

Technology enhanced learning as a tool for pedagogical innovation¹

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1. Introduction

The paper argues that the nature of learning and teaching in a higher education system is an indicator of how adaptable a country is likely to be in response to global change. In the UK we have a system that does change, and has recently updated itself more successfully than many in the western world. It is just over ten years since the National Committee of Inquiry into HE (the Dearing Report) proposed significant changes to the way teaching and learning is carried out in the sector. The intervening years have seen developments that are indicative of an energetic sector interested in self-improvement in the way it supports learning. Is this degree of adaptability sufficient?

There are powerful forces converging on HE. Worldwide demand is increasing beyond the capability to supply. Business demands of HE remain unsatisfied. And knowledge and communication technologies have made education a global enterprise. All these trends affect the nature of learning and teaching. What would it mean to ensure that we are able to adapt to such forces while retaining fundamental academic values that should not change?

The paper proposes that lecturers need to understand what it takes to learn their subject in the context of the environment their learners inhabit. Only they can be responsible for the nature of the pedagogic innovation that is needed if the sector is to be adaptive to this environment. This is the unchanging core at the heart of all the pressures on the sector. The argument here is that technology, although it is part of the problem, can also contribute to the solutions.

2. Recent developments in learning and teaching in HE in the UK

The learning and teaching recommendations from the National Committee of Inquiry were ambitious, aiming to enable a rapidly expanding and diversifying sector to prepare itself for the adaptation it would need. Five main areas were identified as needing immediate action: accreditation of teaching for staff; research and development funding in learning and teaching; funding for innovation; a requirement that institutions develop learning and teaching strategies; and better support for academic staff in the use of ICT in their teaching. In the ten years since, by Watson's analysis of these recommendations (Watson, 2007), the last two in particular made a difference. On both counts, there has been a great deal of activity, making use of a variety of strategic and funding mechanisms. Table 1 summarises the main developments in terms of these five principal areas where action was recommended.

Comment [JPE1]: Suggest commas rather than semi-colons

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1997	Accreditation	R&D	Innovation	Inst'l L&T	ICT support
1998				TQEF	
1999	ILTHE		LTSN	NTFS	LTSN
2000		TLRP (14)			
2001					
2002					UKeU
2003	HEA			HEA	
2004					
2005		NSS	CETLs	CETLs	TEL strategies
2006		TLRP/TEL			
2007					

Key: TQEF: Teaching Quality Enhancement Fund; ILTHE: Institute for Learning and Teaching in HE; HEA: Higher Education Academy; TLRP: Teaching and Learning Research Programme; NSS: National Student Survey; TLRP/TEL: TLRP research call on Technology Enhanced Learning; LTSN: Learning and Teaching Support Network; CETL: Centre for Excellence in Teaching and Learning; NTFS: National Teaching Fellowship Scheme; UKeU: UK e-Universities initiative; TEL strategies: strategies for e-learning from DfES, HEFCE, JISC.

Table 1: Principal developments in the improvement of learning and teaching, in terms of the Dearing recommendations on where action was needed

Table 1 shows a range of initiatives, mechanisms and activities that have helped to strengthen the capacity of UK HE to be responsive to new pressures on learning and teaching. In the ten year period, only one activity failed: the UK e-Universities initiative. It had diverse origins, from the ambition to capitalise on UK HE as a global business, to a recognition of the need for substantial central support for institutions struggling to innovate with new technology. It did not learn the lessons of previous commercial failures to create e-universities, nor from the successes of those universities already making the shift towards blended approaches (Laurillard, 2001). With no central support or coordination of e-learning effort, the HE sector continued to make small gains in localised projects, but not to achieve mastery of the technology in service of its learning and teaching ambitions. The sector still suffers from this failure, and we return to this point below.

By 2007, ten years on from the National Committee of Inquiry, UK HE was in a much stronger position to operate *as a sector* to improve the quality of its learning and teaching. With a secure set of funding, reward, research, and support mechanisms established, it is now well placed to maintain and improve the quality of students' learning experience in HE.

Does it succeed? Academic staff appear to believe it does: more than 60% say the sector is improving overall in terms of its performance in teaching (Amoah, 2007, p. 114). The figures are even better for the assessment of their own institution (ibid: 118). As far as students are concerned, we have no earlier benchmark for comparison, but at least we know from the National Student Survey that over 80% of universities score 4 or more out of 5 on a 5-point scale of overall satisfaction. That is a good score. There is room for improvement, but there are now well-established

Comment [JPE2]: Omit 'ibid' –just put p.118

mechanisms to help with that. Are they enough, if the sector is to withstand the forces affecting a 21st century system?

3. Forces affecting learning and teaching in HE

Higher Education operates in a complex environment of conflicting demands from stakeholders, public (government, taxpayers), private (business, public sector) and personal (individuals and families). If we consider just the demand from Government, students, and employers, there is a considerable potential impact on learning and teaching. If we add in the challenges being presented by new technologies, the impact is even greater.

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3.1. The pressure from policy

The pressures on the sector from Government are all expansionist - more and better, both quality and scale (see, for example, (DfES, 2005)), but without a commensurate increase in funding. There is more funding now through the introduction of graduate contributions to HE, but this does not match the drop in public funding to 63% of its value in 1980 (Watson, 2007: 37). The ambitions are right, but they set a demanding challenge on a sector that has to cope also with the expectations of delivering world class research.

Comment [JPE4]: Watson, 2007, p. 37

3.2. The pressure from demand

Within the UK, student demand for HE remains buoyant, and this seems set to continue, despite the rise in fees. Internationally, the demand for higher education is increasing, and can only increase further. Simply to keep pace with world population growth, there would need to be one university being created each week somewhere in the world (Daniel 1996). In many countries, demand already far exceeds supply, and perpetuates elitism when high quality HE is only available to the rich (Bates, 2001).

Comment [JPE5]: Note inserted comma

We can expect that the demand for good value higher education will continue to grow, and there will be many competitors willing to offer HE for a low price. The UK HE system will not be able to compete on price, although it should be able to compete on quality and value for money. In fact, UK market share dropped from 16% in 1998 to 11% in 2004, but in a growing market this still means a significant rise in the numbers of international students, by 50% to 350,000, over the same period (HEPI, 2007). Maintaining our place in the global HE market is important for HE, and as a recent survey shows, universities' international strategies focus particularly on the economic rationale (Middlehurst & Woodfield, 2007). Competing on value for money means that as volumes expand, there is a potential problem in how we maintain quality. With demand at its current level, even if we could afford a commensurate increase in teaching staff, we cannot train lecturers fast enough to maintain our current teaching model, which relies on a staff:student ratio of, approximately, 1:20. Therefore, in order to maintain quality the unit cost of teaching must decrease as volumes expand, which suggests the need to consider how to achieve a different teaching resource model.

3.3. The pressure from technology

Technology creates another important pressure for change. It is changing both what we need to know, and how we come to know it. As the workplace diversifies, graduates need to keep renewing and developing their high-level skills, e.g. for information-handling, independent learning, critical thinking, reflective innovation, project management, resource modelling, knowledge management, communication, networking, interpersonal negotiation, design, creativity, time management, and

enterprise, and they need ICT skills to support all these. In particular, there are new skills and patterns of knowledge that employees increasingly need in the workplace where technology is ubiquitous (Kent et al., 2005).

Foundational knowledge is important, but will need to be continually updated. The curriculum in HE therefore has to differentiate between building foundational knowledge, and using this knowledge-building process as the vehicle for the acquisition of all the high-level cognitive skills they need. The mismatch between the predominant HE focus on discipline knowledge, and the workplace requirement for high-level cognitive, or 'knowledge', skills, is probably the main reason for the absence of HE from the provision of 'workforce development', even though much of this is now high-level and post-graduate (Connor, 2005). As a result, some businesses have turned to the 'corporate university' solution, not always successfully. Eventually, it is likely that the private sector will learn how to innovate in learning and teaching for itself, and respond to these increasing demands, as HE is not stepping forward to supply.

The three pressures on learning and teaching in HE outlined here suggest that we need to rethink the way we do this. I suggest that digital technologies themselves, while they challenge, can also support.

4. Technology as a catalyst for change

Digital technologies take many forms, and create opportunities for change, and support for new ways of working. However, few universities have gone far beyond the provision of technology for information, communication, and organisational transactions, to use its wider capabilities to improve the quality of the learning experience itself.

Digital technologies present education with a range of opportunities that is hard to comprehend, and even harder to address. There is a sense that they provide something akin to the Gutenberg revolution, as the new technology of the printing press brought the technology of the written word to a much wider audience than was previously possible. This is a good analogy for the internet, but the internet alone seriously under-represents the diversity of the technology opportunities now available (Laurillard, 2006). An interactive computational model in itself provides a form of knowledge representation as radically different from the book as the mode of writing was from the oral mode of representation. **The written medium changed the way an individual could study and reflect on the knowledge being communicated. Prior to that, it was essential to memorise the knowledge that could only be delivered orally.** The act of learning could go beyond sitting at the feet of the master, and become an act of private study and reflection. Similarly, in the shift from the static, non-interactive medium of the written word to the interactive medium of the computer, there is a comparably radical effect on the act of learning. Digital technologies offer many new ways of representing knowledge, such as computational models of human or natural systems, animated diagrams of theories and concepts, role-play models of events and processes. Every discipline area finds new ways of using the technology to understand or illuminate its knowledge. And new forms of representation offer new forms of engagement with, and ownership of knowledge and the individual's developing understanding.

The historical shift from *listening to*, to *reading about*, to *interacting with* ideas, is mirrored in the way the learner is able to express their own ideas: from *talking*, to *writing*, to, with digital technologies, *many different ways*. There is a move from talking to writing, and with the advent of digital technologies a rich variety of possibilities become available. All the forms of representation available to the teacher can be available also to the learner. The teacher can build a model of climate change

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in a spreadsheet to enable learners to explore the effects of changes in one parameter; the learner can also build a model, and check its behaviour against known data. Building a model, a 'constructionist' ideal, is a fundamentally different kind of learning experience from writing an essay.

The technology opportunities for new kinds of teaching and learning will continue to develop, and HE will find it difficult to keep up with them. There is the potential for technology to offer a higher level of engagement with learning about difficult ideas, in a way that is far more motivating than the conventional 'transmission' mode of teaching. What is critically important, however, is that education should not be led by the technology, but should be imagining its own desirable future, and harnessing the development of learning technology to that.

There is often, in the e-learning literature, a certain breathless expectation of how things will need to change. For example:

"As our students enter the workforce, the ability to deal with complex and often ambiguous information will be more important than simply knowing a lot of facts... We need to think in terms of transforming the educational experience so that it's meaningful to the information-age learner" (Frand, 2000)

But is this the right contrast? The conventional educational experience is not, or should not be, 'knowing a lot of facts'. University students set out to develop a fundamental understanding of a discipline, which is not the same. 'Knowing a lot of facts' would be a poor description of a university education. And while we certainly have to make learning intelligible and meaningful, is it really the case that what it takes to learn is so different in 'the information age'? The next section considers this question.

5. Desirable futures?

To think through the future of learning in the context of new technology, it is important to begin from an analysis of 'what it takes to learn'. Without a clear understanding of pedagogy, predictions for the future of learning and teaching will tend to be driven by what the technology makes possible, rather than what learners need.

The analysis of 'what it takes to learn' has been widely discussed and researched in education, across all sectors, over many decades. There is a common thread running through the writings of the great educators, not always shared by learning theorists from behaviourist psychology, cognitive psychology, and cognitive science, but common at least to the great majority of educators. From John Dewey onwards, through Piaget, Vygotsky, Freire, Bruner, Papert, Marton, Lave, the common thread is that learning is *active*. Therefore, the role of the teacher is not to transmit knowledge to a passive recipient, but to structure the learner's engagement with the knowledge, practising the high-level cognitive skills that enable them to make that knowledge their own. The collective analysis of what it takes to learn, combined from all these educators, identifies learning, in the context of formal education, as involving 'cognitive motivation', 'meta-cognition', 'problem-oriented', 'inquiry-oriented', 'goal-oriented action', 'repeated practice', 'feedback', 'reflection', and 'social communication' – i.e. it sees learning not as something that happens to the learner, but as an activity they *do*. With this general degree of consensus it is unlikely that learning will be found to require something radically different in the near future. Learning complex concepts and mastering difficult procedures and processes, will always require effortful thinking. Technology will probably not change what it takes to learn, therefore, but it may change how the process of learning is facilitated.

In order to see what kinds of contribution technology could make to learning, the research community itself is a valuable indicator of the potential. An analysis of the successful applications to the 2007 ESRC-EPSRC funded Technology Enhanced Learning research call demonstrated a rich variety of learning activities and forms, as in the following quotes from proposals:

Inquiry-based	Game authoring	Manipulation skills
Construction	Techno-computing skill-learning	Informal interests
Conceptual understanding	Fieldwork	Self-worth
Taking tests	Communication	Modelling
Problem-solving	Collaboration	Scenarios
Narrative	Learning identities	Evaluating evidence
Literacy	Conceptual networks	

These descriptors reflect many of the concerns of the educational theorists who want to make learning an active process. But what do they see as the role of digital technologies? The research proposals identified a wide range of applications:

Games	Personal learning environments	Virtual objects
Tools	Learner models	Online communities
Cultural tools	Portable devices	Adaptive support
Adaptive intelligent tutoring systems	Conversation agents	Simulation
Avatars	Editable digital artefacts	Collaborative technology
Embodied interaction	Digital data tracking	
Augmented cognition	Haptic devices	

We talk about 'technology' or 'e-learning', as if it is a unitary concept, but the terms listed above cover an immensely wide range of artefacts, offering many different ways of enhancing learning. In the research proposals, these included ways of making the provision of education more flexible, making the learning process more active, improving assessment, scaling up high quality interactions, and giving teachers interactive frameworks for designing lesson plans and learning activities.

Education can pose some testing challenges to new technologies, as we have seen. Suppose we agree we know what it takes to learn? A consensus could probably form around something like the ideal conditions of the small group practice-based tutorial, of well-matched learners, and a teacher able to inspire, encourage and guide the learners individually and collectively to a shared understanding of a negotiated goal. The ideal conditions are very difficult to achieve in a mass education system, and higher education is becoming a mass system with few prospects of providing this ideal very often for many of its students. In the future conditions of an ever-expanding system it will probably be impossible.

So this defines our challenge to the technology: make it possible to emulate the ideal conditions of the small group practice-based tutorial in a large-scale non-elite HE system.

Could it be possible? We know it is possible for the technology to:

- emulate small group tutorial discussions through virtual communications;

- provide realistic feedback on actions in a virtual environment;
- track learner performance to predict the optimal next task;

and many other aspects of good teaching. We know this capability is possible, but its use is not widespread, it is not available in most curriculum topics, and it is not widely understood how to exploit it in the service of good pedagogy and an inspiring learning experience.

The challenge of providing high quality HE on the larger scale is critical. We have seen that the demand can only increase. It is clear that we cannot possibly maintain the effectiveness of higher education through conventional methods. The 1:10 or even 1:20 staff-student ratio is not viable on the large scale. With a falling unit of resource for teaching, down 63% on 1980 figures (Watson, 2007), not compensated by the increase in fees, there is no hope of improving that ratio in future. Worse, within that reduced resource we have to manage not just expansion of numbers, but much greater diversity of need, interest, motivation, and capability in our student population.

Against this rather pessimistic analysis we have the promise of new technology. In addition to the emulation of aspects of the ideal teaching conditions above, it can also sometimes achieve economies of scale. In the context of education, for example:

- the tutor's answer to one student's question is accessible and preserved in the online discussion for a very large number of others;
- the interactive simulation that works for introducing a difficult idea could work the same way for the many, not just the few it was originally created for;
- the small group discussions reporting back to a plenary can be many hundreds of small groups, merging into smaller numbers of large groups, with the few key questions being inherited by a very large plenary.

In such ways, the technology can handle scale in terms of both access to ideas, and the 'inter-connectedness' that enables meaningful discussions.

Equally, it can handle diversity of content. The digital resource demonstrating the application of theory to a case-study can be reused in many different locations by replacing the link to the case-study with a locally defined link to a local study. Similarly, students generating their own digital data from local researches can contribute their findings online to generate a multi-cultural community-owned resource for all to share. In these examples we can see the germ of a future in which the academy operates in a very different way, to achieve its traditional ends. But plotting the course by which we get there is complex. We are currently in the very early stages of learning how to make best use of these multi-functional technologies.

If technology is to be the key to enabling higher education to achieve its ambitions for both expansion and quality, then we need a theory of change that tells us how that is to be achieved. We have a tiny proportion of academic staff engaged in research on teaching. Teacher education, as an academic subject, struggles to lead. As the only major subject with decreasing numbers (Watson, 2007), despite an education system that has expansion and improvement in all its aims and policies, there is little room for radical innovation. In the next section we look at how the teaching profession might tackle this dilemma.

6. Mechanisms for innovation in learning and teaching

If we were to pose the question 'who will lead innovation in learning and teaching?' there is really only one legitimate answer. No academic could countenance a solution

other than to put this responsibility with the academic profession itself. The interrelationship between what is taught, and how it is taught, is too close for it to be otherwise. The occasional fantasy of policy-makers and consultants, that 'content' could be generated by the commercial world on behalf of education, has not yet borne fruit, and certainly would not be shared by academics who care about their field. Academics do not separate 'content' from the process of learning. The 'what' and 'how' and 'why' of learning are internally related, which is what makes learning technologies exciting. As we shift to different representations of knowledge, offered in ways that are as different from books as the written word was from the spoken word, we necessarily change our relationship to knowledge. There is no viable alternative therefore. We have to discover for ourselves how to harness the capability of digital technologies to extend and enhance learning and teaching. Is this feasible?

I would argue that it is feasible, but on one necessary (though not sufficient) condition: if we properly acknowledge that discovery requires something akin to a scientific approach; that we need to problematise learning and teaching, bringing to it the same level of investigation that we do to academic research into any activity.

Our knowledge and understanding of 'technology enhanced learning' will develop faster in an academic teaching community that acts like a learning system, in the same way as knowledge develops fast in peer-reviewed collaborative research. Innovation and discovery, which are peer reviewed and quality assured, will need the same conditions in the context of learning and teaching as they need in any other field. It would involve making explicit our knowledge of *what it takes to learn*, so that we can instantiate it in the digital technology, just as we did with the older technology of the textbook. Once developed, it must be possible to test it, adapt it, refine the design, reflect on the process, rearticulate what it takes to learn, and share that new knowledge. All the characteristics of 'learning', present in the way scientists learn about our natural and social worlds, must be there too, in the way we learn how to improve learning and teaching.

If teaching were to become problematised in this way, then lecturers would conduct the process of teaching as rigorously as they conduct their research. And certain expectations would follow. They would expect

- (i) support for some personal development in how to teach,
- (ii) the means to build on the work of others to design their approach,
- (iii) the means to experiment and reflect on what the results imply for their design and their understanding, and
- (iv) the means to articulate and disseminate their contribution.

Those four characteristics together define the essentials of what we might call 'open teaching' – what James Dalziel has called 'open source teaching'. i.e. an environment in which "educators can freely and openly share best practice teaching" (Dalziel, 2005). This communitarian approach would reflect the ideals of the research community in general, and the scholarship of teaching in particular (Kreber & Cranton, 2000). Specifically, it would enable the academic teaching community, throughout higher education, to learn how to adapt to the new challenges for HE, and to exploit technology in the process.

It sounds infeasible in a system under so much pressure simply to deal with the requirements of expansion and diversity. But from the arguments above it is clear that this situation will not improve, and yet, without harnessing the advantages of learning technologies, higher education will not meet demand. Happily, the technology itself embodies the means to provide the support academics will need:

Comment [JPE7]: Suggested alternative:

..subjecting it to the same level of investigation as we would bring to any academic research topic

Comment [JPE8]: Omit e

(i) support for some personal development in how to teach – there are online learning design tools under development, which are explicitly designed to help teachers gradually bring learning technologies into their work, and link to repositories of existing digital resources in their field²;

(ii) the means to build on the work of others to design their approach – online communities of practice can offer access to existing learning designs, case studies, lessons learned;

(iii) the means to experiment and reflect on what the results imply for their design and their understanding – an interactive learning activity management system can offer a simple authoring environment for the lecturer to sequence a set of learning activities, run it for student groups collaborating online, monitor student progress, offer a simple editing environment to improve it in the light of practice (see Figure 1)³;

(iv) the means to articulate and disseminate their contribution – creating a learning activity sequence is one form of articulation of what the lecturer thinks it takes to learn a particular topic, or achieve a particular learning outcome, and the online community is the means to disseminate that idea, once proven.

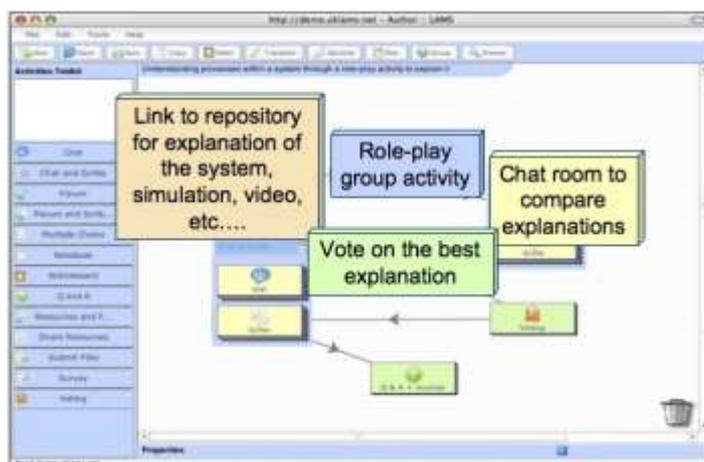


Figure 1: The LAMS authoring environment enables the academic to drag and drop a sequence of generic learning activities onto the panel and link them together. Within each one they can then specify, e.g. the simulation or website to link to, the roles for the groups, the issues to vote on, etc.

Perhaps it is not an impossible dream, to imagine an academic teaching community connected in exploration and discovery of what it takes to learn, and what it takes to enable learners to learn, not just within our conventional teaching environments, but in ways that address the scale and diversity of the HE system of the future. Technology can be a solution to the pressures and demands on HE, but only if pedagogy is the driver, and only if the academic community is doing the driving.

² See the JISC Design for Learning Programme, <http://www.lkl.ac.uk/research/d4l/>

³ See, for example, the Learning Activity Management System (LAMS), <http://www.lamsinternational.com/>

7. Summary

The HE sector has moved a long way in the ten years since the Dearing Report, and has developed the capability to continue to develop the quality of teaching and learning. There are now several enduring mechanisms and agencies for improving teaching and learning, as outlined in Table 1. Technology is forcing the pace of change, but also offers intriguing potential ways of contributing to the adaptability of the sector, in its response to change. From the arguments outlined above, if HE is to make the best of this opportunity, then we should aim for:

Innovation in teaching and learning focused on educational ambitions;

A clear strategy to link research, teaching and innovation;

Academics leading innovation in learning and teaching with technology.

And we should avoid:

Innovation in teaching left to specialists;

Efforts to innovate that are non-strategic;

Technology used as a driver of innovation in teaching.

Comment [JPE9]: Note suggested punctuation inserts.

It is essential that we do not devolve responsibility for innovation to specialists, or publishers, or software houses. But it is unsurprising that academics find little kudos in teaching innovation when by far the most impressive rewards are for research. It is essential, therefore, if academics are to lead the discovery of new pedagogies, that innovation in learning and teaching be linked to educational values, and institutional strategies. However, we lack the leadership we need to ensure either that teaching innovation is linked to strategic needs, or that it is accorded the time and status of research. If we could achieve these two changes, then perhaps we could avoid the awful prospect of forever using technology as a solution in search of a problem.

Even so, the successive developments in HE teaching and learning since the Dearing Report put the UK in a much better position than most other countries to be the world leader in innovation in learning and teaching in HE. With better use of digital technologies, we could be on the point of a breakthrough to a system capable of learning how to teach. This fits very well with the values articulated in the original Dearing report, which saw the aim of HE as being

“to enable society to make progress through an independent understanding of itself and its world: in short, to sustain a learning society” (NCIHE, 1997).

If this is important for society as a whole, how much more important it must be for HE to be ‘a learning sector’, able to develop an understanding of technology enhanced learning as a tool for pedagogic innovation.

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