

Digital technologies and their role in achieving our ambitions for education¹

Diana Laurillard

London Knowledge Lab

Abstract

Educational policy aims are very ambitious: from pre-school to lifelong learning they demand improvements in both quantity and quality, which are multiplicative in their effects on teaching workload. It is difficult, therefore, to achieve these aims effectively without rethinking our approach to teaching and learning. Our essentially nineteenth century model of educational institutions does not scale up to the requirements of a twenty-first century society. Despite their potential to contribute to a rethink, digital technologies have usually been used in a technology-driven way to upgrade our existing educational models. There is an alternative: an education-driven approach to the use of digital technologies to achieve our ambitions for education.

Introduction

Education is on the brink of being transformed through learning technologies; however, it has been on that brink for some decades now. The argument I want to advance in this lecture is that never before has there been such a clear link between the needs and requirements of education, and the capability of technology to meet them. It is time we moved education beyond the brink of being transformed, to let it become what it wants to be.

Education policy ambitions

There is no question that Government education policy is ambitious. The aims for a twenty-first century education system were outlined in its five-year strategy for education and children's services in 2005. After years of

¹ Institute of Education, University of London, 2008.www.ioe.ac.uk/publications

significant investment in education at all levels, the returns were still unsatisfactory, and the strategy was designed to raise the attainment of learners in all sectors, and widen participation at all levels from pre-school to lifelong learning. The principles for reform highlighted personalisation, flexibility, collaboration, staff development, and partnerships. These principles were then interpreted within each of the sector strategies, to set the plans for schools, FE and HE to carry through the reforms that would transform education. Altogether, throughout the document, there are some forty items listed in the 'offer' to learners and other stakeholders, of which the following is a selection from the different sectors (DfES, 2005a):

Better teaching and more personalised support for every child, whatever their needs (p. 35)

An interesting, broad and rich curriculum with more choice and a wider set of out-of-hours opportunities (p. 59)

Every young person able to develop the skills they need for employment and for life

The flexibility to combine school, college and work-based training

More school sixth form, sixth form college and vocational provision, to give more choice to students (p. 71)

Every adult to be able to get and build on the skills they need for employment

Lifelong learning for all – for work or for pleasure – with the widest possible array of good quality courses (p. 83)

High quality university courses with excellent teaching

Access to university for those who have the potential to benefit

More and better flexible opportunities to study (p. 94).

It is an extraordinarily ambitious list – more and better, both quality and scale – 'more personalised', 'more choice', 'better teaching', for 'every child', for 'every adult'. But we can hardly complain. It is what all our research here at the Institute demands of government:

To protect against entry to negative pathways and reverse those that have already begun, continued investment in educational interventions is needed across all of middle childhood. The results reported here may therefore be seen as making an important contribution to the evidence on which the case for *more and continued intervention* depends.

(Feinstein and Bynner, 2004, my italics)

Our results suggest . . . *maximizing individualization* and *differentiation* by teaching to small groups.

(Blatchford *et al.*, 2007, my italics)

The question of the nature and scope of the transformation which must take place in mainstream schools if they are to become inclusive schools . . . has been largely ignored. . . . inclusion is not merely about placement into an unchanged system of provision and practice. It is about *changes to the curriculum, teaching styles, organisation and support systems* within schools.

(Barton and Armstrong, 2003, my italics)

There is no question that the policy ambitions are right. Government is responding to the findings of educational research, but together they set a very demanding challenge to teachers and leaders. Funding to education has been increased, certainly, but hardly on a scale that is commensurate with the real scale of these ambitions.

Personalisation

The demand that every teacher should be able to respond to the individual needs of every child is just fantasy when you consider what that would actually mean for a typical schoolteacher with a class of 30 – or even for a university lecturer with a group of 200. The figures just don't add up. Even with all the additional funding for education over the past ten years, the pupil–teacher ratio has improved from 23.2 to 22.0, a change of just 5% (Annual School Census for local authority maintained schools in England, 1997 to

2006). That means that a child receiving 5 minutes per week of individual attention ten years ago would be getting 5 minutes and 15 seconds now. The bulk of the extra teacher time produced by the increase in funding has gone into preparation and administration. Even 5 minutes looks unrealistic when, for classes of 30, it adds up to two and a half hours of individual teaching a week. Few teachers experience such luxury:

I worry about making sure I speak to each child individually each day – I want them to know that I care about them, not just their group or their class (Y5, 32 pupils).

It is very difficult to get around and see, on a one-to-one basis, each child when you have a class above 25. Children with learning difficulties and slow learners do not get a fair deal, especially if they receive little or no additional support (Y4).

(quoted in Blatchford *et al.*, 2007)

The idea of ‘personalisation’ that inhabits our research findings, and our policy ambitions, seldom finds its mirror in classroom reality.

Flexibility

The requirement to provide flexible opportunities for study, enabling learners to combine school, college, and work-based and home-based learning, is extremely important for learners who need to see the relevance of their education through application, and who quickly reach an age where they are impatient to get beyond the culture of school, as the 14–19 strategy recognised. But this radical disturbance to the system, requiring seamless coordination not just across institutions but across sectors as well, and a very different way of thinking about the relationship between knowledge, skills and their application, is very hard to deliver in practice. Wherever you try to provide flexibility and choice there is an automatic increase in cost.

Inclusion

We can interpret ‘inclusion’ in several ways – to overcome the problems of disability, whether physical, cognitive, or emotional; or logistics, where learners are remote or tied to a location; or disaffection, when learners have

disengaged from education. The case for inclusion of all kinds is strong because the consequences of exclusion are so expensive in human and social terms (Bynner and Parsons, 1997). But disability requires specialist attention and understanding, and differentiated solutions. Including learners wherever they are requires mixed-mode campus and distance learning. Overcoming disaffection requires a different kind of attention and understanding. Again, if we take this kind of differentiation seriously – to the extent that we really provide for the needs of ‘every child’, ‘every young person’ and ‘every adult’ – the impact on teacher time is huge.

Wherever you look in our current educational policies you see the right ideas – evidence-based, morally unarguable, and completely unaffordable. It is very difficult, in fact, to find any quantitative modelling of what it would actually take to achieve these reforms. The combination of higher quality (personalisation, flexibility) and larger scale (more people spending more time in education) is multiplicative. Even the most cursory modelling of even the most minimal improvement gives a sense of what it would take: for example, to provide the extra time needed to increase individual teaching by just 10 minutes a week per primary school child would require the equivalent of an additional 3000 full-time teachers. The actual number of primary teachers has reduced by 2000 over the past ten years; taking into account the reduction in the number of primary pupils, that’s the equivalent of an increase of just over 1000 teachers in that time. That comparison gives us an idea of just how challenging it would be to provide the kind of teaching resource that we imagine when we talk about the idea of personalisation.

That’s the kind of challenge we need the technology for – how else are we to meet it?

The learner’s point of view

Ultimately, all these policy ambitions coalesce around the critical question of whether each individual learner, whatever educational phase they are in, has been able to fulfil their learning potential. That depends on personalisation, flexibility and inclusion, certainly. But could the learner’s experience of these be aided by the technology?

First, rather than start with what the technology has to offer, we start with what learners might need. We should consider how the education system represents itself from the learner's point of view. That means looking at their encounter with the system all the way through their learning journey, from pre-entry, through curriculum choice, study choice, learning, assessment, and ultimately career planning and further learning opportunities. Figure 1 presents this as a single graphical representation (Yapp and de Freitas, 2006). At each stage of the journey, the learner interacts with the system in a different way: initially deciding what it has to offer them (the motivation question 'Why should I learn?'), then wanting to know what knowledge and skills they might learn (the curriculum question 'What can I learn?'), then wanting to know about the mode of study (the logistics question 'How will I study?'), then the ways in which they might learn (the pedagogy question 'How will I learn?'), then how they will be evaluated (the assessment question 'How do I (and others) know I've learned?'), finally coming to the issue of where they might go next with their newly acquired knowledge and skills (the opportunity question 'Where does this take me?'). Insofar as this framework adequately describes the principal ways in which the education system makes an offer to learners, it is useful for considering how well it serves their needs. The framework operates in each educational phase, although for pre-school perhaps it is the parents more than the child who considers the offer being made.

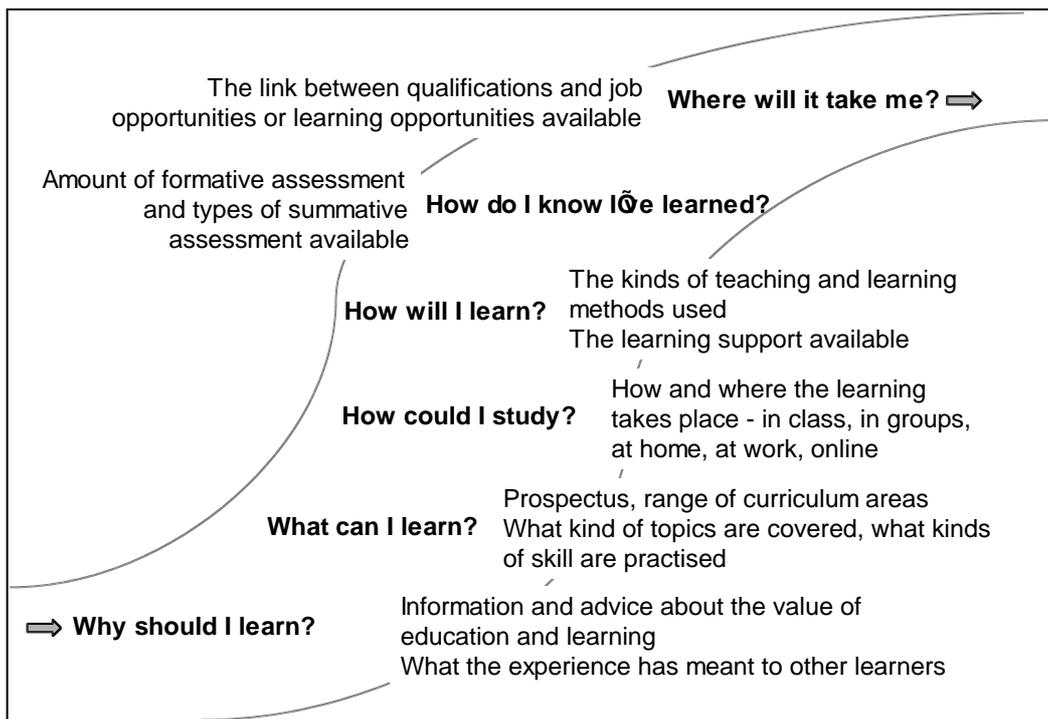


Figure 1: The learner's journey through the education system, showing how education sets out to meet learners' needs at each stage

Ideally, personalisation is relevant to all the stages of the learner's journey: adapting the information and advice to their needs; negotiating the curriculum; responding to their needs in the logistics of study; adapting the teaching to their learning needs; providing individual feedback in assessment (Black and Wiliam 1998); and adapting the advice and guidance to their educational experience and ambitions for their further work or learning opportunities.

'Flexibility' usually refers to the logistics of study, enabling learners to study where and when is best for them, and to the choice of curriculum, which becomes learner-oriented, rather than provider-led.

Inclusion would be relevant for the pre-entry stage to encourage disabled learners to believe the system will work to their needs, or to encourage disaffected learners back into learning. It also requires a form of personalisation to diagnose or identify learners' needs, and to provide study conditions and teaching methods that meet them.

So this framework of the learner's journey gives us a useful way in which to challenge the technology.

How might technology help?

In 2002 I joined the DfES for a three-year secondment from the Open University to lead the development of an e-learning strategy. I was fortunate to coincide with Charles Clarke's arrival as Secretary of State. In his earlier work as Minister of State he had laid the foundations for the embedding of ICT across the school curriculum, and he was keen to build on this, and take on ICT as part of his portfolio of particular concerns. This meant that it was now possible to make the e-learning strategy genuinely cross-sector. It was his analysis that identified the four ways in which technology was to contribute to education: through personalisation, flexibility, inclusion and productivity. It was a brilliant encapsulation of what was needed. The policy ambitions had identified the first three as fundamental requirements of reform in all phases of education; and as I have shown, none of them is feasible unless we achieve a different level of productivity in our educational system – more of the same will not do it. For this reason, Charles Clarke looked to technology to help us meet the vaunting ambitions of our educational aims, and gave his backing to an e-learning strategy that would be appropriate.

Accordingly, the Government's e-learning strategy, published in 2005, took the four challenges of personalisation, flexibility, inclusion, and productivity as the defining focus for the contribution that digital technologies should be making to education (DfES, 2005b).

Now we can ask 'So what can the technology do for us?' – rather than the more typical question 'What can we use the technology for?' – because we know what we want from it. It is very important to put education in the driving seat of future technology development. Too often, we have to make use of technologies developed for other activities – usually leisure or commercial. Here I want to turn that around, and begin with the requirements of education, and challenge technology to meet them. The great advantage of having an ambitious educational policy programme is that it has clarified what needs to

be done. Technology works best when it has to meet a challenge; and worst when it is a solution looking for a problem.

Examples of technology supporting learners' needs

The capabilities of digital technologies are diverse and extensive. For each stage in the learner's journey it would be possible to identify a combination of technology characteristics that could service almost any of the needs identified, using: access to remotely stored information, search engines, multimedia, synchronous and asynchronous communication, simulation, modelling, adaptive decision-making, user-driven design tools, posting sites for user content, etc. A selection of recent research projects, such as those in the London Knowledge Lab, illustrate how digital technologies can be pressed into service of all these learner needs.

Motivation – Why should I learn?

[Making Games](#) – David Buckingham, Andrew Burn, LKL (Pelletier, 2005)

<i>What it did</i>	<i>Impact</i>
Developed a game-authoring tool within a 3-D environment, allowing children to design their own role-playing and action adventure games, engaging them in both critical analysis and creative production of game designs.	Learners can explore the relationship between the internal design principles of games and the external social purposes they are used to fulfil, highlighting that the way we constitute our identity through games hinges on the network of social relations.

Curriculum – What can I learn?

[OpenLearn](#) – The Open University (Eisenstadt, 2007)

What it did

Created an online learning website that is open to anyone, anywhere in the world, using materials taken from Open University courses. It is completely free. Instead of attending classes, learners study online in the LearningSpace, using materials that have been specially designed for distance learning.

Impact

Learners use OpenLearn to:

- enrich their current studies
- research into future course options
- build up a learning portfolio for continuing professional development
- find quality learning materials quickly
- keep up to date with their subject
- try out new subjects.

Logistics – How will I study?

[The Homework project](#) – Rosemary Luckin, LKL (Luckin *et al.*, 2005)

What it did

Used a combination of interactive whiteboard and tablet PC devices in combination with bespoke software. It enables teachers to plan, build and execute individualised lessons for school and related activities for home, using multimedia and television resources distributed to whiteboard and tablet PC devices.

Impact

Improved links between home and school learning and closed the gap between parents, teachers and learners; provided continuity across locations.

Children very much enjoyed having their own personal tablet PC.

Results from pre- and post-study maths tests reveal a possible relation between the amount and kind of home use of the tablet and learning.

Pedagogy – How will I learn?

Techno-mathematical Literacies in the Workplace project – Richard Noss, Celia Hoyles (Hoyles and Noss, 2003)

What it did

Co-developed learning opportunities in Excel to allow employees to represent and manipulate models of financial products. Although employees have at least basic familiarity with such models, they do not normally see their insides, so they may thus appear to them as ‘magic’.

Impact

Employees come to see financial calculations as being based on relatively simple calculation steps which, far from being ‘magic’, are actually understandable.

Assessment – How do I know I’ve learned?

The Adaptive Feedback Framework – Kevin Keenoy and Mark Levene, and the Kaleidoscope Network (Keenoy and Levene, 2007)

What it did

The Adaptive Feedback Framework provides domain-independent personalised feedback to support reflection, guiding and tutoring, where ‘trails’ of answers supplied by learners as they interact with the system are evaluated against the ‘expert’ answer defined by the course tutor.

Impact

Supports learners in reflecting on their personal ‘trails’; identifies where the learner has gone wrong, categorises the answer, and adaptively provides different types of feedback – informative, tutoring or reflective.

Opportunity – Where will this take me?

[Lifelong Learning London for All project](#) – Alex Poulouvassilis, George Magoulas (de Freitas *et al.*, 2006)

<i>What it did</i>	<i>Impact</i>
Created a portal that allows learners to access selected information and resources, plan their own learning pathways, and maintain and reflect upon their individual record of learning throughout their lives.	Learners share their learning plans and pathways with other learners, in order to support collaborative learning and to formulate future learning goals and aspirations. Tutors can publish recommended pathways through courses and modules, thereby facilitating progression into Higher Education and supporting career choices.

The illustrative examples are important, but I want to develop an approach that is also grounded in a theory of learning and teaching.

A theoretical approach to challenging the technology

How do we come to be where we are now, at this point in the early twenty-first century, as an education system? What is the nature of the relationship between teaching and technology?

The relationship between teaching theory and teaching technologies

The repertoire of teaching methods has developed historically from what is required of education and from the means available: from small-group oral methods with transient visuals to large group whole-class teaching with separate practice, discussion, and private study methods. Educational technologies have changed a lot over the centuries – from sand to cave wall to slates to paper to television; from apprenticeships to small groups to classrooms. But the theory of teaching and learning was predominantly ‘tell–practice–test’. So teaching only needed presentational technologies and one-to-many physical gatherings.

A radical shift in thinking began with Dewey at the end of the nineteenth century, continuing through the whole of the twentieth century. Instead of seeing teaching as ‘the transmission of a common culture’, as it is often viewed by policymakers (e.g. Robbins, 1963), educational theorists began to develop a careful analysis of *what it takes to learn*. The transmission model of teaching (tell–practice–test) was clearly inadequate, certainly if you wanted to educate beyond an elite, and to encourage independent creative thinking. Theory focused on learning – ‘experiential learning’, to take Dewey’s phrase (Dewey, 1938). Throughout the twentieth century we developed a variety of descriptors: inquiry-based education, constructivism, discovery, conversation theory, social learning, problem-based learning, reflection, social constructivism, meta-cognition, awareness, situated learning, collaborative learning – all of them sharing the common conception of learning as an essentially active process: learning as a ‘doing’ word (Entwistle, 1991; Harel and Papert, 1991; Jonassen, 1994; Lave and Wenger, 1991; Marton and Booth, 1997; Papert and Harel, 1991; Pask, 1976; Vygotsky, 1962). What it takes to learn, we know now, is more than being told.

Interestingly, the radical shift in thinking about learning was not matched by a shift in the technologies of education. For mainstream education they were the same at the end of the century as they were at the beginning: one-to-many physical gatherings with mainly presentational technologies (books, blackboards, slides, etc). Half-way through the century a new technology arrived – the digital computer. And since then it has spawned an immense variety of digital technologies, whose characteristics, as we have seen, can be combined to offer all the different kinds of learning experiences the theorists have been telling us are so important – inquiry, construction, discovery, conversation, problem-solving, collaboration . . . and yet . . . !

Why has the teaching profession not pounced on this extraordinary opportunity to bring the potential of digital technologies into the service of what we know learners need?

A slow response to technology is not peculiar to education, of course. Most of our major commercial institutions and enterprises have undergone extensive transformation in the way they operate as a result of digital technologies,

while public services have been very slow to change. This is partly because in the public sector transformation needs too high a level of investment, the processes are too complex, and the change poses a high risk to large numbers of the most vulnerable members of society. Large-scale public-sector IT projects fail badly when they fail. In education, fortunately, we have not had major IT failures because the use of technology has slowly crept into both administration and teaching, without effecting any major transformation of the system. That is the upside. The downside is the same: the lack of any major transformation, with the risk that education may be unable to adapt to the rapid change going on around it.

Why has there been so little transformation?

Here are five plausible explanations (Laurillard, 2008a):

1. Education is a complex system of powerful drivers – assessment, curriculum, inspection/quality requirements, funding flows, promotion criteria – none of which have changed significantly in recognition of what technology offers. These drivers determine the ways in which teachers and learners orient their energies and are judged by others. Unless the drivers of the education system change, the behaviour of its members will not change.
2. Technological change is very rapid. We have seen the digital equivalent of many key technologies for education in the space of half a century – the equivalent of writing, the pamphlet, the book, publishing, photography, film, broadcasting, the telephone, the printing press, the postal system. While it took many centuries to develop our education systems through these old technologies, we have not yet had time to make the radical changes afforded by digital technologies (Laurillard, 2005).
3. The education system is run by leaders who are not comfortable with either the detail or the implications of the technology potential, and those who are comfortable with them are not powerful enough within the system. However there has been significant and successful change in some institutions, demonstrating the importance of leadership. Institution leaders

need the direction to be set at national level, and they need more support for the changes they must direct within their own institutions (DfES, 2005b).

4. Education is essentially a political activity and a national enterprise, embodying the moral values of a country, so it does not easily become commercialised or globalised, and therefore avoids being subject to the innovation that market forces encourage (Readings, 1996).

5. Education systems change slowly because they tend to be hierarchical command and control systems, rather than devolved-power adaptive systems. Teachers and lecturers are given neither the power nor the means to improve the nature and quality of the teaching/learning process through technology (Elton, 1999).

On that analysis, our education systems are doomed to irrelevance and inefficiency, unable to even begin to meet the challenges of the twenty-first century, because they cannot rethink themselves fast enough. I think all five elements play their part, but in the remainder of this lecture I am going to focus on the last, as the one that provides the most powerful key to enabling the transformation we need.

What does it take to learn?

This question I take as an anchor. In the turbulent world of rapid technological change and breathless excitement about how technology will change everything in education, you need some solid ground from which to view these extraordinary potentials. I recommend this idea: that the fundamental principles of what it takes to learn do not change significantly. They may be characterised in a variety of ways, as we have seen, emphasising different aspects of learning, but they all share a common conception of learning as an essentially active process. Together they can be shown to constitute an iterative sequence of interactions between teacher and student on two levels: the discursive (articulation of concepts, ideas, theories, comments, questions) and the experiential (application of the theory or concepts to some task or practice).

We can map the main theories of learning in these terms:

Instructivism: The teacher presents concepts and theory – the learner asks questions – the teacher adapts a practice environment for learners’ needs – and sets a task goal – the learner adapts their action to the goal, based on their current conception – the teacher reflects on this performance and modifies their presentation of the ideas, and marks the learner’s performance.

Constructionism: The teacher adapts a practice environment for learners’ needs – and sets a task goal – the learner adapts their action to the goal, based on their current conception – the practice environment provides feedback on their action – the learner reflects on that interaction – then adapts their actions – and tries again to meet the goal.

Social learning: Each learner presents their ideas or concepts to one or more other learners – each learner comments on the ideas of other learners.

Collaborative learning: The teacher adapts a practice environment for learners’ needs – and sets a task goal – the learner adapts their action to the goal, based on their current conception – the practice environment provides feedback on their action – the learner reflects on that interaction – the learner shares their output with another learner – reflects on other learners’ shared outputs – presents their ideas or concepts to one or more other learners – comments on the ideas of other learners – then adapts their actions – and tries again to meet the goal.

Together, these different ways of characterising learning and teaching can combine to give a complete description of what it takes to learn. This is what I termed the ‘conversational framework’ because it emphasises the continual iterative character of learning. It does not explicitly include the aspects of motivation and self-realisation that are so important for learning, but both should be emergent properties of the iterative process (Laurillard, 2002). As Professor Susan Hallam argues in her recent lecture:

Adopting mastery approaches to learning, where learners aim to improve on their previous performance and continue to develop their knowledge and skills without reference to the progress of other learners, enhances motivation.

(Hallam, 2005:24)

That is exactly what the iterative goal–action–feedback–reflection–adaptation–revision–feedback–reflection cycle embodies. I would argue that social motivation also plays an important part in learning, and that the impulse to share your outputs with your peers, defend and debate your ideas, and learn from your peers (even if you don't admit it) makes that social and collaborative part of the framework critical to effectiveness. The constructivist element is equally important, as the right learning environment engages the learner in authentic tasks that either work or show you how they fail to work – the feedback, rather than being just right/wrong, is the intrinsic feedback that shows you the result of your actions.

This argument for greater authenticity may well apply to the difficult case of school science, for example. We might ask ourselves why drama and media subjects are so much more attractive to the student population than science and engineering subjects. As Professor Michael Reiss has shown, learners need a greater sense of authenticity, such as fieldwork (Braund and Reiss, 2006), where school science can be more like the forms of discovery and experimentation they can do in their creative leisure pursuits. Field trips are popular because authenticity creates meaning and purpose, giving science study some utility value. They are expensive, of course, and will not dominate the science curriculum. However, there is an alternative.

With appropriate use of technology, virtual field trips could do some of the same, if constructed with care. School science would then come closer to the constructivist approach, drawing on more types of knowledge production. School learners cannot uncover the laws of nature, but it is not enough to simply demonstrate them. The learners need to be active and in control – as they are in the digital environments that are their natural habitat. Too often, technology for science is used merely as a source of information and presentation, rather than as an opportunity for an active, simulated experience of discovery and experimentation. Again, the constructivist element of the conversational framework is essential.

This attempt at a complete and coherent account of the learning process was a necessary target against which to test the excitable claims for the new technologies.

Figure 2 shows a very ‘democratic’ model of teaching and learning, but it also shows that the role of the teacher is not identical to that of the learner. The teacher has the opportunity to learn about their learners’ points of view and their practice, but the teacher’s knowledge is privileged over that of the learner. As a consequence, it is their job to ensure an intelligible learning experience – they must adapt the practice environment to the capabilities of their learners, provide the appropriate goals and feedback, and reflect and learn from that process, as much as the learners learn.

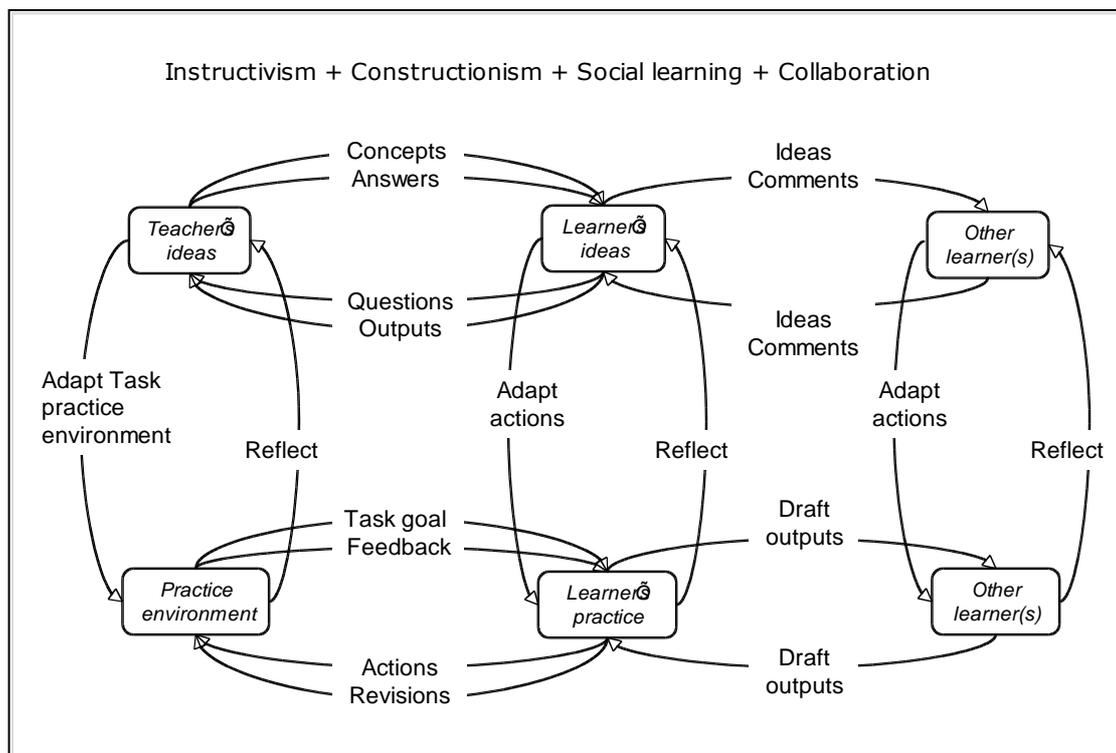


Figure 2: What it takes to learn: the ‘conversational framework’ for the teaching–learning process

In summary, the conversational framework is an attempt to draw on the learning theories developed over the last century, and encapsulate them in a form that enables educators to confront the technology with the challenge to deliver them.

What can technology offer?

Unfortunately, we need the conversational framework, or something like it, because the world of digital technologies appears to believe that the transmission model of teaching is still viable. Educational software, from 'virtual learning environments' to much of the high-production-value software in use in schools, seems to be predicated on the idea that learners need access to information and multiple-choice questions. As Professor David Buckingham observes:

most educational materials on the web and on CD-ROM are distinctly limited . . . visually impoverished, lacking in interactivity, and thin on engaging content. . . . Our research on educational games has found that the learning content in such games is detached from the game-play . . . merely a kind of reward for getting the questions right.

(Buckingham, 2005)

The framework can act as a good antidote to the hype of digital technologies as well as challenging the old and trusted methods. The lecture delivers just one element of the framework – the presentation of the teacher's concept to the learner. What does a book do? – the same. A website? – the same. A podcast? – the same. A blog? No, a blog delivers a different one, the learner's presentation of their ideas, the same as a personal journal. An educational game? – those that David Buckingham describes do nothing more than a goal–action–answer cycle, not even offering feedback on what the action achieved. What does a workshop deliver? – the whole process mapped by the framework. Very few digital technology environments can match that. So by using the framework it is easier to see each exciting new technology for what it really is – what its essential properties are with respect to aiding the learning process.

What makes the digital technologies interesting is the access and distribution capability they offer. The blog turns the personal journal into a broadcast production. That has its own kind of motivational and logistical value, and we cannot discount that, but in terms of supporting the development of conceptual understanding, or a high-level skill, it does not, in itself, offer

anything more than a piece of paper. The technology becomes much more interesting when it is used to give the learner a tool for understanding, not just a fancier form of book.

We can see a similar role for technology in the area of learning difficulties. As an example, we could be making better use of the technology to counter learning disabilities such as dyscalculia, where findings from neuroscience tell us that for some learners the perception of number that comes naturally to most of us is as uncertain as the perception of letters is for dyslexic learners (Butterworth, 2005). The normal number tasks in the early years of schooling remain a mystery, and numerals have little meaning as a consequence. This can manifest itself in various ways – in counting in 10s across boundaries, for example, they often switch to a different order of magnitude, as in . . . 70, 80, 90, 100, 200, 300 . . . Special needs teachers use counters and bead strings to help learners see these relationships. A digital environment can create a different kind of experience, where a learner is asked to navigate their way along the number line, zooming in and out from digits to 10s to 100s, and moving left and right, to locate a particular number. Or they could set a number for the program to find, using the same controls. Or they could set a number for another learner to find, and suggest what string of commands to try if they can't find it. This would be a form of collaborative learning, where learners experience the behaviour of numbers in relation to their own commands, giving them an experience of the mapping between different forms of representation that is not possible in the real world. Again, this delivers all the elements of the conversational framework except the teacher's presentation of their concept.

For learners with learning difficulties such as dyslexia and dyscalculia, these kinds of learning environments could be very powerful, providing repeated private practice on tasks with multimodal presentation and feedback. With digital manipulatives, for example, the learner counting the physical beads, or placing physical letters could see and hear the same actions being mirrored by the computer. As with navigating the number line, the digital environment can provide a rich, personalised and rewarding learning experience that would be impossible any other way.

Technology must be exploited to tackle these learning difficulties. We desperately need that policy of inclusion, but the scale of the problem makes it hugely ambitious. As Professor John Bynner has shown, poor numeracy is a serious disability, since failure persists into adulthood and affects both educational and employment prospects: 26% of 30-year-olds in 2000 were below Entry Level 2 – Knowledge of whole numbers and common fractions (Bynner and Parsons, 2005). How else could we possibly tackle such an ambition of inclusion without building on the findings of neuroscience in this area (Goswami, 2004), and exploiting the quality of learning experience, on the large scale, that digital technologies offer?

So if technology is to achieve its potential to deliver all the aspects of the learning process, and take us further towards achieving those ambitious policy aims, we need much greater engagement in the process.

A policy-driven strategy for technology

So we need a strategy, and it has to be cross-phase, for three reasons. First, every learner these policies refer to is an individual, whose learning journey takes them across the boundaries between school, college, work and university. They need the technologies they are using at one stage of their life to work seamlessly with the rest. Secondly, all the issues I've been discussing, whether policy ambitions or theories of learning, are common to all sectors. There are differences in funding structures, and organisational structures, but at the level of the quality and effectiveness of the teaching-learning process, and the kind of support an individual learner needs, the principles and issues are sufficiently similar. Thirdly, we know we have a problem of affordability. One of the challenges to the technology is productivity. Digital technologies are well adapted to achieving economies of scale, so we should aim to take advantage of that by migrating the lessons learned, the success stories, and the technologies themselves across as many institutions as possible.

How should such a strategy tackle the problem? There have been many education policy initiatives over the last ten years, but they are not working as well as we need them to. My colleague, Professor Frank Coffield, in his recent

extremely illuminating inaugural lecture, set out a carefully documented account of how and why all the detailed work on policy for the skills sector was not yet delivering on all fronts. I want to follow up on two of the problems he identified – a cultural problem and a conceptual problem:

1. It is a culture that sees the ideal practitioner as a technician who is regularly upgraded in order to implement without question the latest government initiative – ‘We will ensure that the workforce can implement what they are asked to do’ (DfES, 2005a: 25). The teaching profession is being re-formed, as Geoff Whitty argued, with teachers being restricted to ‘craft skills rather than professional understanding’ (Whitty, 1997).

2. ‘In all the pelting torrent of official documents which have flooded the sector since 1997, there is, however, one significant silence: there is no discussion of, and not even a definition of, the central concept of learning’ (Coffield, 2007).

I have already tried to characterise the central concept of learning, and I now want to address the idea of the teacher as professional, and endorse Coffield’s solution, that we need ‘a learning system’, but add to it. His central idea, ‘towards a learning system’ works as well for the whole education system as for the skills sector he is focusing on. In fact, as he points out, this was Charles Clarke’s vision for his five-year strategy:

And all of this depends . . . on a radically reshaped system . . . and in particular a reshaped role for Local Government and for my Department, moving away from direction towards an enabling and empowering role. It depends on freedom for those at the front line to personalise services and to improve them.

(DfES, 2005a)

The same point was echoed in another professorial lecture, by both the professors, Kathryn Riley and Louise Stoll, as well as their respondents John Bangs of the NUT, and Professor Tim Brighouse:

Really changing practice is extremely difficult. . . . insufficient time is made available [for] observing peers, engaging in action research,

trying out and practising new strategies, reflecting seriously on how they work with different pupils, learning from these reflections, and adapting and refining them as necessary.

(Riley and Stoll, 2005)

Professor Coffield offers five elements of change, none of which mention any role for technology. I will comment on two: 'a government that shows itself capable of learning', and 'an explicit model of learning and of change' (Coffield, 2007), and try to show how a technological perspective would contribute to both.

The role of the teaching profession

In an earlier section I set out a way of looking at the education system from the point of view of the learner. Now I want to look at it from the perspective of the teacher, or to use terminology that I hope is inclusive of sectors and phases of the system, the teaching professional.

Why have education systems not adapted so far? One of the reasons I cited was that education operates as a command and control system, not as an adaptive, learning system – the point that Professor Coffield focused on. The solution is in the culture – make it an adaptive system, as part of the broader notion of the 'adaptive state'.

We need systems capable of continuously reconfiguring themselves to create new sources of public value. This means interactively linking the different layers and functions of governance, not searching for a static blueprint that predefines their relative weight.

(Bentley and Wilsdon, 2003)

In this study, for leadership for inclusion to be effective, it was critical for the senior leadership to . . . create an adaptive organization through various forms of leadership that was . . . capable of using its structures, cultures and systems to think beyond its structures, cultures and systems.

(Leo and Barton, 2006)

The main drivers for the teaching professional are curriculum, quality assurance, resources available, and the requirements of the assessment process. Teachers who take a professional pride in the essence of teaching – enabling a learner to reach their learning potential – will also be driven by their insights into learner needs, and the desire to make their subject loved and understood by others. These are powerful forces for the individual teacher, but while educational policy certainly has the needs of the individual learner prominent in its rhetoric, the realisation of this in practical terms is through the means by which policy governs teacher and institutional behaviour – curriculum, quality assurance and inspection, resources (funding), and assessment. Nowhere is the teaching professional in the driving seat.

What I now want to put forward is a proposal that both enables government – and indeed the whole education sector – to learn, and that offers an explicit model of learning and of change.

Teaching professionals as agents of change

Teachers' professional experiences of designing teaching have a lot in common across the three sectors. They may begin, at a personal level, with a desire to make their subject loved and understood – that is what takes them into teaching, in universities, colleges and schools. The realisation of that impulse then takes a circuitous route through the formalities of planning, decision-making, constraint-satisfaction, negotiation, and logistical organisation – attending to all the drivers of curriculum, assessment, resource and inspection – before the process comes back to that fundamental triad at the core of education, the relationship between the teacher, the learner and their subject, which is where the dream began.

This circuitous route may be frustrating, but it is essential. After all, mass education, in all sectors, is a complex enterprise. It is attempting to organise learning experiences for the personal development of millions of individuals, not all of whom are fully complicit in this shared goal, despite making a major contribution of their own time and/or money. It is not rocket science. It is much, much harder than that (which only has to organise the movement from A to B of a bunch of atoms, whose behaviour is fully understood). The

circuitous route is essential because the complex process has to be extremely well organised if it is to achieve its goal. The fact that it manifestly fails – our education systems do not enable every individual to achieve their learning potential, nor even the much lower-level targets we set them – means that education will continue to be subjected to the innovation and change imposed by its major national influencers. The new managerialist approach to education – strategy, micro-management, accountability, inspection, targets, league tables – reflects the anxiety of the public-sector policy-makers to make education work better.

In the e-learning strategy developed within the DfES there was an explicit focus on making teachers themselves the agents of change towards innovation through learning technologies. The strategy had to address all the drivers in the current system by ensuring that each of them embraced technology and did not work against it. The 'ICT across the curriculum' approach had already ensured that at school level there were opportunities for every curriculum topic to make use of technology. It was not a requirement, however. So curriculum did not act as a driver of change – the initiative was a good enabler, not a driver. Similarly, Ofsted had begun to report on ICT use, but it was not a requirement that inspectors develop and promote an understanding of how it should be used. So again, inspection did not act as a driver of change. The e-learning strategy set out, therefore, to embed e-learning across the Department by engaging all its agencies, in all sectors, to find ways of using the technology to achieve its policy ends, not simply make use of it here and there. In particular, the teaching profession was seen as critical to this process, and the then TTA (Teacher Training Agency), LLUK (Lifelong Learning UK) and HEA (Higher Education Academy) were all supportive of the roles they had been asked to take in helping them 'become effective ICT users and innovators' (DfES, 2005b), and 'build a professional workforce which can both collaborate and innovate' (DfES, 2005b). The support for teaching practitioners was the main priority lost in the task that the Department subsequently transferred to Becta. Fortunately, Becta, as an agency in close touch with the way schools operate, is well aware of the

importance of supporting the front-line professionals, so it is possible that this most important part of the strategy will still be maintained.

What would it mean for teaching professionals to be agents of change? Clearly they need to be operating as learners, so why not develop our model of change in terms of the model of learning that I outlined earlier? Figure 3 shows how we can interpret the conversational framework for the teacher as learner. This is now a model of the teacher as learner, learning about the process of teaching and learning. The ‘teacher’s ideas’ in the top left-hand corner now becomes the set of ideas as embodied in the curriculum and assessment policy they have to work to. The ‘practice environment’ is their learners learning in the teaching environment that is put in place by our education policies.

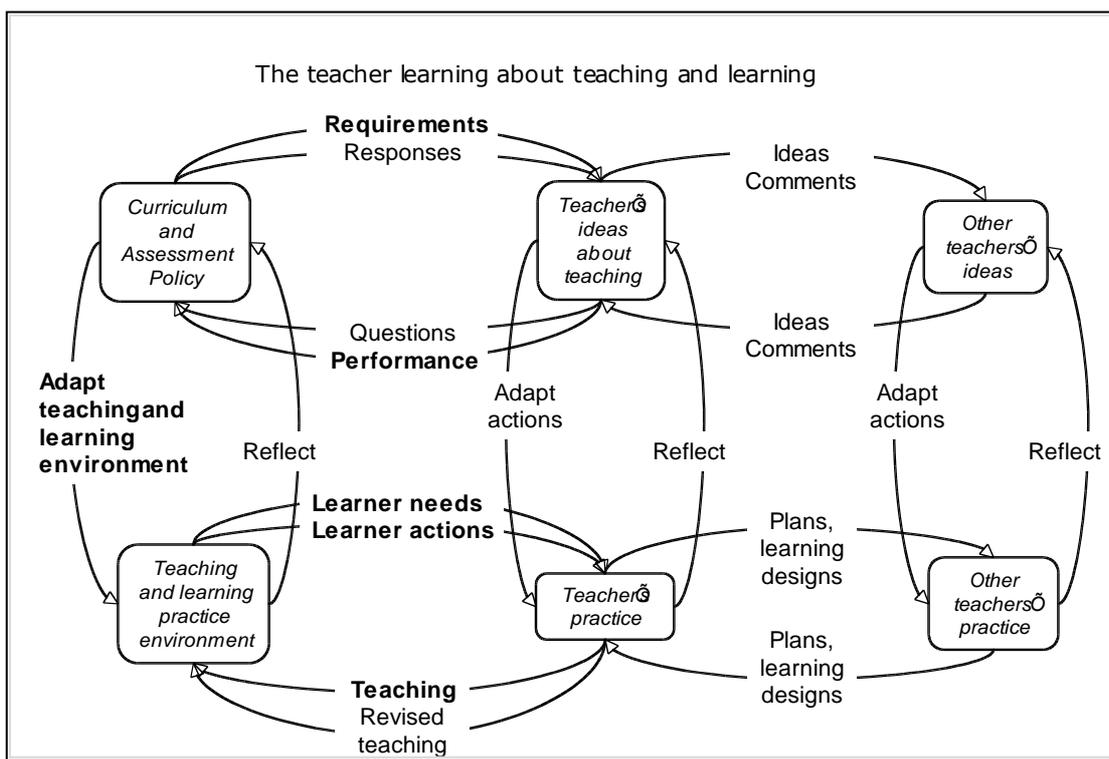


Figure 3: The conversational framework, interpreted for the teacher learning

If the conversational framework can be accepted as an adequate representation of our collective theories of what it takes to learn, then it should be applicable to any form of intentional learning, whether it is by an individual,

a group, an institution or a system. At the least, it is worth testing the extent to which this is viable. I developed it originally as a way of encapsulating the challenge that education brings to what technology has to offer – and demonstrated how it can be used that way. But it also works to challenge the extent to which we have a learning system, in any context we choose (Laurillard, 1999). If Figure 3 is an adequate representation of what it takes for a teacher to learn, then we have a way of testing the extent to which we are currently meeting the requirements set by the framework. Clearly, for most teaching professionals – in schools, FE or HE – this model does not describe their experience of teaching as a learning system. Although all the *nodes* are present, the *connectors* between them are not. From our consultation on the e-learning strategy and from the papers referenced above, I would argue that those in bold in Figure 3 are the only ones currently present in our system.

My model of learning and of change, therefore, is to adopt an iterative, dialogic, collaborative, constructive, and adaptive model of learning such as the conversational framework, and populate our education system with the missing links, that is:

- Give policy-makers more direct access to the practice in teaching–learning environments.
- Create the dialogue between policy-makers and teachers that allows questions and responses, not just requirements and performance records.
- Enable teachers to build their own ideas into their practice, and develop them through reflection on their practice.
- Enable teachers to collaborate, both through exchange of ideas and through sharing their plans and practice.

This is applicable in all education sectors, and would help to make teaching professionals themselves the agents of change.

Teachers as learning technology innovators

This is what it would mean for teachers to be able to innovate. We have to rethink the nature of the profession, seeing teachers as reflective

practitioners, action researchers, collaborative innovators – a learning profession in a learning system.

My final point comes back to the technology. Adopting this approach we could see technology as the means by which teaching professionals could discover how to use technology to achieve the ambitions inherent in our education policies. This means using technology to solve a specific problem, not finding the problem that the technology is a solution for. The specific problem is to support teachers in learning about learning and teaching. There are few research projects that focus on this. One of them was the project by Paul Black and Dylan Wiliam on assessment for learning (Black and Wiliam, 1998), where they showed how teachers were able to share their knowledge within and across schools. The follow-up project 'Learning how to learn' argues that we need to understand better how to foster such practice:

This phenomenon is relatively uncharted territory in educational research. Whilst much is unknown about the institutional conditions that help teachers to learn new classroom practices, there is even less understanding about how knowledge is created and shared across schools.

(James, 2006)

. . . and even less support for doing it.

Teaching is not just an art or a science; it is, or it should be, more like a design science – experimental, innovative, collaborative, iterative, creative (Cobb *et al.*, 2003). The relational character of the learning process – learning something, building on one's previous experiences of the content and its context, relating it to the current context, linking it to some possible future context – makes teaching a highly complex process. The complexity means that teachers have to be experimental, iterative and reflective, acting like scientists or engineers. Teaching is a bit like building a bridge when you only know about your side of the bank; you don't know about the terrain on the opposite bank, or how far away it is, or how deep the river is. If engineers have to be experimental, how much more so must teachers be.

Unlike engineers, teachers have few tools to support their designs for building the conceptual bridges that their learners need. Pedagogy is articulated either directly in the generalised statements in theories of learning, or indirectly as instantiated in the curriculum materials, textbooks, videos and software provided for them. Where teachers generate their own learning designs, there are no means or mechanisms for them to pass on whatever lessons they learn or their effective designs. In terms of the missing links in Figure 3, what they need is the means to develop and test their own teaching ideas, in an iterative design-and-test practice environment, with the means to share and debate their ideas and designs with other teachers. This is where teaching becomes interesting and exciting for the professional, akin to a creative, collaborative research process, and it is often what takes people into the profession, but these are not the mainstream activities of most teachers in any sector. Digital technologies have the means to support such activities. The idea of 'computer-supported collaborative learning' has been a focus of work in e-learning for years, but with the focus only on students doing the collaboration and the learning. Teachers need this too. So, what might such tools be like?

Power tools for teaching professionals

One of the current research projects in LKL is to research what it would mean to give teachers the tools they need to be reflective practitioners (Schön, 1987) working in a community of practice (Wenger, 1999). Developing such a tool has to begin with the teacher's current practice as they design their teaching. We develop a plausible prototype, and then watch how they use it, collect feedback and redesign. The prototype we have developed so far offers an interactive dialogue structured to support their design decisions as they work through aims, objectives, topics, methods, outcomes, assessment, schedule, and resources. Once they have defined the constraints for a particular learning period, such as a classroom session, a supervised project or independent study, they can then go through a structured dialogue to look at possible ways of designing the learning activities, search for existing resources relevant to their topics, and for learning designs relevant to their learning outcomes, and then design, edit, and test the learning activities for

their own learners. The virtue of a digital tool is that it can analyse and offer feedback on the internal relations in their design, search and link directly to online resources, information and guidance, then record their design for sharing with other teachers, and capture teachers' and learners' commentary and usage of the design they create, making it relatively easy to adapt and improve.

We have not progressed very far with this research as yet, and it is likely to take some time. It is akin to creating the kind of computer-aided design environment for teachers that architects began developing several decades ago. Indeed the 'learning patterns' work in educational technology that is exploring the idea of generic learning patterns often draws on the theoretical work on architectural patterns (Goodyear, 2005). It is a process that will necessarily make explicit what teaching professionals do when they design learning, its virtue being that this makes it feasible for teachers to be a collaborative learning community. It brings us a step closer, I think, to the kind of teaching professional that Geoff Whitty was arguing for a few years ago now, in terms of the 'democratic professionalism' that needs to develop as a counter-balance to both the state and the market (Whitty, 2000), recognising the new forms of association that need representation in the governance of education. Bringing that down to the level of the classroom, it would allow learners to be part of the continuing professional development that the teacher is undertaking. Within a digital environment, in which the teacher is able to learn more about their learners (even with the essentially privileged position of the teacher intact, as I believe it must be), the learner has a clearer role as not only recipient of teaching and object of evaluation, but also as evaluator and commentator on the teaching.

Figure 4 illustrates the kind of learning design decision such a tool might support. The output from this stage would show other teachers how they expect their learners to use their time, either across a module lasting several hundred hours, or, using the same approach, across a learning session lasting a matter of minutes. In our recent pilot studies, lecturers have responded enthusiastically to the prototype for such a tool (San Diego *et al.*, 2007).

This is the kind of modelling and experimentation that we really need if we are ever to understand how best to use our resources in education. If we take one of the very challenging questions posed by Professor Rosalind Levačić in her recent lecture: ‘How does changing the mix of resources affect students’ learning outcomes?’ (Levačić, 2005), it cannot be answered properly except at the level of the teaching professional experimenting with different ways of using their own and their learners’ time with different kinds of teaching methods. And if they are all working in a digital environment there is at least some chance of a record of what they are spending their time on, and what level of performance results. When we desperately need an understanding of how to most productively use our precious resources of learner and teacher time, as well as books and software, we should be taking maximum advantage of these new opportunities afforded by the technology.

Once the learning session is defined we then want to support teachers in designing the learning activities themselves. One promising development in this direction is the Learning Activities Management System (LAMS), designed at Macquarie University, and being piloted in several schools, colleges, and universities in the UK, as well as in many other countries (Laurillard, 2008b). Evaluation has shown that academics and teachers

The screenshot shows a software window titled "The London Pedagogy Planner" with a menu bar (File, Help) and a toolbar (Properties, Teaching Methods, Link, Allocate). Below the toolbar are three checkboxes: "Hours" (checked), "Cognitive Activities" (checked), and "Group Sizes" (unchecked). The main area contains a table with the following data:

Teaching Method	Hours	Attention	Inquiry	Discussion	Practice	Production
Lectures	12	10		2		
Tutorials	14	2		12		
Study Guides	50	25	25			
Set Readings	20	20				
Online Asynchronous Conferenci...	50	20		30		
Tutor-marked assignment	50		15		10	25
Total	196	77	40	44	10	25
Target	200					

Two callout boxes provide context: one points to the "Hours" column with the text "Distribute your learners' time across the teaching methods you have selected", and another points to the "Cognitive Activities" columns with the text "These show default values for the learner experience of each teaching method in terms of the cognitive activities they are likely to be engaged in. Edit the values according to the way you run each method."

Figure 4: The ‘teaching methods’ stage of learning design in a pedagogy planning tool, with pop-up explanations of what it offers. It shows how teachers can model the effects on learning of different combinations of conventional and blended learning. By changing either the selection of teaching methods, the distribution of hours across methods, or the way they run a teaching method to elicit different learning activities, teachers can model the likely experience of learning they are creating in terms of the distribution of their learners’ time across the different kinds of cognitive activities being elicited.

welcome the functionality it provides for designing and managing sequences of learning activities for individual tasks and group collaboration (Masterman and Lee, 2005), although it may challenge more conventional teachers, given its essentially collaborative pedagogy.

Figure 5 shows how the drag-and-drop authoring environment for LAMS enables a teacher to build up a sequence of activities, and edit-in their own tasks, digital assets, or existing learning activities, which the system then runs, linking up individuals and groups of students.

The simple and highly flexible interface makes it relatively easy and enjoyable for teachers to design and run their own learning sequences, either in a wholly digital environment, or mixed with class and face-to-face activities. Each sequence developed captures the generic aspects of its pedagogy in its form. If an existing sequence is adopted by a teacher, the form may remain the same, but the specifics – the topics suggested for debate, the resources to be accessed from the sequence, the questions put to students, etc. – are all chosen by the teacher. Having run the sequence with groups of students, the teacher may decide that the sequence needs adjusting – by reordering, or adding further activities, for example – and can easily make those changes in the same drag-and-drop authoring environment, and run it again. This iterative design–test–re-design–re-test process should enable improvement on the pedagogic form, in which case it can be published for the benefit of

others, both in its specific and its generic form. The benefit to the community is that a practice-based design, the pedagogy now captured in the generic form, is available for others to build on and refine.

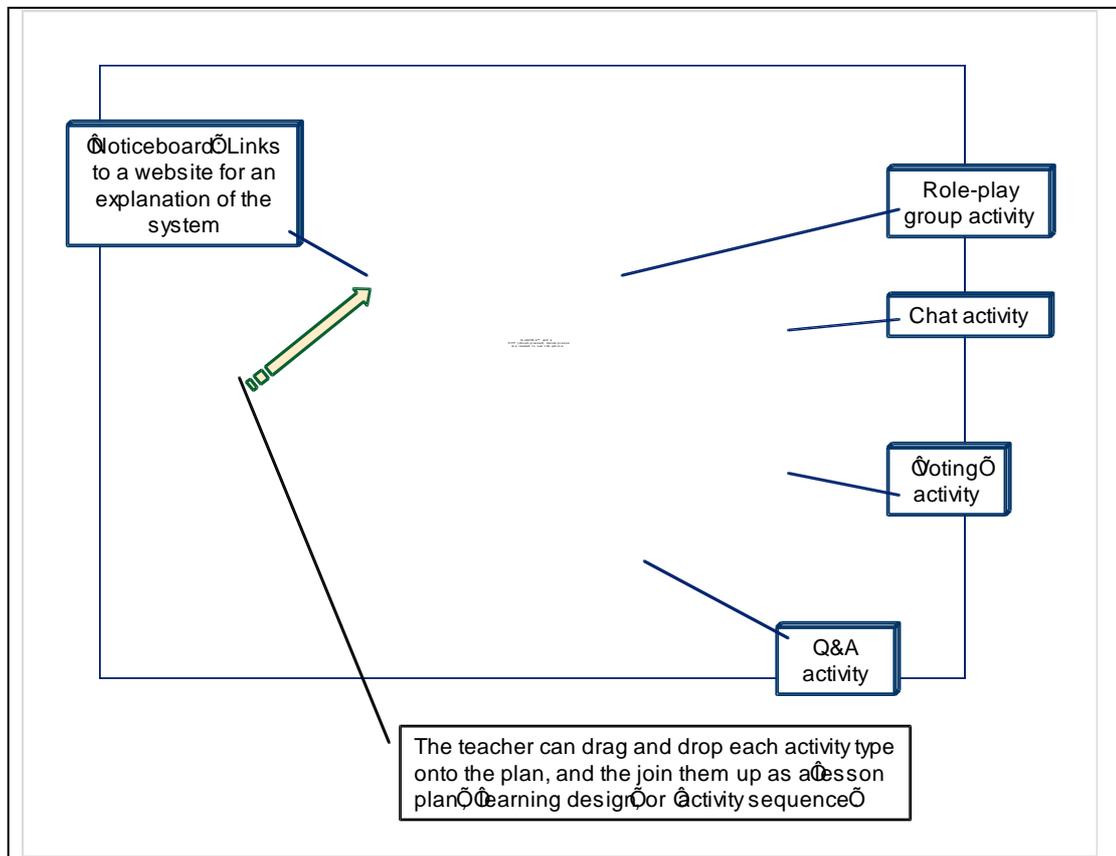


Figure 5: The LAMS environment, showing how teachers can set up a series of individual or online collaborative activities for their learners, capturing their design for testing and revision, or for others to use.

My argument, then, is that using digital technologies to capture and share learning designs turns teaching into the reflective, iterative, adaptive and collaborative design process it needs to be if we are to meet our educational ambitions.

Concluding points: Getting from here to a desirable there

The time-honoured structure for a professorial lecture is to analyse the problem and then come up with a solution in the form of a set of proposals for what we should do now – at least three or four, usually rather general, and

always ambitious. Of course I will succumb to temptation and do the same. But I have already accepted that our educational policy aims are nothing if not ambitious. And, following Professor Coffield, I do not want to press for yet more initiatives. I would rather accept that we already have the policy ambitions and principles of reform we need, but should use them more selectively – and that government should not attempt to micro-manage every last minute of what happens in a classroom. A more important principle of reform would be to trust teachers and lecturers, and give them the time and the tools to be learning professionals. And I have argued that the tools they need are the digital design environments that are capable of turning them into innovative, collaborative, reflective learners.

And we need to see this as a long-term process, not a short-term initiative. We have only really had ten years to deal with a great many new technologies – digital versions of all the educational technologies developed over the centuries. If we were to plot the comparative timelines of conventional educational technologies (e.g. writing, paper, books, libraries) against their digital equivalents (computers, hard disks, laptops, the Web), we would see that we have had only a few decades to work out how to use the digital equivalents of technologies that took many centuries to shape education. Resist those who point to the commercial world as evidence of rapid adaptation: ‘you can see the computer age everywhere except in the productivity statistics’ was an insightful observation by Robert Solow, Nobel Prizewinner for Economics (Madrack, 1998), reflecting on three decades of computers in industry. The vast investment in change that has been typical of every other professional and commercial enterprise has not been matched in education, despite the UK’s leading reputation for ICT in education, and the fact that it has better figures than most countries in terms of the technological infrastructure for education (Becta, 2006). And note that education has not had the spectacular and costly IT failures of the other big public sector departments, largely because it has been funded through our unique central agencies, JISC and Becta, via devolution to local management, cautiously developing its use of technology in relation to need.

So we are in good shape, relatively speaking. We have the technology. We have the ambition. We have the world-class agencies such as JISC and Becta, and institutions such as the IOE and the OU.

Now we need to give teachers the time, the tools, and the trust to develop their use of digital technologies according to the needs of their learners, within the framework of our highly ambitious education policy aims.

In summary:

- Give pedagogy back to the teachers.
- Embrace technology as part of the solution.
- Begin with the ambition and use the technology to achieve it.

And our part in the London Knowledge Lab is to collaborate with the researchers and teaching professionals here in the Institute, and build the tools and resources that enable teachers to be the creative, adaptive, learning professionals they want to be.

Web links

The Making Games project,

http://www.lkl.ac.uk/cms/index.php?option=com_contentandtask=viewandid=162andItemid=91

The OpenLearn project,

<http://www.open.ac.uk/openlearn/get-started/get-started-learner.php>

The Homework project,

http://www.lkl.ac.uk/cms/index.php?option=com_contentandtask=viewandid=149andItemid=91

The Techno-mathematical Literacies in the Workplace project,

<http://www.ioe.ac.uk/tlrp/technomaths/>

The Lifelong Learning London for All project,

<http://www.lkl.ac.uk/research/l4all/>

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