Technology in learning

A response to some questions from the Department of Business Innovation and Skills

October 2010

Table of contents

Foreword by John Cook and Richard Noss

In his 2001 book 'Oversold & Underused: Computers in the Classroom'[1], Larry Cuban drew on a range of sources to conclude that, with few exceptions, teachers have not made any serious changes in the way they teach as a result of the introduction of technologies for learning. As a consequence, he contentiously suggested that the experience of students in typical classes had not been changed in any significant way. He argued that technological innovations that do not take the routines and organisation of schools into account will have little effect on instruction. Cuban put his finger on a debate that has raged now for 20 or so years. Issues surrounding the use of elearning include: evidence for policy and practice, no significant difference, resistance to change, the not-invented-here syndrome, the importance of learning context, and so on. These issues have been a feature of the policy, practice and research debate of recent years. Indeed, because of the complexity of the situations in which e-learning interventions are made, claims for generic benefits can often be contentious at all levels, whether they concern policy or practice. For example, Seymour Papert (1987)[2] identified the limitations on what he called the "technocentric treatment" model when looking for evidence:

> *"Technocentrism is often supported by a certain model of what a "rigorous" experiment in educational psychology consists of. I'll call this "the treatment model." You take two groups of children. One group, the experimental group, is given a certain "treatment." (For example, these students are taught Logo.) The other group, the control group, is not given the treatment. Everything else is kept constant. After a suitable lapse of time you come back and apply a test to see whether the particular thinking skill that interests you is better developed in the experimental group than in the control group. There is nothing wrong in principle with this "treatment" model. Some very good science is based on it. It is the standard model for testing medical treatment by drugs -- hence its name -- and, indeed, some very good support for Logo has come from it ... But the use of the model requires care, and technocentrism places unskilled users at risk. The risk is greatest in the interpretation of negative results. If you need to know whether drug X reduces blood-pressure, you may fairly safely draw a negative conclusion from a "treatment model" experiment in which hospitalized patients were given X and no change in blood-pressure was observed. On the other hand, you would not deduce that drug Y does not increase fertility from the simple fact that hospitalized patients who received it had no babies. You would want to know more about other conditions that are known to be necessary. Nor would you deduce that ice is a bad material for building dwellings if you heard that I tried to build an igloo in Boston in mid-summer and failed. The right environment and, I presume, a high degree of special skill are necessary. Such a failed experiment would say much more about me than about whether "igloos deliver what they promise."*

However, and with Cuban's and Papert's warnings ringing in our ears, this review demonstrates that there is now a significant body of work that shows from various perspectives that the use of new technologies in learning can have a positive impact on learning. The warnings are important: it really is somewhat fruitless to ask what is the impact of technology-in-general. But we are at a crucial turning point at which there is emerging an answer to that question that is more than the sum of its parts, consisting of particular technologies in particular contexts.

The timing of this report could not be better. Education world-wide is currently undergoing a massive transformation as a result of the digital revolution. Collins and Halverson (2009)[3] point out that this transformation is similar to the transition from apprenticeship to universal schooling that occurred in the 19th century as a result of the industrial revolution. In the apprenticeship era, most of what people learned occurred outside of school. Universal schooling led people to identify learning with school; however, today the identification between the two is unraveling. The central challenge is to ascertain whether our current sites of formal learning will be able to adapt and incorporate the new power of technology-driven learning for the next generation of public schooling and education in further, higher and adult contexts. As we will see in this review, evidence of benefits to learners is widely available with respect to specific technologies in specific contexts and knowledge domains.

ALT and the Technology-Enhanced Learning Research Programme are particularly pleased to have been able to contribute to this review which is highly relevant to three aims of both ALT and TEL, namely to:

- facilitate collaboration between practitioners, researchers, and policy makers
- raise the profile of rigorous research in learning technology
- contribute to the development of policy.

John Cook, *Chair of the ALT Research Committee and Trustee of ALT*
Richard Noss, *Director of the Technology Enhanced Learning Research Programme*

October 2010

Introduction: purpose and scope of this response

Following some discussions between ALT and BIS, BIS posed a number of questions to ALT concerning whether, how and in what circumstances eLearning is effective; and the evidence base for the comments. By agreement with BIS, ALT involved the ESRC/EPSRC-funded Technology Enhanced Learning (TEL) programme in commenting on an earlier draft of this document, which is now submitted jointly.

Evidence from the UK and the US is included in this review, particularly meta-analyses and reviews. In the UK, the emphasis in e-learning research has generally been weighted towards evaluation in specific contexts rather than on comparative studies. Because of the complexity of the situations in which e-learning interventions are made, claims for generic benefits can often be contentious at all levels, whether they concern policy or practice.

One measure of possible cost effectiveness is that adopted within the private sector and in training situations. Thus, where cost is a driver for both learner and supplier, the hypothesis of supporting learning with technology is viewed as a "no brainer". Evidence for this will appear in the forthcoming report of the Online Learning Task Force (OLTF, 2010).

When considering any evidence of benefits, a distinction has to be made between *learner performance*, other kinds of *enhancements to the learning experience*, and benefits which are not directly felt by learners e.g. *organisational efficiencies*. They constitute the different ways in which benefits can be measured, and of course they are not all independent of each other.

Evidence of benefits to learners is widely available with respect to specific technologies in specific contexts and knowledge domains: indeed, few innovations have been introduced into the mainstream of learning and teaching without such evidence, though in some cases the relevant research has been carried out or supported by the developers themselves. A problem with many studies is that they are inevitably conducted in situations where novelty, researcher attention, teacher enthusiasm and special funding may all have a role to play in the enhanced performance or experience of learners and so a significant placebo effect can be present for which a correction is rarely made. Furthermore, research typically doesn't address the problem of building an ecology of learning, and doesn't take the integration of the innovation into account as a research issue. Once integrated into the mainstream the enhancements associated with specific technologies can often diminish or disappear[4].

Although new technologies still continue to receive research attention as things-in-themselves, there is a growing trend in English-speaking education systems to assume a technology rich environment for learning, and to investigate the impact of particular pedagogical approaches or learning strategies within that context. As "new" networked and mobile technologies become

ubiquitous aspects of learners' personal experiences, it becomes both less useful and less valid to ask questions about whether or not a given technology is effective in the classroom. Research has consistently demonstrated that learners will use technology to support their learning regardless of the specific requirements of the task and tutor, and that the ways in which they use technology are becoming an aspect of personal learning style[5]. So, while emergent technologies such as immersive worlds continue to be studied in terms of their specific performance and experiential impacts, established technologies such as podcasts are difficult to study in these terms: learners may, or may not, choose to access podcasts to support their learning depending on a range of factors that have nothing to do with their immediate classroom experience.

Perhaps no experiments show the overall benefits of technology more than those associated with the "Hole in the Wall". Mitra has experimented worldwide with schoolchildren to show how to use technology to support self-organising systems with startling overall results, especially among the most disadvantaged children[6].

In the UK, there has been a period when significant government funding has gone into acquiring evidence of eLearning impacts. This has been through the Joint Information Systems Committee (JISC), the Research Councils, The Higher Education Academy (HEA), Becta, the funding bodies and others. For example the JISC, on behalf of the FE and HE funding bodies, has supported an ongoing programme of pilots and development projects, all of which have been evaluated and the results consistently archived[7]. The TEL programme, funded by EPSRC and ESRC, has also contributed substantially[8]. Becta has funded work in the FE sector[9]. The HE Academy EvidenceNet project[10] is collating evidence on behalf of any interested practitioners and scholars. ALT continues to review the evidence from a practitioner point of view.

There is thus a very large body of knowledge which could constitute a UK evidence base.

1. What works, in what context(s), to what extent and – if there is evidence – why and/or how?

1.1 Evidence of general performance enhancements through eLearning

The EduServ-funded Reveel Final Report (January 2008): How compelling is the evidence for the effectiveness of e-Learning in the post-16 sector?[11] summarises an extensive review of research studies, and consultations with expert researchers, thus:

> *'Key factors in e-learning were identified as being learner confidence, prior knowledge (both operational and conceptual), the presence and involvement of the teacher, communication (the dialogues between teachers and learners) and the cultural issues relating to managing change. This range of categories in itself identifies the complexity of the field under review.'*

It concludes that: *'learning in technology-rich environments... occurs in multiple contexts both within and beyond the institution. ... Institutions however need to move away from the use of simple KPI outcome measures and begin to focus on quality improvement.'*

ALT and JISCinfonet's JISC-funded CAMEL Tangible Benefits of e-Learning Project[12] found that where e-learning projects provided figures for student achievement, they were recording improvements of around 10% in pass rates as a result of e-learning implementations. A briefing paper[13] written by ALT, JISCinfoNet, and the Higher Education Academy gives access to a range of further findings arising from funding body activities.

Online learning has some clear advantages over face-to-face instruction when it comes to teaching and learning, according to a key meta-analysis released by the U.S. Department of Education in 2009[14]:

> *The study found that students who took all or part of their instruction online performed better, on average, than those taking the same course through face-to-face instruction. Further, those who took "blended" courses — those that combine elements of online learning and face-to-face instruction — appeared to do best of all. .. The Education Department examined all kinds of instruction, and found that the number of valid analyses of elementary and secondary education was too small to have much confidence in the results. But the positive results appeared consistent (and statistically significant) for all types of higher education, undergraduate and graduate, across a range of disciplines*[15]

This meta-analysis was based on 51 studies undertaken in the period 1996 – 2008 which met strict criteria for inclusion. It attributes most of the positive benefits to learners having more control over their learning process, and (perhaps related) taking more time to complete and reflect on tasks than in face-to-face situations.

1.2 Evidence of benefits from institutional (strategic) approaches to eLearning

The JISC/SFC e-Learning Transformation Projects[16] produced evidence for enhanced achievement and retention through use of technologies on an institution-wide basis. JISC followed this up with Institutional Approaches to Curriculum Design, funding 12 large-scale institutional projects over a four-year period to see whether the advantages are sustained. These projects are suggesting that integrated information systems can create significant cost efficiencies in core business processes such as curriculum design and review, timetabling, marketing of courses, collection of marketing and quality information; and that learners, through performance and retention, benefit from more personalised approaches in the choice of learning and delivery method.

The National Centre for Academic Transformation (US) has, since 2002, carried out an extensive and carefully evaluated a series of studies into the impact of redesigning the post-compulsory curriculum around greater use of technology. The most recent evaluation took place in 2007[17]. This reports that:

ten of the 15 successfully completed projects found improved learning outcomes; all of the 15 successfully completed projects found cost savings; nine of the 15 successfully completed projects found improved retention rates.

The remaining projects in each case either found no change or had not submitted data to the review team.

Becta's 2010 report Understanding the Impact of Technology: Learner and School level factors[18] builds on almost 10 years of 'impact' studies at primary and secondary school level. A schoolbased study, the report is significant in two respects. First, it confirms the shift of emphasis over those ten years, away from researching the impact of specific technologies and towards researching the impact of learners' overall engagement with ICT as an aspect of their learning experience. Second, it reiterates that use of ICT is becoming highly differentiated and personalised, with disparities between learners even in the same class and (apparently) experiencing the "same" in-school ICT environment.

Findings included that:

learners' investment in their own learning is critical to academic success but this is enhanced by schools exhibiting maturity on a range of measures including "e-maturity"; effective learners responded positively to personalised challenges presented by teachers [but in general] personalisation, if only perceived as learner autonomy, was a consistently negative predictor of performance... most pupils thrived when their learning took place in an educational environment that set a clear framework for their learning; more mature schools, providing a more personalised learning experience supported by embedded and used technology, achieved above average learning outcomes; embedding technology was swift when it matched pedagogies (eg interactive whiteboards), but slow if not (e.g. learning platforms).

1.3 Evidence of enhancements to the student experience of learning

Evidence about learners' expectations and experiences of technology in their learning must be read against a background of extraordinary expansion in their general access to information and communication technologies, young people using new forms of communication which appear to include layers of meaning not accessible by 'traditional' language skills alone[19]. In the UK, young people aged 12-15 have an average of six media devices in their bedrooms, and children aged 8-11 have an average of four such devices[20] while the 2009 ECAR survey of undergraduates in the US[21] found 98% computer ownership including 79% owning a laptop that was less than a year old. Use of social networking is approaching 100% among young undergraduates, and expanding rapidly in the older cohorts. Eight out of 10 (80%) in the ECAR survey were '*very confident in their ability to search the Internet effectively and efficiently*' – though as other studies show, we may need to take this confidence with a pinch of salt. Except for the underprivileged few, then, universities no longer enhance the learning experience simply by providing access to networked computers.

However, although '*young people demonstrate an ease and familiarity with computers, they rely on the most basic search tools and do not possess the critical and analytical skills to assess the information that they find on the web*'.[22] Another study found that students were strongly influenced by their experience of learning with technology in school, where *'[there are] only a few embryonic signs of criticality, self-management and meta-cognitive reflection*'.[23] Indeed, there is a growing body of research that is showing up some of the contradictions in the characterisation of young people as 'digital natives'.[24] Whilst new forms of media are clearly significant in shaping their practice, learners' engagement with digital media is complex and differentiated[25], and needs to be interpreted taking account of the results of the OECD studies on reading competence which suggest a problems with literacy performance more generally: except for in a few countries. For example in Finland, around 18% of 15 year old students tend to be unable to read texts[26]. This is in the sense of comprehension: finding information in a paragraph, interpreting the information and reflecting on or evaluating it.

The JISC/HEA Committee of Inquiry into the Changing Learning Experience (report: Higher Education in a web 2.0 world[27]) found somewhat unsurprisingly that:

> *Present-day students are heavily influenced by school methods of delivery so that shifts in educational practice there can be expected to impact on expectations of approaches in higher education.*
>
> *Face to face contact with staff – the personal element in study – matters to students.*
>
> *Imagining technology used for social purposes in a study context presents conceptual difficulties to learners as well as a challenge to their notions of space.*
>
> *They need demonstration, persuasion and room to experiment in this context.*
>
> *Staff capability with ICT is a further potential problem area.*

These findings are also supported by students responding to the 2007 HEPI survey of their undergraduate experiences[28]. They rated smaller teaching groups over an increase in the number of teaching contact hours a week. However, they rated training for lecturers even higher than smaller teaching groups, suggesting that it is the quality of the teacher, including their knowledge and understanding of the use of technology in learning which concerns students more than the character of the teaching occasion.

2. Is the evidence from the perspective of the student, teacher or the institution?

The reports cited above cover all of these perspectives, though not equally.

A review of 83 'learner-centred' studies from the e-learning literature, conducted by Sharpe et al[29], found that only 7 genuinely included evidence gathered from the students' perspective (as opposed to survey data). They concluded that 'there is in general a scarcity of studies of the learner experience' and that 'the overwhelming majority of e-learning research to date has focused on establishing the value of particular e-learning course designs, teaching methods or tutor interventions'. It should be noted however that, since this review, a number of learner-focused studies have been funded (e.g. Report 5, above), and that the UK ELESIG research network (founded by members of the JISC programme with the support of the HE Academy) has nearly 1000 members who are actively researching learners' experiences of e-learning in postcompulsory contexts.

The UK has built up a significant number of researchers who work in close collaboration with practitioners (often they are the same individuals). This means that the research workforce is focused on results with the workers realistic and resilient. This close relationship between research and practice is a considerable strength for the UK.

3. What are the improved learning outcomes (including quality and retention)?

3.1 Evidence of generally enhanced learning outcomes

The JISC-funded ALT, Higher Education Academy and JiscInfonet CAMEL Tangible Benefits of e-Learning Project[30], already cited for recording improvements of around 10% in pass rates, found tangible evidence for benefits for students in the following additional areas (NB these were found in some, but not all, of the 35 studies reviewed):

- Improvements in learning style, insight and/or reflection.
- Enhancement of skills, employability and/or confidence.
- Enhanced satisfaction, motivation, attendance and/or retention.
- Enhanced recruitment through greater accessibility or opening up of new markets.
- Learners also indirectly experienced the following benefits, identified for staff involved in technology-enhanced learning:
- A stimulus to creative teaching and to educational research
- Enhancement of staff satisfaction and retention
- Enhancement of staff skills, employability and/or confidence
- Analyses of eLearning have also, more controversially, found evidence of:
- Time savings to teaching and other frontline staff (however, extra time burdens have also been recorded)

- Specialism and diversification of teaching roles (some benefits and some risks have been reported)
- More effective use of resources/management of assets
- Carbon savings (an interesting emerging agenda)
- Performance in quality reviews.

It is also claimed that the use of technology for learning makes the experience more uniform and therefore easier to subject to QA. However, as the technologies available in the classroom and outside it become more varied, so the use of technology can introduce new kinds of variation as well as inequality among learners in the same cohort[31].

However, there is no doubt that digital technologies allow more aspects of the learning process to be monitored. Recording interactions in virtual environments and capturing learning 'in action' using digital media both provide new opportunities for assessment and reflection on the part of the learner, and for quality assurance and enhancement on the part of the course provider. New ethical considerations also arise as a result of the greater potential for monitoring learners' activities and experiences.

3.2 Enhanced learning outcomes from specific types of technology or intervention

These reports tend to be more context-dependent and the evidence less easily generalised than is the case with the meta-analyses from the previous section.

The JISC/SFC e-Learning Transformation Projects[32] included the REAP project, which found that *'assessment redesign with technology can result in improved learning, higher student satisfaction and more efficient use of staff time, with students actively generating their own feedback and scaffolding the development of their peers'.* TESEP[33] demonstrated that e-learning can enhance active, self-directed learning *'particularly where learners use technology to locate their own material and for collaborative work, formative assessment and discussion with peers.'*

Projects funded under the JISC e-learning and pedagogy programme[34] and ongoing case studies published in the JISC 'effective practice' series of reports have identified a number of ways in which the use of technology can transform learning outcomes.

The JISC innovative practice in e-learning projects[35], distributed e-learning projects[36] and transforming curriculum delivery with technology projects have also demonstrated enhancements to a variety of specific pedagogic approaches through use of technologies.

Some learning outcomes can only be achieved through the use of certain types of technologies such as media capture and editing devices (for the expression of ideas in specific media), media sharing technologies (for reflection, peer-review and showcasing of achievements), e-portfolio (for personal development and CPD). Immersive environments and simulations, and the related use of digital tools, all support specific outcomes that would not be possible in a different learning environment. Disciplinary pedagogies may be served by their own technologies such as digital

instruments, geo-spatial aware technologies, specialised analysis software and instrumentation, research environments, etc[37]. The digitisation of the workplace, professions, scholarship and research, as well as the digitisation of social life, all require different learning outcomes which only experiences with digital technology can authentically support. This is explored further in response to question 5.

In relation to all of these potential uses it is important to note that the technologies provide new opportunities for learning, but also make new demands on teachers and learners. Without digital and learning literacies on both sides, the technology can be powerless to transform lives and opportunities.

Up-to-date summaries of the evidence for specific technology-based interventions are provided in the newly published ALT series 'What research has to say for practice'[38]

3.3 Evidence concerning access and assessment

There is now robust evidence of enhanced outcomes arising in two specific areas of eLearning: access and assessment.

Many learners would have little or no access to learning opportunities without the support of technology. There is evidence of benefits to learners from:

- Assistive technology[39]
- Time/place independent access[40]
- Open educational resources – for example evidence of impact from the MIT OpenCoursewareInitiative[41] and the UK's OpenLearn[42]

Many advances in e-learning technology have been used to offer learners more choice about how they engage with the curriculum. In these cases there are no comparative benefits to be observed within the learning programme, but there are lifewide impacts on learners in terms of improved opportunities to engage in learning. In addition to those with physical access difficulties, learners who have had negative experiences with traditional education may benefit from the opportunity to use their own familiar devices, networks and/or learning spaces to access learning. However, for eLearning opportunities to be fully realised by learners, they require some new as well as many traditional learning skills.

There is now robust evidence that technology can support assessment in several ways that are beneficial to learners and to their teachers and organisations[43].

- Removing much of the burden of managing assessments, freeing up staff to focus on setting effective assessment tasks and giving effective feedback.
- Allowing assessments to be more – and more transparently – uniform and fair.
- Allowing students opportunities to practice assessment tasks before undertaking high stakes assessment, and optionally to choose the timing of their assessment.
- Generating multiple instances of 'the same' task, problem or question to allow multiple

opportunities for practice.
- Allowing assessors to share tasks, problems and questions, learn from each other, and standardise good practice across assessing bodies.

Assessment and feedback are key to learners' experiences of and development in learning. A HEPI report[44] noted that assessment and feedback is the category which respondents to the National Student Survey rate as weakest in UK HE, but computer-based interventions around assessment achieve among the most consistently positive results, suggesting that this is a field which merits further investigation. Computer-assisted assessment is now a research and development field in its own right, with a wide-ranging literature, internationally recognised interoperability standards, and a range of tried-and-tested systems available to institutions. It may be able to offer particularly credible evidence of enhancement because assessment interventions tend by their nature to be intensively monitored and large scale, and to yield quantitative results. They have also often been supported and lent credibility by national bodies.

3.4 A note on retention

Retaining students is the 'holy grail' in post-compulsory education worldwide. An examination of more than 400 studies about factors contributing to student retention and degree completion in the US (2004) concluded that 'face time' with faculty and peers was essential to students feeling included and integrated into the academic environment, and so to their retention and academic success[45]. However, as social networking has become embedded into the lives of young students in particular, there is evidence that the experience of inclusion can be engendered by interactions in an online environment[46].

It is unsurprising to find that uses of technology which reduce staff time spent on other activities, allowing them to spend more time giving personalised feedback and in other forms of close interaction with students, help to enhance retention. For example, the REAP project[47] found that a single teacher was able to organise rich and regular peer feedback dialogue for 560 students on a series of online essay-writing tasks, resulting in significant learning gains compared to previous years. Note, though, that these gains would not have followed if the technology had been used to reduce overall staff time spent on this course, rather than redistributing staff time towards activities which engaged learners most positively. In the REAP Psychology case study there was:

> *'a redistribution of effort with staff spending more time supporting learner-led interaction with course materials with less time being spent on lecturing or traditional assessment activities... Students spent more 'time on task' and the mean exam mark improved from 51.1% in 2005/6 to 57.4% in 2006/7.*

There is also evidence that technology can provide more extended and satisfactory forms of contact between students, their tutors and peers, and other elements of the learning organisation. Consistent communication, and routine access to information such as timetables, learning locations, students

services, lecture schedules, examinations and tests, their results and progress etc all contribute to learners' sense of being supported in their studies, and likelihood of remaining engaged.

The JISC 'Exploring Tangible Benefits of e-Learning' study found:

> *...clear evidence of improved student retention as a result of the improved personalisation and mentoring opportunities afforded by e-learning applications such as e-portfolio systems. We have seen these benefits demonstrated in areas such as Nursing with a high proportion of non-traditional learners where attrition rates are traditionally high. An improvement of only 1% in retention across the sector would, even at the lowest rates of funding, be worth over £132 million per annum to institutions.*

In addition, research shows that students who work in groups develop an increased ability to solve problems and evidence greater understanding of the material.[48] There is emerging evidence that e-learning can be used to support this effective form of collaborative learning.[49]

4. Is there evidence of greater cost-effectiveness for the providers?

Various studies such as the JISC Tangible Benefits report include material on cost-effectiveness but it is not as yet well researched. This is an increasingly important area.

As the costs of technologies fall – and as institutions increasingly make use of learner-owned devices and open source software – the costs of adoption are largely accounted for in terms of staff and learner time. Cost models for staff time are complex; for example, most courses still use a contact model to calculate staff costs, despite the evidence that virtual 'contact' can be equally if not more beneficial to learners. Few institutions yet consider student time in their costing models, though as learners pay more towards the costs of their learning and are increasingly more likely to work for money alongside their studies, there may be pressure to demonstrate that specific forms of learning are more time/cost efficient as well as more effective.

Recent work on the development and release of Open Educational Resources[50] (OERs) is typical. Evaluation has shown that early adopters of OERs do not expect to experience any cost benefits. The staff development associated with new practices is a significant investment, and many technology-supported tasks take longer initially. Institutional practices have to be reviewed and sometimes realigned; there are risks associated with moving early with a new development. However, institutions are still investing in OERs because they expect long-term savings through shared/rationalised content development, they see market-share advantages in being ahead of their competitors, and they know that the lost opportunity costs of not engaging with the OER agenda will become significant over time.

As with any educational intervention, it is extremely difficult to quantify the benefits of

technologybased approaches – what is the cost equivalent of enhanced retention, recruitment, learner achievement, ICT capabilities and so on? The preferred solution has been to assess any such improvements independently from cost/efficiency concerns.

Yet one area has produced credible cost efficiency evidence. With carbon-related costs increasing rapidly, the case for distance learning and for more students learning from home or work can only grow. The UK has a CRC policy from which education is not exempt and there are also international targets to be met. ELearning has a major role to play in saving both travel costs and the costs associated with building and maintaining campuses. There is a good recent worked example and further references in Epic plc's "Carbon Reduction and eLearning"[51].

5. Of equal benefit would be to provide evidence of what doesn't work, in what circumstances and why

There have been many failures. These tend to be underreported in the literature as future funding prospects for those concerned may be damaged. This is no different to other facets of research, though anecdotally the UK is reported to be more averse to admission of failure than some competitor countries.

There are some exceptions: the HEPI report "spent force or revolution in progress: eLearning after the eUniversity"[52] covers what went wrong with one of HEFCE's more expensive experiments.

The rigorous approach to evaluation and archiving that has more recently been followed by funding bodies means that there are a number of archives with significant evidence of why some projects fail to reach their objectives or, having reached them, fail to make a significant impact on mainstream practice. However they are archives and they may not be accessed that often: nevertheless the evidence is there waiting to be mined.

One common significant problem identified was that of development projects that were out of step with the priorities of the host institution. A second common problem is where technical teams are more interested in their own development agenda than in building on the work of others. Yet another is to over concentrate on the technology. A fourth common area is where the researchers have failed to produce something that is scalable: administration or other costs cannot be afforded once the researchers and their funding withdraw. Apart from the staff development issues below, these four factors account for a significant proportion of failures.

Finally, there is very extensive evidence that introducing technologies into classrooms and curricula without appropriate staff development is a fruitless exercise. In higher education particularly, there is an argument for aligning staff development and recruitment more closely with a scholarship agenda wherein staff explore how digital technologies are changing practices in their area, and then consider how best to communicate those changes in a teaching context.

Intensive curriculum development work in multi-role teams has been shown to raise capacity, as has the introduction of digital literacies into the learning and teaching programmes for new staff. General skills development, for example in the use of specific technologies or devices, has a role to play but is not sufficient to engage frontline staff in changing the paradigm of learning and teaching provision. There are still too many teachers at all levels who "opt out" of keeping up to date or even familiar with developments.

It is important that any model for investigating 'failed' projects should be appropriately multidimensional and should have broad community support. ALT would be interested in undertaking such a task and would welcome support so to do.

6. It would also help if you can identify any major gaps in our knowledge of these issues, where there is no properly grounded empirical evidence, since this might help direct future research

6.1 Emerging technologies

Futures analysts differ as to which emerging technologies are most likely to have an impact on learning and which therefore deserve ongoing investigation and piloting[53]. There is a good deal of interest in:

- data mining
- the semantic web[54]
- video/audio capture with semi-automatic transcription, analysis and annotation
- immersive multi-sensory environments and haptic technologies[55]

6.2 Emerging research issues

There are a number of areas in which evidence of benefits is emerging and requires further work.

Learning spaces need to evolve to support near-ubiquitous access to technologies and networks, and to accommodate learner-owned technologies. Computer labs are giving way to communal spaces with wireless access and plug points, and to classrooms where technology blends seamlessly into the furniture[56]. Like many public spaces, these spaces are increasingly 'hybrid': virtual learning environments can be blended into the real via mobile or wireless coverage,while real-world locations are increasingly virtualised with e.g. GPS data and support for location-aware devices. How HE and FE institutions are responding, and with what impact on learners, has been researched by the JISC[57] and the Scottish Higher Education Funding Council[58].

There is limited evidence that technology is changing learners' preferred locations to study. Evidence can be obtained from a number of distance university reports, especially from Australia (which is well provided with distance and which also has some of the more successful distance learning programmes delivered outside the host nation). Evidence covers range of students, crosscultural

connections, and professional needs. There will be studies which address the impact of enhanced learning spaces in subjects allied to medicine and from the MoD, areas in which training is of extremely high value, and in which professional practice involves extensive use of digital tools.

Related to learning spaces is the space-independent or mobile learning agenda. Benefits are being found for off-campus and work-based students, excluded and at-risk students, and for students based permanently or temporarily in areas where land-based internet connections are unreliable (At the school level, the Personal Inquiry project[59], based at the Open University and the University of Nottingham, has begun to show clear evidence of effectiveness in the domain of science learning). *Mobile Learning: Structures, Agency, Practices*[60] sets a research agenda for the future with its focus is on mobile/cell phones not as "the next new thing" but meaningfully integrated into education, without objectifying the devices or technology itself. There is no doubt that this would require a transformation in educational cultural and pedagogies[61]

There is emerging evidence that a strategic approach to the use of technology for learning can benefit organisations, for example by offering the cost effective benefits of scale, standardising good practice across the organisation, streamlining learner-facing processes such as registration, module selection, timetabling, access to services and by offering learners better access to information about their options, their courses, and their progress.

While there has been considerable investigation into the skills and capabilities that graduates need to thrive in a digital economy and society, it is important to keep these up-to-date and learn from them rather than restrict our view to a specific snapshot (See Skills UK: IT and Telecoms insights 2010[62] National Strategic Skills Audit 2010[63]).This needs to be followed up with

- more work on how the learning outcomes of higher education need to adapt to meet the requirements of the digital age; and
- investigating the mechanisms of adaptation, e.g. the curriculum, links with professional bodies etc. and address what learning experiences in FE and HE will support the development of those skills and capabilities.

The evidence that can answer these questions will be complex, the data longitudinal, and challenging to interpret, but it is more likely to produce answers that can support the UK economy and education systems than questions about the effectiveness of specific technologies or interventions.

Several recent reports (e.g. LLiDA[64], LEX/Curriculum Delivery[65]) have recommended further investigation into how and when learners most benefit from support in the development of their digital literacies.

The EU as well as other English-speaking countries recognise that functional access to digital technologies is essential to citizenship and social participation. This gives rise to an entitlement agenda which runs across the education sectors, especially the non compulsory ones, as more people engage who have missed out on a 'digitally informed' school education.

However, there is also an enhancement agenda. This concerns how individuals become qualified in specific kinds of expertise – professional or scholarly, as well as vocational[66]. It is difficult to imagine any form of graduate-level expertise that is not being transformed by the use of digital technologies and networks. Therefore the professional bodies have a significant role to play, supported by education. They need to update their practices and professional update schemes. Students are no longer acquiring a stable expertise which will see them through their working life but instead the capacity to adapt rapidly and resiliently to change, in practice as well as knowledge. This needs to be encouraged in education and by government.

7. Any other observations that you'd like to make taking account of the overall thrust of this exercise.

It is important to emphasise that it is not possible in this area to separate theory from evidence: such an undertaking leads to reductive thinking.

There should be a focus on learning technologies as enabling/enhancing/transforming the way we learn, and on the ways in which they can work with the grain of the kinds of general teaching or learning intervention that are already known to be effective[67]. We did not include words such as "Transformation" and "Innovation" in the list at 3.1, but believe that these can be important outcomes of value to learner and to teacher, at an individual or local level as well as more widely.

We believe that staff development is key and hence that the solution to many problems of uptake is to routinely up-skill trainee teachers and have good CPD for those in post as well as a good recruitment strategy. The benefits for the UK will be substantial as can already be seen from FE and HE.

We believe that all the evidence points to success being process led rather than content or technology led. This would imply a greater use of content and software product that are widely available, preferably free of charge to the sector. It points towards open solutions and community standards as far as possible. The innovation and hence the potential success comes from the individual or group of teachers, not from a particular learning platform, simulator, or piece of assessment. But to innovate it is necessary to have the requisite pedagogic and technological understanding.

Thus the pain of inevitable cuts in HE and FE budgets would be slightly soothed if the government were to encourage institutions of HE and FE to adopt a friendlier stance towards the open source and open content movements. This will then be reinforced by basic economics to reach a desirable "Nash equilibrium".

We have avoided citing ALT's own major research journal "Research in Learning Technology"[68]. It is nevertheless full of UK and international evidence of the sort required and should be an early call for those looking for evidence based research in the area.

Finally and most importantly, it is vital that all the work supported by funders does not just disappear as a corollary of some of them ceasing to exist in the abolition or rationalisation of quangos. We believe that, in line with government thinking, there is a strong role for charities, learned societies and membership organisations in undertaking some of the evaluative, evidence sifting and dissemination work and experiment that has previously been fully funded by central government through agencies. The role as a publisher is covered in the previous paragraph. In addition, we think that ALT and others can also perform much more cost effectively a body of work previously undertaken by agencies as our members give freely of their own time to activities that they wish to do.

However, reduced cost is not the same as zero cost. It will be all too easy for government to stop funding research and evaluation in eLearning thereby losing a lot of the (not inconsiderable) investment of recent years and with it a UK leading role in the world. Precipitate cliffs of funding can have very bad effects.

We are grateful for the opportunity to respond to these questions: it has been a good experience to put the response together. There is a lot to be done.

End notes

Produced for BIS by members of the ALT Research Committee and ALT staff including John Cook, John Slater, Seb Schmoller, Alexandre Borovik, Norbert Pachler, Liz Masterman, Mike Sharples, Mike Keppell (Australia), and Laura Czerniewicz (South Africa), and with substantial additional input from the TEL community including Richard Noss, Helen Beetham, and James O'Toole, May to October 2010.

Association for Learning Technology (ALT) – http://www.alt.ac.uk/

Technology Enhanced Learning (TEL) – http://www.tlrp.org/tel/

Seb Schmoller – seb.schmoller@alt.ac.uk; 0114 2586899

Richard Noss – r.noss@ioe.ac.uk; 020 7763 2137

A PDF of this document can be found in the ALT Open Access Repository at http://repository.alt.ac.uk/839

[1] Cuban, L. (2001) Oversold and underused. Harvard University Press.

[2] Papert, S. (1987). Educational Researcher, 16(I), January/February 1987. Available at http://www.papert.org/articles/ComputerCriticismVsTechnocentric.html, accessed October 2010. Another version appeared as M.I.T. Media Lab Epistemology and Learning Memo No. 1. (November 1990).

[3] Collins, A. & Halverson, R. (2009). Rethinking Education in the Age of Technology: The Digital Revolution and Schooling in America. New York: Teachers College Press.

[4] Russell, T. (2001) No Significant Difference. WCET, last accessed 31st August 2010. http://www.nosignificantdifference.org/

However, a useful informal review of the evidence was produced by Oblinger and Hawkins for Educause in 2006. Under the heading 'The myth about no significant difference', this concludes – as we are arguing here – that whether or not there is a statistically significant difference in student performance 'depends how the question is asked': http://net.educause.edu/ir/library/pdf/erm0667.pdf

Oblinger, D.G., and Hawkins, B.L. (2006) The Myth about No Significant Difference. Educause Review, last accessed 31st August 2010 http://net.educause.edu/ir/library/pdf/erm0667.pdf

[5] Thriving in the 21st century: Learning literacies for the digital age, by Helen Beetham, Lou Mcgill & Allison Littlejohn (JISC 2009) http://www.jisc.ac.uk/publications/reports/2009/elearninglidareport.aspx#downloads, last accessed 26 September 2010

[6] Mitra, S.,(2006) The Hole in the Wall: Self-Organising Systems in Education. New Delhi and New York. Tata-McGraw Hill Publications Ltd.

[7] JISC (2010). e-Learning Innovation Programme, last accessed 31st August 2010, http://www.jisc.ac.uk/whatwedo/programmes/elearning.aspx

[8] ESRC/EPSRC TLRP-Technology Enhanced Learning Programme (2009), last accessed 31st August 2010 http://www.tlrp.org/tel/

[9] Becta (2010) Reports and publications, last accessed 31st August 2010, http://research.becta.org.uk/index.php?section=rh&catcode=_re_rp_02

[10] HEA (2010) EvidenceNet, last accessed 31st August 2010, http://www.heacademy.ac.uk/evidencenet

[11] REVEEL project, University of Sussex, (2009) last accessed 31st August 2010, http://www.reveel.sussex.ac.uk/reports.php

[12] JISC (2008) CAMEL Tangible Benefits of e-Learning, kast accessed 27th September 2010 http://www.jisc.ac.uk/whatwedo/programmes/elearningcapital/camelbelt

[13] JISC (2008) Tangible Benefits of e-Learning: Does investment yield interest? Last accessed 31st August 2010, http://www.jisc.ac.uk/media/documents/publications/bptangiblebenefitsv1.pdf

[14] Means, B., Toyama, Y., Murphy, R., Bakia, M. And Jones, K. (2009) Evaluation of Evidence-Based Practices in Online Learning (US Depatment of Education. Last accessed 7th Sept 2010, http://www.2.ed.gov/rschstat/eval/tech/evidence-based-practices/finalreport.pdf

[15] Inside Higher Ed, (2009), The Evidence on Online Education, last accessed 31st August 2010, http://www.insidehighered.com/news/2009/06/29/online

[16] Glenaffric Ltd (2008) Formative evaluation of the e-Learning Transformation Programme: Final Report, last accessed 31st Aug 2010, http://www.sfc.ac.uk/information/information_learning/presentations_publications/elearning_elt_formative_evaluation_report.pdf

[17] Twigg, C., (2006) The Roadmap to Redesign (R2R), The National Center for Academic Transformation, last accessed 31st August 2010, http://www.thencat.org/R2R/R2R_Project_Outcomes.htm

[18] Becta (2010) Understanding the Impact of Technology: Learner and School level factors http://research.becta.org.uk/index.php?section=rh&catcode=_re_rp_02&rid=17726, last accessed 26 September2010

[19] Kress, G. (2003). Literacy in a New Media Age. London: Routledge.

[20] Ofcom (2008) Media Literacy Audit – Report on UK children's media literacy. Last accessed 21st May 2010, http://www.ofcom.org.uk/advice/media_literacy/medlitpub/medlitpubrss/ml_childrens08/

[21] Smith, S.D., Salaway, G., and Borreson Caruso, J. (2009) The ECAR Study of Undergraduate Students and Information Technology, 2009. Educause. Acessed 31st August 2010, http://www.educause.edu/Resources/TheECARStudyofUndergraduateStu/187226

[22] JISC and British Library (2008) 'Google Generation' is a myth says new research, last accessed 21st May 2010, http://www.jisc.ac.uk/news/stories/2008/01/googlegen.aspx

[23] Becta (2008). Web 2.0 technologies for learning at KS3 and KS4: Learners' use of Web 2.0 technologies in and out of school. June), last accessed 21st May 2010, http://partners.becta.org.uk/index.php?section=rh&&catcode=_re_rp_02&rid=15879

[24] Coultas, J., Luckin R. and du Boulay, B. (2004), 'How compelling is the evidence for the effectiveness of e-Learning in the post-16 sector?', A research review funded by an Eduserv Research Fellowship, last accessed 27th September 2010, http://www.reveel.sussex.ac.uk/

[25] Bennett, S., Maton, K. and Kervin, L. (2008) The 'digital natives' debate: A critical review of the evidence). British Journal of Educational Technology , last accessed 27th September 2010, http://onlinelibrary.wiley.com/doi/10.1111/j.1467-8535.2007.00793.x/abstract

[26] OECD (2004) Messages from PISA 2000. Last accessed 21st May 2010, http://www.oecd.org/dataoecd/31/19/34107978.pdf

[27] Hughes, A. (2009) Higher Education a Web 2.0 World, JISC, last accessed 31st August 2010, http://www.jisc.ac.uk/publications/generalpublications/2009/heweb2.aspx

[28] Sastry, T. and Bekhradnia, B. (2007), 'The Academic Experience of Students in English Universities', Higher Education Policy Institute report, last accessed 21st May 2010, http://www.hepi.ac.uk/466-1309/The-Academic-Experience-of-Students-in-English-Universities-2007-report.html

[29] JISC (2007). Learner experiences of e-Learning phase, last accessed 31st August 2010, http://www.jisc.ac.uk/elp_learneroutcomes

[30] JISC (2005) Regional pilots, last accessed 31st August 2010, http://www.jisc.ac.uk/whatwedo/programmes/edistributed/pilotsdetail

[31] See e.g. Hargittai, E. (2010). Digital Na(t)ives? Variation in Internet Skills and Uses among Members of the "Net Generation". Sociological Inquiry. 80(1):92-113

[32] Glenaffric Ltd (2008) Formative evaluation of the e-Learning Transformation Programme: Final Report, last accessed 31st Aug 2010, http://www.sfc.ac.uk/information/information_learning/presentations_publications/elearning_elt_formative_evaluation_report.pdf

[33] JISC (2007) Transforming and Enhancing the Student Experience Through Pedagogy Project (2010). last accessed 27th September 2010, http://www.jisc.ac.uk/whatwedo/programmes/elearningsfc/tsep.aspx

[34] Based on JISC (2009). Effective Practice in a Digital Age, last accessed 31st August 2010, http://www.jisc.ac.uk/whatwedo/programmes/elearning_pedagogy/elp_practice.aspx

[35] See JISC (2010). Innovative e-Learning practice case studies, last accessed 31st August 2010, http://www.jisc.ac.uk/whatwedo/programmes/elearning_pedagogy/elp_innov_casestudies.aspx

[36] See JISC (2005). epistle – e-Portfolios student learning, last accessed 31st August 2010, http://www.jisc.ac.uk/whatwedo/programmes/programme_edistributed/etools2.aspx

[37] JISC (2003). e-Learning Innovation Programme, last accessed 31st August 2010, http://www.jisc.ac.uk/whatwedo/programmes/elearning_innovation.aspx

[38] ALT Research Committee (2010) What research has to say to practice, last accessed 31st August 2010, http://wiki.alt.ac.uk/index.php/What_research_has_to_say_for_practice

[39] Seale, J., Draffan, E.A., Wald, M. (2008) Exploring disabled learners' experiences of e-Learning. LEXDIS project report. Last accessed 31st August 2010, http://www.jisc.ac.uk/media/documents/programmes/elearningcapital/lexdis_projectreport_dec08final.pdf

[40] Oblinger, D.G., (2004) The Imperative of Anytime, Anywhere Learning, last accessed 2nd October 2010, http://www.mcli.dist.maricopa.edu/ocotillo/retreat04/docs/anywhere_essay.pdf

[41] MIT OpenCourseWare (2006) 2005 Program Evaluation Findings Report, last accessed 31st August 2010, http://ocw.mit.edu/ans7870/global/05_Prog_Eval_Report_Final.pdf

[42] Thille, C. and Greeno, J. (2010) The OER effectiveness cycle, last accessed 31st August 2010 http://olnet.org/node/135

[43] Nicol, D. (2008), 'Transforming Assessment and Feedback: Enhancing Integration and Empowerment in the First Year Success: Integration and Empowerment'. Published by Quality Assurance Agency, Scotland. http://www.enhancementthemes.ac.uk/documents/AETC2008/DavidNicol%20_%20Booklet.pdf

[44] Sastry, T. and Bekhradnia, B. (2007), 'The Academic Experience of Students in English Universities', Higher Education Policy Institute report, last accessed 21st May 2010, http://www.hepi.ac.uk/466-1309/The-Academic-Experience-of-Students-in-English-Universities-2007-report.html

[45] Lotkowski, V.A., Robbins, S.R., and Noeth, R.J., The Role of Academic and Non-Academic Factors on Improving College Retention (ACT, 2004).

[46] O'Donoghue, J. & Warman, L. (2009). Can social networking support student retention?. In G. Siemens & C. Fulford (Eds.), Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2009 (pp. 3011-3015). Chesapeake, VA: AACE.

[47] Re-Engineering Assessment Practices in Higher Education (REAP) (2010), last accessed 27th September 2010, http://www.reap.ac.uk/

[48] Stanford (1999), 'Cooperative Learning: Students Working in Small Groups'. Stanford University Newsletter Speaking of Teaching, Winter 1999 produced quarterly by the Center for Teaching and Learning. Last accessed 21st May 2010, http://ctl.stanford.edu/Newsletter/cooperative.pdf

[49] Coultas, J., Luckin R. and du Boulay, B. (2004), 'How compelling is the evidence for the effectiveness of e-Learning in the post-16 sector?', A research review funded by an Eduserv Research Fellowship, last accessed 27th September 2010, http://www.reveel.sussex.ac.uk/

[50] OER, JISC Synthesis and Evaluation Project (2010) Business Cases and Benefits Realisation. Last accessed 31st August 2010, http://www.caledonianacademy.net/spaces/oer/index.php?n=Main.BusinessCasesAndBenefitsRealisation

[51] Axon, S. (2010) Carbon Reduction and E-Learning (an Epic White Paper), last accessed 31st August 2010 http://www.epic.co.uk/content/news/november2009/wp_carbon_reduction_elearning_2010.pdf

[52] Slater, J (2005) Spent force or revolution in progress? eLearning after the eUniversity. Higher Educationa Policy Institute. Last accessed 27th September 2010, http://www.hepi.ac.uk/466-1163/Spent-force-or-revolution-in-progress-eLearning-after-the-eUniversity.html

[53] New Media Consortium & Educause Learning Initiative (2010) The Horizon Report 2010 Edition, last accessed 27th September 2010, http://www.nmc.org/pdf/2010-Horizon-Report.pdf

[54] ESRC/EPSRC TLRP-Technology Enhanced Learning Ensemble project (2009), last accessed 31st August 2010, http://www.tlrp.org/tel/ensemble/

[55] ESRC/EPSRC TLRP-Technology Enhanced Learning hapTEL project (2009), last accessed 31st August 2010, http://www.tlrp.org/tel/haptel/

[56] ESRC/EPSRC TLRP-Technology Enhanced Learning SynergyNet project (2009) last accessed 31st August 2010, http://www.tlrp.org/tel/synergynet/

[57] JISC (2009). Designing Spaces for Effective Learning, last accessed 31st August 2010, http://www.jiscinfonet.ac.uk/infokits/learning-space-design/dsel

[58] Scottish Funding Council, Alexei Marmot Associates and haa design (2006) Spaces for Learning: A review of learning spaces in further and higher education. Last accessed 31st August 2010 http://www.jiscinfonet.ac.uk/Resources/external-resources/sfc-spaces-for-learning

[59] ESRC/EPSRC TLRP-Technology Enhanced Learning Personal Inquiry project (2009), last accessed 31st August 2010, http://www.tlrp.org/tel/personal-inquiry/

[60] Pachler, N., Bachmair, B. and Cook, J. (2010). Mobile Learning: Structures, Agency, Practices. New York: Springer.

[61] See Becta (2010) Personal Technologies for Learning, last accessed 27th September 2010, http://publications.becta.org.uk/display.cfm?resID=42235&page=1835 and Becta, (2010) Narrowing the gaps, last accessed 27th September 2010 http://publications.becta.org.uk/display.cfm?resID=42232

[62] e-Skills UK (2010) IT and Telecoms Insights 2010, last accessed 27th September 2010, http://www.e-skills.com/Research-and-policy/Insights-2010/2671

[63] UK Commission for Employment and Skills (UKCES) (2010) The National Strategic Skills Audit, last accessed 27th September 2010, http://www.ukces.org.uk/our-work/research-and-policy/national-strategic-skills-audit/

[64] JISC (2009) Learning Literacies for a Digital Age, (LLidA), last accessed 27th September 2010, http://www.academy.gcal.ac.uk/llida/

[65] JISC (2006), LEX: learner experiences of e-Learning, last accessed 27th September 2010, http://www.academy.gcal.ac.uk/llida/

[66] Hoyles, C., Noss, R., Bakker A., Kent P. (2010) Improving mathematics at work: the need for techno-mathematical literacies. London: Routledge.

[67] Hattie, J. (2009). Visible Learning: A Synthesis of Over 800 Meta-Analyses Relating to Achievement. Routledge.

[68] ALT-J (to be 'Research in Learning Technology' from January 2011) (2010), last accessed 27th September 2010, http://www.tandf.co.uk/journals/titles/09687769.asp

A PDF of this document can be found in the ALT Open Access Repository at http://repository.alt.ac.uk/839

ISBN: 978-0-85473-912-7