in the case of participatory or active learning (Mosaica and The Corporation for National Service 1996) as retention rates increase to 50 per cent in discussion groups, to 70 per cent in practice groups and finally to about 90 per cent for individuals who teach others. This comparison displays the substantial improvement in information retention associated with active learning methods (Chi et al. 1989) which is about three- to ten-fold better than other methods. As a form of problem-based learning, research has proved that more active methods create situational interest among students, which then increases the amount of time engaged with the subject, while also motivating exploratory behaviour and better knowledge acquisition (Rotgans and Schmidt 2011). Universities and research institutes are therefore not being optimally efficient in their teaching methods if they continue with passive methods (Wingfield and Gregory 2005). Current higher education should therefore prioritise active learning as standard procedure across the curriculum. Although there is a trend towards problem-based learning, the pace of progress is quite slow.

Focus group studies point to increased efficiency in the research environment when research is related to teaching. When staff are actively taking part in recent research, this can shape and update their research interests. From the student perspective, the inclusion of recent research into the curriculum is known to affect student perceptions, conveying the impression that staff are enthusiastic about the course (Jenkins 1998). This allows them to better appreciate how research is incorporated into the lives of lecturers. Moreover, involving students in research fosters an inclusive culture, where students become part of a larger team. Personally, looking back to my undergraduate years, I quite vividly remember becoming part of a research group in sciences. I felt a strong need to imitate my advisor and took pride in belonging to a group of

researchers. From that point onwards, my goals were much clearer: excel at research related courses and quickly learn as much as possible.

The studies on the relationship between research and teaching usually aim to find a premise for the following: they are either positively or negatively correlated, or not related. Instead of that simplistic model, Marsh (1979) postulated a connected model of their interaction and how the abilities to be effective in research and teaching might be positively correlated as a function of ability and time (Figure 2.1.2). In the UK, there is a strong correlation between the external national rating of departments for teaching, research and teaching quality assurance (Cooke 1998). The connection is not evident in other countries, such as the USA and Australia (Ramsden 2003), indicating that a high research output does not necessarily relate to effective undergraduate teaching. Moreover, drawing on a meta-analysis of 58 studies, some researchers even state that this relation might be a myth or carry a lower correlation than assumed (Hattie and Marsh 1996). The simple assumption that more research automatically equals better learning is under suspicion (Ramsden 2003), emphasising the need for deliberate and carefully built links between them.



**Figure 2.1.2** Differential variables method suggested by Marsh for research and teaching relationship. Adapted from Marsh (1979)

Since research and teaching have many confounding factors – such as different students, staff, departments, universities and nations in the broader context – direct comparisons of their quantitative analyses are a hard task indeed. What I intend to do with R=T is not entirely new but it is a novel approach looking further into this question. Instead of continuing the decades-old debate, the aim is to concentrate on how they overlap across higher education and focus on a unifying force between them.

### 3. The adhesive force: learning

Humboldt was an influential Prussian philosopher in the eighteenth–nineteenth centuries who suggested an educational concept that holistically combines research and education (Verburgh et al. 2007). Often accepted as one of the best education ministers in modern history, he had a vision of a holistic education, *Humboldtian Bildungsideal*. It would not only provide vocational training for the needs of the labour market but also cultural knowledge and the freedom for individuals to shape their character according to the best knowledge of themselves: *Ausbildungsfreiheit*. The academic freedom and economic autonomy in educational institutions were innovational for the Enlightenment and seen as a template for many other national education systems. Humboldt’s inspirations live on to this age and, in the same way, research and teaching could be examined as similar practices with a single core goal: to promote learning and access to knowledge across all stages of university life.

Research and teaching share one common factor: the act of learning (Brew and Boud 1995). In fact, learning can be thought of as the glue between research and teaching (hence  $R=L=T$ ). The elements of any learning process conventionally involve at least two individuals: a teacher and a learner. Innately, there is an information gap often resulting in a hierarchy. This creates a problem, as the lecturer already knows before a lecture that there isn’t much to learn. This passive learning model leads to very low knowledge-retention and constitutes an inefficiency. The solution might be symmetrical learning in a lecture to engage both the lecturer and students, where everyone is active and interacting continuously. In fact, a recent study conducted on undergraduate STEM (science, technology, engineering and mathematics) students has shown that transforming passive listeners into active participants through hand-held ‘clickers’, short group discussions or randomly calling on individuals/groups to speak in class not only boosted grades by about one half

standard deviation/half letter grade (i.e. B to B+, equivalent to about 6 per cent) but also reduced failure rates in the class (Freeman et al. 2014).

Imagine a learning environment where everyone is equal and there are no limits on the roles for teacher and students in the classroom. This could be achieved by creating an environment where no one knows the answers or the problems, revolutionising established hierarchies. One way to accomplish this is through course design. Research and teaching could be achieved in one unified package throughout a course. In fact, five distinct means to this end were identified through reports of academic staff regarding their experience of the research–teaching relationship. Two of them are particularly relevant to enhancing the quality of student learning: (1) teaching by modelling critical inquiry; (2) research and teaching sharing a learning community (Light and Calkins 2014). Learning could be a binding force between R=T, expanding the title further to R=L=T as all three are interconnected.

Accordingly, Professor Levesley, hosting one of the R=T Masterclasses, shared the following quote while inspecting the role of lecturer in the lecture: ‘I am god and the stage is mine’ (Levesley 2016). Apparently, there are alternative views of knowing adopted by different lecturers. In the above-quoted form of absolute knowing, knowledge is viewed as certain. It has to be acquired from an authority (Baxter Magolda 2004), it could be described as the lecturer pouring information into the students’ brains. On the other hand, in transitional knowing or independent knowing most knowledge is uncertain; everyone has to think for themselves. In a classroom utilising independent knowing, a lecturer is just someone with more experience in the journey of learning, guiding the student on the path of learning if and whenever necessary.

In fact, a study of undergraduates participating in higher research programmes to bring them together with postgraduates/researchers has shown that this is likely to develop students as better learners. Epistemological reflection was measured and recorded by students, which was then compared to control groups, indicating that they became more self-confident learners and independent problem-solvers (Baxter Magolda 2004). This suggests that mentor-assisted approaches are promising. Even subject mastery classes like biology, chemistry and mathematics could be designed in ways that develop students as learners. This can be done through directing students into thinking like scientists, asking the necessary questions and designing experiments to hypothesise from eventual results.

Research-oriented, student-assisted content creation is an important tool that seldom finds support. In an ideal research, learning and



teaching (R=L=T) scenario, student-centred investigation processes could serve two purposes: (1) involve students in staff research to accelerate the learning process; (2) supply research projects with fresh minds that could easily provide novelty and vitality. There is an element of reciprocity: while students are learning further, lecturers might have unexpected sparks of insight through observation. Hence everyone can benefit from a R=L=T scenario. The result is an enthusiastic environment where both parties progress and learn. This can enhance intellectual development and have long-lasting effects on the inquiring society (Clark 1997). Whether students continue in academia or move into industry, the effects would be long-lasting for society. There would be challenges in integrating research into teaching as it means changing curricula at the faculty, university and national level. Moreover, how students and lecturers react to such changes is another question. Change is not always easy, but if the positive outcomes of an integrated R=L=T environment can be proven to larger audiences, there is the potential for a wider acceptance.

#### 4. Challenging conventions: research vs. teaching

The following question often startles me:

Why is there a disparity between the rules separating research and teaching when they are exercised closely under the same roof?

Perhaps every student in education has criticised exams as unfair at one point or another. Currently, competition is fierce and grades are the major determinants of success. This is not only stressful but also different from how research works. Researchers, scientists and engineers often work collaboratively in teams with a common goal. Everyone in the team wins when a journal article, research grant or project is successfully completed. Think of NASA's Mars Rover project, the International Space Station or the discovery of the Higgs Boson at CERN (Aad et al. 2012). They comprise cooperative international groups of individuals with a common purpose. When someone in the team improves, so does the whole team. Most of today's high-impact research is increasingly national/international in scope, and has many researchers working in collaboration with separate groups.

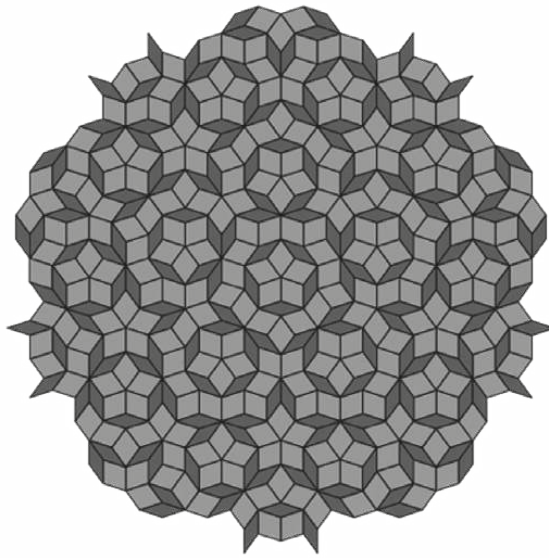
A typical lecture hall includes a teacher who is responsible for the flow of information towards students, while students are assigned to

the activities of listen and learn. In research, you are your own teacher, responsible for figuring out what to learn and where to find it. Research is an open-book exam indeed, where you can use endless resources to solve open-ended problems related to materials, society, nature and the universe at large. In research and life in general, only yourself is the ever present advisor.

Typical assessments often come in multiple-choice format: many similar choices and only one correct answer for each question. In research too there are multiple answers to most of the questions, many of which are correct in their own way. One becomes resistant to the fear of failure. If your publication is rejected then you are, hopefully, given corrections and recommendations. Criticisms and harsh rejections might be embarrassing in the short term, for example at a conference in public. However, they also motivate a scientist to become a better researcher. In fact, failure is an important part of the learning process. Every research project is a series of trial-and-error experiments with the hope that some will prove lucky. Research is often full of false starts and wasted time. Yet the road to success depends on learning lessons from these experiences and moving on to the next with greater knowledge.

For many postgraduates, research has been and still is, different from teaching/learning. In research, there are no right answers that lead to clear rewards and you do not need to be right in the first trial. There are many opportunities to experiment and gather skills and passions in surprisingly novel ways. If one happens to discover something groundbreaking, the status quo might be hardly disturbed. Dan Shechtman observed a five-fold rotational symmetry (Figure 2.1.3) in aluminium–manganese alloys in 1982 (Shechtman et al. 1984). The discovery challenged the concepts of translational symmetry, on which modern crystallography was based. Shechtman was looked upon by other scientists as proposing something against the laws of nature and was eventually forced to resign his lecturer post at a university. However, he persisted with his discovery and published further findings, eventually receiving the Nobel Prize in Chemistry in 2011.

These examples provide comparisons and the urge to question the current rigid education structure to prepare students in higher education for their future lives. Should we continue using double standards for research and teaching? Among all people, researchers especially should not be afraid to leave their comfort zones, have acceptable disregard for the impossible and turn conventional ideas upside down.



**Figure 2.1.3** A quasi-crystal pattern with five-fold symmetry forced the International Union of Crystallography to officially change the definition of ‘crystals’. (Image used under Creative Commons CC0)

## 5. Careful: more tuitions ahead

The first R=T Masterclass was hosted by Professor Lora Fleming (2016) from the University of Exeter. With over 30 years of academic expertise spanning both UK and US educational establishments, Fleming compared the differences between the two countries. The outlook for research funds is perhaps better in the USA – but what about obtaining them? The USA might be a very competitive place indeed. It is common to master grant applications during postgraduate studies. In fact, the start of Fleming’s personal academic career was unexpectedly quite straightforward: she was told to apply for funding, obtain a grant, start teaching and subsequently she would be employed as a researcher. That was it. She found herself teaching and doing research soon after.

Professor Fleming sees UK higher education as being in a transition stage, as there has been a substantial increase in tuition fees from almost zero to about £9000 a year within the space of less than ten years. Moreover, the price cap will be removed starting from 2016/17, so expect tuition fee increases in line with inflation (or more during

Brexit) in a few years' time. This is something that has been accepted in American society for some decades already. Correspondingly, student expectations of education in the UK have also increased. Perhaps that is why there are more questions being asked and more answers sought today. Current fee-related changes are likely to push research, teaching and universities towards a more student-oriented higher education to address what students really want to adapt to their changing needs. More satisfaction surveys and reports within UK academia are likely. Academia is slow to adapt to the changing needs of work, industry and society in general. Finally, Professor Fleming's advice to university students was to develop communication and transferable skills through practising clear, tight, pitch-like presentations and participating in volunteer projects.

The opportunities we look for do not necessarily need to be in our discipline, as there is now more unity in research through interdisciplinary work. Professor Robert Eaglestone (2016) of the Department of English at Royal Holloway, University of London hosted an R=T Masterclass and expanded his take on transcending disciplinary boundaries. As a researcher who enjoys and values interdisciplinary work, he believes that scientists may perhaps strive to talk across different disciplines even more. What is a discipline and why do we allow our brains to be bound by rigid structures anyway? It does not necessarily mean that disciplines should form limiting barriers, since they are likely to have evolved from solutions found yesterday and perhaps are still useful today. But we cannot expect them to be practical tomorrow. In the information age, particularly, the rate of knowledge growth is exponential, causing revisions to knowledge. Once we leave the comfort zone of our discipline and venture into the unknown, the potential benefits for research and teaching are enormous. That is the reason why collaboration across disciplines may enlighten our path further in the search for the truth, just as geology utilises physics to inspect geology problems. After all, the truth would accept all forms of currencies.

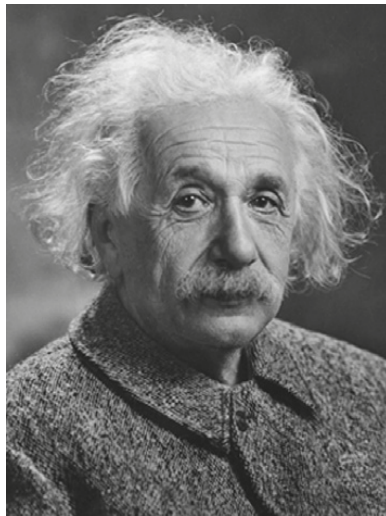
## 6. Curiosity vs. pragmatism

The human mind has always been curious. It seeks explanations. Today, ever more serious questions are being asked to reach the essence of truth. Research and teaching promote an inquiring society in higher education by letting students take control and ask questions freely. As part of the current reigning culture, however, expediency and pragmatism seem to

dominate and rule over any visionary intuition. Courses, assignments and research projects are completed just for their sake. In fact, this is the worst thing that can be done to research, but it is forced by current assessment methods. Open-ended assessments offer a solution. Their suitability will depend on the subject and university and are not particularly common in science and engineering. In the interests of assessment justice, instead of a single person grading the performance and knowledge of each student, assessment should be through peer evaluation (Levesley 2016). Many students comment on the performance, comprehension and knowledge of one another throughout the course, with the final grade based on the average of all these multiple grades.

How exactly did we end up in a society that values pragmatism more than curiosity and reflection (Figure 2.1.4)? This is not easy to answer. It is no surprise that university degrees are commoditised too. Many lectures are almost automatised – not only for teachers but also for students. There is often a silent status quo with everyone forced to focus on the next goal.

One might argue that there is quality control to prevent any of these problems. Commonly used audits, surveys and grades evaluating lecturers/students would provide solutions. Yet they fail to provide meaningful answers. The key solutions in academia for lecturers/researchers are usually reduced to numbers and dichotomies: publish or perish; teach



**Figure 2.1.4** ‘It is a miracle that curiosity survives formal education.’  
Albert Einstein (Image used under Creative Commons CC0)

or leave; secure funding or leave. For students it changes to: memorise/produce results or fail. These are deliberately oversimplified to emphasise some of the crucial flaws that are, well, quite normal these days.

It is hard to notice whether you have an interest in research in a curriculum that reserves independent projects until the later stages. A solution could be in diversity: higher education should in fact offer an extensive menu, to allow students to ‘taste’ every flavour. After all, it is hard to know what to like without any prior knowledge.  $R=L=T$  provides a method for students to engage with research to see their potential fields of interest. This not only provides increased efficiency in finding potentially suitable researchers. It also gives students ownership of their choices while they are engaged in higher education, and offers them a glimpse into creative, wide-open approaches to research.

There is an appreciation and value attached to research in our world’s society. The positive correlation between research and economic productivity is the reason for this (Seltzer and Bentley 1999). The value attributed to research is important, so are the skills for doing research and a desire for further education. The mutual benefits between research and its applications are already accepted as vital. It becomes even more important as the benefits have been increasing exponentially over the last decades. In fact, research and related research skills are perceived as the key to knowledge economies.

Why is there a need to change parts of a higher education system that is already working? Because the successful integration of research into teaching can supply an enhanced intellectual and spiritual vitality to the work done within universities. Laboratory sessions do not have to be time-limited sessions where strict procedures are followed. Instead, they can be an opportunity for student-driven research questions, with answers discussed in a spirit of refreshed curiosity. Even routines can be transformed into valuable parts of advisor-driven research. Thus, students should be infused throughout their time in higher education with a sense of the potential that their work has in a larger context; something empowering for both students and universities. This could be realised through re-engineering the curriculum in light of  $R=L=T$  in such a way that develops and motivates students as ever-inquiring learners.

## 7. Conclusion: change in the making

The accumulation of frustrations with conventions might be the driving force for seeking change. During the  $R=T$  Masterclasses, observing

genuine criticism from professors in sincere group discussions has been enlightening; seeing that most scientists are aware of the problems and are looking for answers was partially relieving. The joy of working on common goals as part of a large family is hard to explain in words. It has been really motivating, so I had to write about it. What I understand from  $R=T$  has been these three mantras: democratise education, challenge conventions and empower everyone involved. Something is genuinely different this time, perhaps because everyone really wants real change.

The intellectual core aims of universities are to help students devise sophisticated conceptions of truth and knowledge. The aim of this chapter was to investigate how to unleash potential by combining the experience and knowledge of researchers with the boundless curiosity of youth. The link between learning and research is open for exploitation through the better design of courses. There is much to learn about learning by inspecting successful researchers' ways of operating. A convergent approach to research and teaching is proposed as they share one thing in common: the learning itself ( $R=L=T$ ).

Teaching students how to become better, independent learners should be a primary goal for higher education. Accordingly, environments should be designed to enrich the learning process. The aim is to harness the benefits of interaction between Research and Teaching by focusing on learning across the curriculum with the assistance of deliberate course design. Research in higher education indicates that such designs are possible. Active and participatory learning should be extended throughout all possible departments and curricula, due to proven positive outcomes in both grade increments and reduced failure rates (Freeman et al. 2014). In order to improve the cognitive outcomes in class-specific materials, passive learning methods should be replaced with active, experiential learning (Michel et al. 2009). Second, harnessing the benefits of an integrated Research and Teaching approach can be possible through problem-based course designs, where students and teachers stand on an equal footing for a particular course. Perhaps they could choose research questions after group discussions. Group work would be a key standard across the curriculum, with randomly selected individuals to limit biases. This is important due to the necessity of teamwork towards accomplishing learning goals.

Finally, exams or assessment systems might need to be altered. Open-ended assessments should predominate. Lecturers are already using open-ended, peer-review based assessments (Boud et al. 2001). Eventually, learning could become more collaborative, problem-centred and peer-directed. From either a research or teaching perspective,

learning is the key ingredient (R=L=T) that has the potential to transform higher education.

As scientists, we sometimes tend to forget the importance, beauty and extent of the work we do. As a UCL ChangeMaker, my aim is to involve both parties and stimulate enthusiasm in everyone. Let us not forget that reform is a process; it is not a single event. And I think that it might have already started in the realm of UCL. Specifically, I know of at least one group of individuals for whom the combination of UCL Arena, Connected Curriculum and ChangeMakers has succeeded in making a meaningful difference by inspiring them to take action.

Initiatives focusing on bringing together research, learning and teaching (R=L=T) might potentially help the higher education system to evolve for the better. Let us not forget that the questions of today are derived from the answers of yesterday and there is a growing accumulation of knowledge snowballing with original and increasingly complex questions. As institutions mostly focused on research and teaching, universities should keep an open mind and be willing and able to ask the bravest, most daring questions that need to be asked for the prosperity of science. We should seek it for our society and future generations. It is our responsibility in higher education not only to question but also to conserve and develop the tradition of our brilliant predecessors who contributed in bringing humankind to the once unimaginable point where we find ourselves at present.

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