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Chapter Author(s): Eirini Gallou and Peter Abrahams

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Creating space for active learning

(Opportunities from) using technology in research-based education

Eirini Gallou

UCL Institute for Sustainable Heritage, and The UCL Bartlett Faculty of the Built Environment

with Professor Peter Abrahams

Warwick Medical School, University of Warwick

This chapter deals with the challenges of using technology to enhance the education process and the student learning experience – not just to replace the teacher by technological or digital gimmicks. The secret of this process is to base it on the student's active participation in the development of their own learning tools. Eirini rightly stresses the possible trap of replacing the old human teacher with the new computer machine but notes that the actual thinking process needs to be different and actively involve the student in the development of this new digital material. Examples are given of interactivity in science, medicine and architecture where the new learning process might engage sounds, vision and 3D processing, and even 'hot-off-the-press' 3D printing. Other disciplines have used video of speeches, sounds from music, or scenes of theatre productions, all of which can be made into serious gaming programs with interactive responses which cause the student to get actively involved in the end product of their discipline within a real-world environment. As she mentions, hands-on learning in an experimental manner, even using the student as a peer teacher, is the aim of using all the tools of technology to make a stimulating exciting interaction – which often will take many times longer than just preparing a simple lecture. However, the rewards for both student and teacher are greater, especially if applied through an experimental learning cycle as illustrated by Eirini.

As a professor well past my 'sell-by date' and a 'digital immigrant', it is intellectually tough keeping up with all the new advances in technology, so using one's young 'digital native' students to help develop these new programs for their own education makes common sense. The teacher becomes student but the student becomes self-teacher or peer teacher, adding to their layers of knowledge. It is a win–win situation for all within higher education.

Professor Peter Abrahams

1. Introduction

The R=T initiative has offered me and many other students the opportunity to get involved in discussions around research-based education at UCL through a series of masterclasses, connecting researchers and teachers with the student experience. The theme of the R=T Tech event – the use of multimedia and online platforms – forms the basis of this chapter, which looks at exploring innovative and effective ways to link technology, education and research.

The thoughts that follow are inspired by the presentation by Professor Peter Abrahams of Warwick University, who shared his thoughts on research-based education in the digital age through examples of his own teaching in anatomy and medicine. They also seek to express some of the ideas from the subsequent panel discussion with UCL staff and students, and of course incorporate personal reflections based on my own experience in engineering and museum studies.

My current PhD research, in the interdisciplinary field of sustainable heritage, places me at the intersection of humanities and STEM studies, challenging my practice as both a student and future teaching assistant, caught between two different value systems. It is through the lens of this interdisciplinary background that I explore the question posed at the start regarding the potential of technology to enhance active learning in higher education.

2. The technology challenge: creating new forms of experience and enabling active learning

Both the power and weakness of technology lie in the way it can be used. As with any tool created by humans to improve a way a process can be realised (usually by replacing labour with mechanics), it can certainly augment the time a lecturer can focus on the material itself, rather than making the material more easily accessible or perceivable for the students.

Twenty-first-century blended learning models advocate a mixed use of traditional and new teaching and learning modes, combining face-to-face with online learning. However, the power of the new modes of learning is attenuated due to the limited opportunities that the existing built learning environment infrastructure can offer (Mitchell 2003).

It has been argued that misuse of technology in a classroom can suppress or hinder student learning (Grasha and Yangarber-Hicks 2000; Koehler et al. 2007; Koehler and Mishra 2009). Therefore, instructors need to think about the relevance or appropriateness of using a particular technology in their classroom so that the focus remains on manipulating ideas rather than technological tools (Brown et al. 2004; Kuda-Malwathumullage 2015).

The dilemma remains in setting the limits of how to utilise technology in higher education. Its role can undermine traditional lecture techniques, the human power of which cannot be easily contested.

On the one hand, some researchers argue that technology is merely a tool for accomplishing teaching and learning goals for instructors and students (Grasha and Yangarber-Hick 2000; Miller et al. 2000). Others advocate incorporating technology into teachers' knowledge base, generating a special knowledge (Koehler et al. 2007; Koehler and Mishra 2009). In any case, the debate is not around replacing tutors but about supporting their role – in the way a device may support how we accomplish a task.

Technology-enabled active learning (TEAL) is an innovative approach applied at the Massachusetts Institute of Technology (MIT), providing a successful alternative to the potential of technology to enhance active learning in universities.[1]

TEAL describes a research project in MIT Physics freshmen classes, aiming at delivering greater learning gains than the traditional lecture format through the use of interactive engagement (which first appeared in the 1990s). A variety of assessment techniques used by TEAL have proven the effectiveness of interactive engagement across a range of student backgrounds. The teaching methods used in the TEAL classroom managed to double the average normalised learning gains for low-, intermediate- and high-scoring students when compared to traditional instruction. The method followed in such a class typically incorporates lecture, recitation and hands-on experiments in one presentation.

Instructors deliver twenty-minute lectures allowing filtration with discussion questions, visualisations and pencil-and-paper exercises. Students' learning is reinforced by using animated simulations designed to help them visualise concepts and carry out experiments in groups during class.

This successful, pioneering example in physics has affected similar teaching curricula. Looking at the broader picture, since MIT first launched the concept in 2003, some emerging TEAL models have proliferated outside of the US (for example, CDIO (conceive, design, implement, operate) in the Faculty of Engineering, University of Melbourne; the doctoral engineering design studio at the University of new South Wales), which are still in the early stages of evaluation.[2] Although the original TEAL model was launched to rejuvenate the teaching of Physics 1 at MIT, subsequent versions of it have proliferated in disciplines such as geology, chemistry, engineering, education and architecture. It is in engineering that the most advances have been made, and this is largely because of the need for engineers to have a wide range of competencies that cannot be assessed solely in the examination room. This observation highlights the fact that opportunities are not equally distributed in different disciplines. Some environments can offer a more fertile ground for technology-enhanced learning to flourish.

Having discussed these basic challenges and the TEAL model suggestions, its role in enhancing active learning can now be delineated by considering a number of case studies from different disciplines.

3. Enhancing active learning through technology: some case studies

I include examples in this section from teaching practice to clarify ways of employing technology for enhancing active learning. There are two major sources of inspiration. First, the work of Professor Abrahams: the ideas presented in the Masterclass can be thought of as inspiring and exemplary for the discipline of medicine. Second, my personal experiences in creative and cultural studies both in and outside UCL (specifically, museum studies, UCL's Institute of Making (IOM), as well as my background in architectural engineering). These examples are meant to provide a canvas for comparing initiatives with the lessons learned from TEAL, and to juxtapose the differences between disciplines and priorities in teaching and learning served by technology.

3.1 Examples from Professor Abrahams's work

These three examples from Professor Abrahams's practice illustrate ways technology may enhance active learning in the classroom and out of it within a research-based curriculum.

First, through his postgraduate teaching work, Professor Abrahams uses 3D printing to create models of human organs.

The building process helps in deconstructing the nature of the organs, increasing the possibilities for students to learn anatomical features prior to building the model. In addition, students can implement their existing knowledge of anatomy through actively engaging with the process of creation, exploration, inquiry and object-based learning. Finally, it allows more abstract and difficult medical/scientific concepts to be explained through the use of a physical object, so can be particularly useful for teaching postgraduate medical students. This sequence resembles the circle of experiential learning presented here earlier in theory, in a well-linked prototype.

> **Technology is used as an incubator for interconnections between different stages of the learning process.**

Second, Abrahams combines some of the skills and research methods applied in different disciplines. The interdisciplinary nature of the project and the insertion of research aspects (for example, research knowledge on improving current digital production of organs) familiarises students with new skills, providing a real-life and active experience. Thus, it increases the opportunities for different types of students to engage with the inquiry-based process and thus increase their learning by participating in this experiential learning activity. This case also suggests ways to incorporate students as partners in education: getting postgraduate students to create educational material is a rather illuminating example of how students can make the best research workers. The material can be then used for teaching purposes and reflect the expertise coming from the faculty itself, enabling a higher appreciation of the research realised within the institution and transcending disciplines. Students benefit from taking the researcher's role, with all it entails. Interdisciplinary research subjects and collaborations are fostered.

> **Technology is used as an incubator for interconnections between different disciplines and levels of the curriculum.**

Third, Abrahams' work illustrates another way of applying technology in facilitating teaching, and promoting active learning the classroom.

X-rays, CT scans and angiograms are three ways of visualising human anatomy. Real anatomic sections, matched together, can help to provide a holistic understanding of the human body for medical students. The students can test themselves, participate by entering games combining the three technologies, and then compare how different parts of the human body look on an X-ray or a CT scan – a rare opportunity to learn through an innovative way.

To take this further, a teacher could provide a structured way of assessing this knowledge beyond the classroom. For example, by making an iTunes book, a teacher can enable access from anywhere, increasing the independence of students and possibly expanding the audience. Another part of Professor Abrahams' work points out how using multimedia experiences could assist in explaining difficult- to-grasp medical concepts to students. For example, by creating songs and employing lyrics with medical terminology, he experiments with stimulating students' minds and leaving them with unforgettable memories. He is creating an invisible process through which experience is turned into knowledge over a larger period of time through assimilation. This practice enables active experimentation and students 'learning by doing': students create songs themselves and then practise them immediately, having a concrete learning experience (i.e. how two stages of experiential learning are connected, following D. Kolb's model).

> **Technological means are used to enhance visualisation of hard-to-grasp concepts, making knowledge accessible in many ways. Multimedia's ability to create stronger learning experiences is used beneficially. Variation fosters creativity, increasing students' progress.**

These examples showcase multimedia as a means of interactive engagement in the class. But is this applicable to all subjects? It would be interesting to consider whether other disciplines could provide similar case studies focusing on activities that could be embedded in the traditional classroom. As an engineering student, I am aware how creative practices can bring something intriguing into class and stimulate participation from less active students. Technology can certainly provide variety in the means to achieve that.

The role of the tutor, however, remains crucial in providing cohesion between the information imparted and the experiences the students engage with. As Professor Abrahams explained in the R=T Tech event:

> You have to think: how can I make this memorable? By bringing in everything that is around the subject, not [trying] to teach the didactic bits – they can go and get them [from] the web. Make it a story, make it an exciting story. Because as a teacher . . . your passion, your enthusiasm actually does more than any fact you can get to the student. Ever.

The element that needs to be emphasised is the passion of the tutor when encouraging his students to experiment with technological means and be creative in classroom. It is the first spark to support initiatives that the curriculum may encourage further, like co-creating material for the classroom, combining evaluation and teaching.

Where the teacher's role may also prove powerful – in the process of employing technology-based learning activities – is in linking disciplines, creating new opportunities that would direct research efforts towards harnessing the skills of specialised (research) students to enhance the learning of students in a variety of other disciplines.

And the role of students? Students can encourage or ask for such projects and gain a collaborative role in managing such partnerships. Active learning gains more power this way, projected out of the classroom and into the arena of research.

Of course, an assumption underpinning these kind of initiative is a well-linked institutional network of facilities that supports student–staff collaboration. Two examples from UCL Museum Studies initiatives are illustrative and offer a perspective from another discipline.

3.2 Examples from UCL Museum Studies

The UCL Museums & Collections (M&C) department offers many opportunities for applying object-based learning, especially in faculties linked with the museums; Museum Studies and the Institute of Education principally organise courses based on M&C's cooperation. The role of information and communications technology (ICT) in museums allows, for example, interactive displays to present tailored information to audiences and permit virtual access to artefacts held in museum stores. MA Museum Studies students familiarise themselves with both real-life practice and the latest research by using conservation technology as a means to understand the properties of various objects within the UCL M&C.

For example, the recent student exhibition, 'We Need to Talk: Connecting Through Technology' (created by MA Museum Studies students at the Institute of Archaeology and displayed at the A.G. Leventis Gallery from May 2015 until April 2016), provided multiple opportunities by having technology as a theme. It gave students an active role in exploring and presenting technologies that people have used to communicate with each other in different periods of time, reflecting on their discipline and practice using this diachronic approach. The project's Twitter page[3] shows how state-of-the-art technological applications in documenting archaeology were presented and proves how the subject gave a lot of people the opportunity for creative teamwork (i.e. images and material produced, such as wearable tech). In a research-intensive university such as UCL, collections have to keep pace with cutting-edge innovations and new discoveries. Objects on their own help to develop the important skill of drawing conclusions based on an examination of evidence, paying attention to the limitations and reliability of that evidence. They are also ideal for generating group and class discussion.

> **Technology can be used as a theme for connecting disciplines. It provides opportunities for interdisciplinary research for all levels (undergraduates and postgraduates), expanding the skills students gain by being an active part of those projects. It can provide knowledge on the latest scientific applications, increasing interest and inspiration for the further research accomplishments of young student–researchers.**

The second example from UCL Museum Studies is a 2016 exhibition that was co-organised by the IOM, UCL research personnel and researchers and students of Museum Studies and Chemistry on the use of materials. The exhibition illustrated the double use of materials: for industry and for the scientific research-enabled cooperation of different disciplines (Chemistry department, Museum Studies, History of Technology). At the same time, it proved to be engaging for wider audiences. The educational aspect of this exhibition was supported by providing real objects for viewing – from the IOM collection and some of the faculties' own machinery/historic tools, items normally inaccessible to the public. Scientific explanations of the processes of material treatments were combined with lay-language descriptions, providing an opportunity for the participants (research students) to practise an important aspect of a researcher's role: public engagement and knowledge-sharing.

> **Technology can be the initiator of partnerships and a useful tool for realizing public engagement by researchers and students. Employing research results and presenting them efficiently to wider audiences, they exchange roles with their teachers creating knowledge instead of consuming it.**

A third interesting project featured recently in UCL's object-based learning webpage is from the Department of English Language and Literature. Dr Chris Laoutaris used the UCL Art Museum to help his students understand Shakespeare plays outside the closed context of their own field, accessing the museum's online anatomy pack.[4] His experience underlines the multiplicity of existing opportunities and material within UCL that can be combined in new, imaginative ways, stimulating more than one of the five senses of students. Audio museum guide material can be combined with anatomical drawings and text reading in the classroom. The impact of such initiatives' could be extended through experimentation by the teaching assistants participating in them, and by encouraging the use of the latest technological improvements to equipment used in art and heritage conservation.

> **Technology can provide multi-sensorial experiences by increasing the means by which information is acquired during teaching and thus increase the chance of creating memorable classes.**

Realising these initiatives as exhibitions underlines the role of partnerships in turning ideas into reality. The exhibitions are a means of engaging the wider university community with the interdisciplinary research-based projects being undertaken – and inspiring students.

3.3 A final example

Finally, as a comparative example, I would like to quote my personal experience as an architectural engineering student.

Disciplines like engineering have become increasingly digitised over the last decades, with newly designed research programmes based on technological advances promoting a digitised way of teaching. This teaching mode may differ in many ways from that adopted by more traditional universities – those that foster the historic valuation of the built environment over practical skills. In this sense, architecture provides a good example of embedding technology in teaching and enhancing active learning. Advances in 3D printing and laser-cutting technologies have informed the way both professionals and academics perform their duties, and given rise to the more interactive teaching found in design studios. Students get hands-on experiences in laser-cutting labs, increasing their inquiry-based knowledge assimilation. At the same time, opportunities are provided to share skills, to become technical instructors and develop both academically and professionally.

However, students and staff all have to be vigilant. In an era of constant adaptation, it is not only the means of teaching that change. The disciplines themselves are continuously being redefined through that process.

4. Conclusion: what about all together?

The themes/conclusions drawn from the case studies show multiple ways and benefits from applying technology to assist active learning in different disciplines. They also showcase technology's power in enhancing aspects of research-based learning in the curriculum, such as interdisciplinary and cross-disciplinary learning.

Students and staff will always have distinct motivations and rationales around working together. The differing perceptions of one another's roles and tasks surely affects their motivation and their active engagement in the process of teaching and learning. Technology-based learning activities could act as a unifying platform for dealing with differences between professors and students, enhancing not only learning but also communication and collaboration.

Building on the R=T initiative and the UCL Connected Curriculum, voices coming from both sides should be heard. We can only benefit from the use of technology if it is used as an interactive 'in-between' zone, as a common teaching language between different disciplines, and also as a means familiar to both teachers and students – a platform that will enable role-exchanges within universities. Looking towards long-term changes in teaching and learning, the successful application of technology within the curriculum requires us to embrace change while also respecting tradition. This means we need dialogue if we are to reach the desired balance for both students and teachers.

Notes

1. See http://web.mit.edu/edtech/casestudies/teal.html
2. See: http://www.oecd.org/education/innovation-education/centreforeffectivelearningenvironmentscele/45565315.pdf
3. https://twitter.com/IoAExhibition15
4. http://www.ucl.ac.uk/teaching-learning/case-studies-news/object-based-learning/anatomical-drawings-shakespeare

References

Brown, A. H., Benson, B. and Uhde, A. P. 2004. You're doing what with technology? An exposé on 'Jane Doe' College Professor. *College Teaching* 52, 100–4.

Grasha, A. F. and Yangarber-Hicks, N. 2000. Integrating teaching styles and learning styles with instructional technology. *College Teaching* 48(1), 2–10.

Koehler, M. J. and Mishra, P. 2009. What is technological pedagogical content knowledge? *Contemporary Issues in Technology and Teacher Education* 9, 60–70.

Koehler, M. J., Mishra, P. and Yahya, K.. 2007. Tracing the development of teacher knowledge in a design seminar: Integrating content, pedagogy and technology. *Computers and Education* 49, 740–62.

Kuda-Malwathumullage, C. P. 2015. Impact of technology-infused interactive learning environments on college professors' instructional decisions and practices. MS (Master of Science) thesis, University of Iowa. http://ir.uiowa.edu/etd/1867 [Accessed 16 June 2016].

Miller, J. W., Martineau, L. P. and Clark. R.C. 2000. Technology infusion and higher education: Changing teaching and learning. *Innovative Higher Education* 24, 227–41.

Mitchell, W. 2003. 21st Century Learning Environments. Presentation at a workshop on new learning environments at Queensland University of Technology in conjunction with K. Fisher.