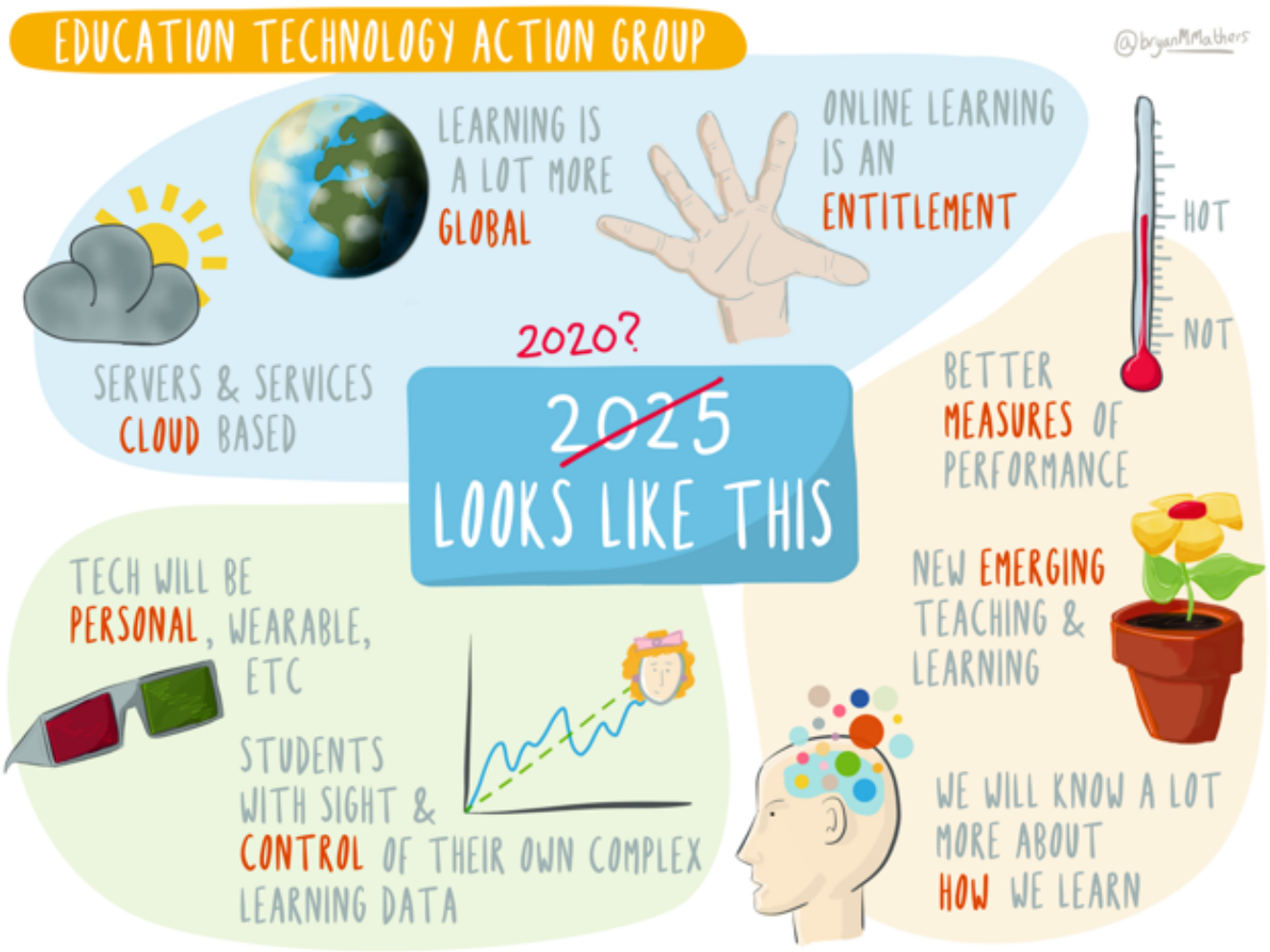
Education Technology Action Group

Our Reflections



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Executive summary

At the beginning of 2014, Ministers from DfE and BIS set up the Education Technology Action Group (ETAG). We are an independent group and we were asked to advise on how digital technology might empower teachers and learners by enabling innovation across schools, further education and higher education sectors for the benefit of students, employers and the wider economy. The group is chaired by Stephen Heppell who has authored the approach presented here on the basis of contributions from other ETAG members.

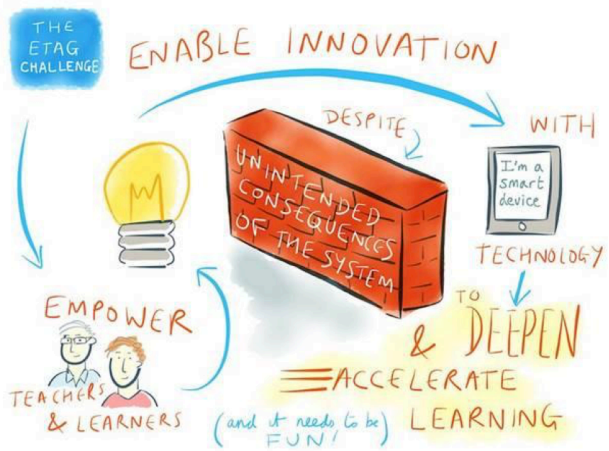

Figure 1 - The ETAG Challenge, by ETAG's Bryan Mathers

Fundamentally, we concluded that the use of digital technology in education is not optional. Competence with digital technology to find information, to create, to critique and share knowledge, is an essential contemporary skill set. It belongs at the heart of education. Learners should receive recognition for their level of mastery; teachers and lecturers should too.

Digital technology can and should bring joy and engagement: a delight in stellar progress, the exhilaration of unexpected challenges, some playfulness, the reaffirmation of a global audience.

Some things will need to move over, to be dropped, to change and to vary to allow all this to happen. We are calling for everyone to play their part in enabling this progress.

Foreword

At the beginning of 2014 a Ministerial team from DfE and BIS asked a newly formed Education Technology Action Group (ETAG) how digital technology might empower teachers and learners by enabling innovation using the new smart technologies around us. Their intention was to see how that empowering could deepen and accelerate learning - and by the way they added, "it needs to be fun".

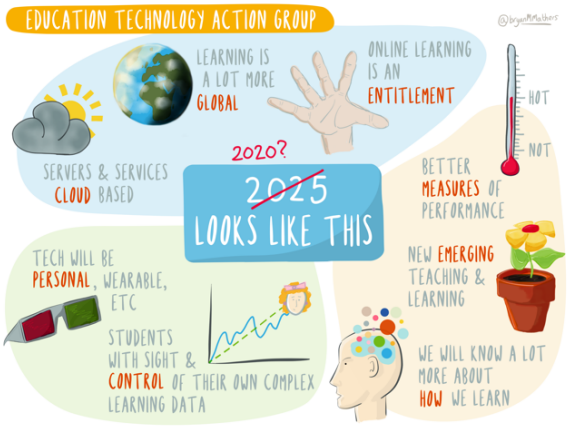

Figure 2 - 2025 looks like this? By ETAG's Bryan Mathers

That was, of course, a hugely seductive brief and I was delighted to be asked to chair the group. But it didn't end there. Ministers also asked if we could guide them towards undoing past policies that had had unintended, and less than helpful, consequences. Further, they asked us to be “ambitious”. Politics moves on, those ministers are now superseded, but our brief continues today, still supported and welcomed.

At the outset we didn't see this as a "committee" to produce "a report" and, although here you will find a number of suggested recommendations from our experienced group, the task is really for everyone reading this to pursue that brief themselves, in schools, colleges, business and company training departments, universities, indeed everywhere.

Many countries have five year, or ten year, plans. Many policy recommendations are made around the world only to lay dormant on shelves. What distinguishes our work, I believe, is both the boldness of that brief and the starting point we gave ourselves:

To give our suggestions relevance we wanted a starting point with a clear consensual view of what tomorrow will look like; to be clear where we are going with Learning. We thought that would guide ministers, principals, parents, governing bodies, students, families, companies and everyone. We left out the crazier predictions, but immersed ourselves in white papers, other policy documents worldwide, tech futures briefs and of course our own collective long years of experience. Our gentle conclusions guided our policy suggestions but should serve as a litmus test for anyone reading this and wanting to add their own ideas of "how digital technology might empower teachers and learners".

This graphic was on our public facing website from the outset and remains directly relevant now to everyone making any decisions about technology and learning. Many policies are possible, but it is helpful (and less wasteful) if they are leading us in a direction that we know to be our future:

Why should all this matter? Two reasons: around the world new targets for learning success are emerging that we need to move forward to achieve. One example: the PISA measures of international learning comparison are changing rapidly to recognise the new needs of this complex world. From 2015 PISA assessments will be digital technology-enabled and a new emphasis on collaborative problem solving appears. This heralds even bigger changes for 2018 when Pisa revisits "literacy", to include such capabilities

as "recognising credible websites and online documents", or "students' awareness of the interconnected global world we live and work in". This is clearly not a time to stand still or to simply finesse the past.

But secondly, around the world we have some 2.2 billion children. Barely half reach secondary age education. For a very large number of them the education they need to move forward economically, or as parents and citizens, is elusive. 55 million of them, probably a lot more, have no schooling at all. 114 out of 208 countries have a "significant" shortfall of teachers. The world needs nearly 13m more teachers, today. We are a wealthy nation with a uniquely long history of harnessing technology to learning. I believe that there is a moral imperative to think freshly about how learning might be better for all, cheaper, deeper, faster, more relevant and yes, fun too. We won't impact on that colossal need by simply replicating expensive and often disengaging 20th century Western style schools. We need to think afresh, to step clear of legacy solutions. This ETAG task, with the very welcome and bold brief of our ministers, hopefully will be the beginning of the much fresh thinking still to come from everyone.

Our work is indicative, rather than prescriptive. It is for **everyone** to move forward. The need is clear, and the need is now.

Professor Stephen Heppell

Felipe Segovia Chair of Learning Innovation at Universidad Camilo José Cela, Madrid.
Chair in New Media Environments, CEMP, Bournemouth University.

Process and rationale

The ETAG members subdivided into three workgroups.

Workgroup 1: access, equity and funding (led by Bob Harrison and Phil Richards)

Workgroup 2: leadership and professional development (led by Angela McFarlane and Diana Laurillard)

Workgroup 3: assessment and accountability (led by Peter Twining, Maren Deepwell and Stephen Wright)

Each workgroup explored current practice worldwide, reviewed literature and evidence, invited opinion, drew on their own very considerable experience and wisdom, and offered suggested ways forward.

Together, we have decidedly not produced a plea for massive change in legislation, or for the substantial new funding of just one or two initiatives. It is more complex than that. There are very many agencies involved in building education through schools, colleges, universities and elsewhere. From Ofsted to parent governors we have produced a clear call for action, not for one or two “silver bullets” by one or two groups, but for a subtle recipe of significant change, involving everyone. None of the ingredients within the ETAG reflections would be described as difficult - but it certainly is complex and everyone, every institution, every organisation, needs to play their part in moving forward if England is to achieve the pace and ambition needed.

A clear story throughout is that simply adding technology to existing practice adds expense and misses the point of what might, and should, be achieved. A worksheet on a tablet is still a worksheet, but more expensively so. An undergraduate timed essay, but typed, still misses the point of the new intellectual tasks that emerge through connected learning. The hardest thing about moving forward is deciding what to leave behind.

However, there is a clear imperative here: to move forward and to move forward from complacency. For many institutions the sense that ‘we are doing OK, you should see the place down the road though”, or from sectors “universities are ahead of the game, it’s schools we worry about”, or from some governors “we’ve done innovation, now we are focussed on consolidation” and so on. The pace of change, of work, of society, of technology itself, of globalisation, of the growth in competitors, of our transformed cognitive and pedagogic understanding of what makes astonishing learning, all combine to suggest that complacency will bring catastrophic atrophy. We are not saying prescriptively “do this precise thing”, but we are saying loudly “do some things” and below is our reflection, and justification, for what those things might include.

Time and time again we have found the learners’ voice to offer wise inputs, thoughtful reflections and very little complacency indeed. For everyone reading this, organisations, institutions, individuals, we are also saying that working with, rather than simply for, learners is a clear pathway forwards. We really are all in this together.

In many ways, the process of collaboration we embraced - using shared documents on Google Drive, mixing quite rare face to face contact with a continuous connected distributed conversation, welcoming input through social media as well as informal chats in coffee houses, producing an ongoing website rather than a printed

document, running teams within a model of a very, very flat hierarchy… All this is indicative of an existing working world not well served by much current educational practice.

We have been subjected to hugely reaffirming levels of goodwill and support, from ministers and officers through to students themselves. We are aware that there will be gainsayers too; education suffers from more than enough of them, and we are aware that for some this is all underambitious. We thank, and apologise, where appropriate.

Fundamentally, we concluded that the use of digital technology in education is not optional. Competence with digital technology to find information, to create, to critique and share knowledge is an essential contemporary skill set. It belongs at the heart of education. Learners should receive recognition for their level of mastery; teachers and lecturers should too.

Additionally, digital technology adds to the pedagogic repertoire available to support learners and learning. To make informed decisions about what uses of digital technologies might make learning better everyone, from teachers and students to policymakers, need to properly understand the portfolio of possibilities on offer. That might include informed decisions to not use digital technology of course.

Digital technology can and should bring joy and engagement too: a delight in stellar progress, the exhilaration of unexpected challenges, the reaffirmation of a global audience.

Arguably, change is inevitable: Digital technology is having a major impact on all aspects of society. It is changing:

- **disciplines**, allowing them to answer new questions because they have new ways of collecting, analysing data and representing their understandings
- the **workplace** - with new skills, competences, collaborations, careers and dispositions
- **government and citizenship** - with the potential for new forms of representation enabled by technology just around the corner. Whilst newly accessible realtime data might transform decisionmaking
- **parenting and the family** - changing communication within the extended family, whilst new models of employments impact on roles (for example grandparents), and on the exchange of practice and evidence
- and of course social interactions, entertainment, our sense of membership and belonging, the way we shop, our health **and so much more**

It is not unreasonable to expect education to change to meet the new needs of this changing world and in turn to be changed by the opportunities presented by digital learning technologies. A new world to be prepared for, with new ways of preparing.

Some things will need to move over, to be dropped, to change and to vary to allow all this to happen. Everyone needs to play their part in enabling this progress.

Thanks

We would like to thank everyone who has thus far contributed time, energy, wisdom, arguments and passion to this work, and that includes our public servants. So many people: from formal representations by the many organisations we are blessed with in the UK, to the casual *en passant* conversations with individuals enjoyed by all our ETAG team.

There was a very significant weight of contribution on-line - through many channels - and we would particularly highlight this, with our thanks.

A lot of people contributed a lot of time, for free, because they cared. Hopefully, that shines through clearly in the reflections so far.

ETAG 2016

We are anxious that progress should happen and that everyone will play their part.

The ETAG team will reassemble in one year's time to review progress. Where we see institutional sectors and organisations struggling with progress or direction we will offer perhaps more robust and targeted suggestions to help get them on track. **And of course we would share and highlight the good progress and actions that have occurred.**

This should not be an imposition, or be onerous, or be expensive. In particular we might perhaps at this point remind everyone of our initial remit to make learning fun, more engaging, seductive even. Many might take that remit, and the opportunity to attain it presented by new technologies, as a starting point for real progress throughout 2015.

Similarly the considerable progress that the ETAG team have observed, and in many cases of course are part of, will continue to evolve. In a year's time, we also look forward to highlighting new initiatives that have further contributed, since we drew these conclusions at the start of 2015. We have agreed a direction; there are many routes.

Risk

Throughout all our conversations and exchanges we heard over and over the sense that a risk averse fear of failure was both a result of past mistaken policies and a powerful barrier to progress.

Rightly or wrongly individuals and institutions seemed to be saying “it is safer to try nothing than to try and fail”. This is particularly acute where the responsibility for innovation sits solely on the shoulders of an individual rather than managed change being a strategic part of the development of a whole school, college or university. Perhaps this is a rather British failing, but the sense was of a single failure potentially blighting a reputation.

This is an area where we would seek to shout out loud and clear that faced with the certainty of uncertainty and the constancy of change, the greatest risk, the most reckless course, lies in trying nothing new. We would and should expect occasional failure. Properly observed, professionally managed, collegially shared, a little failure is a necessary step in progress. Which is not to say that constant and abject failure is tolerable or useful. But in, for example, quality assuring an institution, an element of risk and discovery - of research - would surely always be a pre-requisite of the highest quality of practice in an educational organisation?

Trying nothing new is reckless and dangerous. It puts our economy, our political stability, our wellbeing at risk and it is a sad way to extinguish joy in learning, both for students and for learning professionals. To make the necessary progress with digital technologies in learning “try something new” is a mantra to be embraced (joyfully!) by all, including all organisations and institutions, supported within a culture of organisational growth.

Evidence

Evidence is a problematic concept when thinking about digital technology in education because:

- is it very difficult to show a clear causal relationship between a single variable (such as the introduction of phones) and learning outcomes - all the more so with unstoppable change all around too.
- digital technology has changed the nature of disciplines outside school and thus should also impact on the curriculum inside school, and it provides new strategies for supporting learners, however the existing metrics in education (including high stakes summative testing and QA frameworks e.g. the Ofsted Framework) have not been changed enough to reflect this, and thus fail to capture new impacts that digital technology has had on practice and learning outcomes. An example would be the new strategies for collaboration (in social media perhaps) and the new weight placed on remote collaboration within the workplace.
- the effectiveness of digital technology to enhance learning is dependent upon how it is used, and very subtle differences in the way it is implemented can have large impacts, thus it is difficult to make valid generalisations between different implementations/contexts

Arguably, a more productive approach to enhancing the use of digital technology in education would be to adopt an engineering mind set, rather than a more traditional scientific one. Thus, rather than trying to disprove hypotheses, the focus should be on building upon the success of specific solutions to refine them.

It is often suggested that NASA would never have got an astronaut on the moon if they had adopted a scientific approach, because they would have quickly found evidence that it wasn't possible. That is not to say that one shouldn't build upon sound scientific evidence -as for example we do with the new revelations from cognitive science.

Of course a great deal is known from research on the pioneering UK implementation of digital technology in schools that started in the early 1980s. Indeed, in 2006, a review of the implementation of part of the Harnessing Technology strategy highlighted that the problems being encountered then were the same problems that had been identified by research over the previous 30 years, which had not yet been addressed (Twining et al., 2006).

At the heart of this is a debate about learning outcomes - which are themselves complex and multi-variate. What we are saying though is simply this: try something new that has already worked elsewhere and where you have seen and trusted the outcomes. Tailor it to your context and feed back your own conclusions as they emerge.

Defining ICT

The term ICT is used differently across different contexts, in different nations, often leading to confusion and miscommunication. For example, it has been used to refer to a specialist subject (learning about digital technology); to the use of digital technology across the curriculum (learning supported by digital technology); and to refer to hardware, software and associated digital technology infrastructure.

In order to avoid confusion, ETAG use the following terms:

Digital technology - the technology infrastructure, including hardware and software.

ICT - the cross curricula use of digital technology to enhance learning.

Computing - an umbrella term to refer to subjects which are focused on teaching about digital technology and its use, including: Computer Science, Information Technology, and Digital Literacy.

Computer Science - is a scientific discipline, covering principles such as algorithms, data structures, computational thinking, programming, systems architecture, design, problem solving etc.

Information Technology (IT) - the assembly, deployment, and configuration of digital systems to meet user needs for particular purposes. (Note that this is narrower than the use in industry, which generally encompasses Computer Science as well).

Digital literacy - the ability to operate effectively as a citizen in the 21st century. It covers the following areas:

- Understanding the impact of new technologies on society, including the ways in which new technologies change disciplines (e.g. history, chemistry, English, etc)
- Understanding the nature of digital identities and being able to manage your digital identities appropriately
- Being able to interact safely in a digital world (encompassing e-safety, cyber-bullying, data security, etc)
- Being able to locate, organize, understand, evaluate, analyze and (re)present information using digital technology (including using dynamic and procedural representations) - what you might think of as 'the creative' making and doing aspects of using digital technology (though of course many other aspects of the subject are creative too).

Learning technology - the broad range of communication, information and related technologies that can be used to support learning, teaching, and assessment.

Workgroup 1: Access, equity and funding

Short summary

Increasingly education technology means on-line. Cloud-based computing enables cost savings, ensures content and software is always up-to-date and allows access anytime, anywhere and on any device. Collaborative learning crosses institutional and geographical boundaries. Resources and opportunities are global.

Pragmatically, that means schools, colleges, universities and other providers must have a robust, fast broadband connection as a pre-requisite. Making effective use of available broadband requires widespread access to, and the welcoming of, mobile devices (as well as providing specialist computers for particular purposes - maker spaces or school radio for example).

Technology is fast changing and it is hard for providers to keep pace with developments or to understand what digital technology is best for them. Although in real terms the cost of broadband and digital technology is on a downward curve, it can still represent a significant cost, and investment in digital technology **can vary hugely in different education institutions**. Independent advice on digital technology and reduced broadband rates can help providers get the best digital technology solution for them and ensure value for money.

Other countries are making significant investments in ICT (the cross curricular use of digital technology) to take advantage of new forms of collaboration, delivery, access to content and greater efficiencies. The position in England is too varied with some areas of good access and/or good use of ICT and some with poor access to, with restrictions and/or poor use of digital technology.

Increased use of on-line learning and digital technology helps equip children and students with the digital skill set they need in life to access education, employment, government services and training opportunities. It is seen as one of the key drivers to narrow the gender gap.[1] Without real progress we will lose ground to our competitors and continue to produce a workforce unequipped for the needs of industry or of citizenship.

Seeing the joy of our younger learners as they try to solve the world locations of their regular Mystery Skype chats it is clear that the mindset of the global learner is in place. They urgently need the infrastructure to support it.

Four key recommendations

1. Schools, Colleges and Universities should provide learners with an entitlement to a substantial minimum level of fast broadband connectivity which is based on number of learners and a rising expectation of increasing, institutional and personal use.
2. Schools, Colleges and Universities should provide learners with a minimum entitlement to a safe, secure, resilient and robust organisation-wide Wi-Fi system for all their devices with access to both use, and contribute to, all learning resources when learners are not on the premises/campus.
3. School, Colleges and Universities should build BYO (Bring Your Own) approaches into their immediate and medium term digital technology strategies.
4. Schools Colleges and Universities should have access to an independent, objective help/advice/support service for technology procurement and deployment.

Plus three others to think about:

- Schools and colleges might be given priority in national broadband roll-out
- Discounts for school broadband - and using the collective power of learners to drive their 4G connectivity / device personal rates down
- Without exception all the inputs we received highlighted procurement policies as obstructive and unhelpful. Many simply ignored them, but for larger scale procurement they were an excellent example of the “policies producing unexpected barriers” that we were tasked with uncovering. Procurement needs unpicking and then transforming, urgently.

Please see Annex A for detailed reflections on Infrastructure and advice recommendations.

Workgroup 2: Leadership and professional development

Short summary

Considerable change is afoot. Cognitive science and social media are **both** telling us much more about how we learn effectively: learning professionals research and exchange effective practice, as high level research informs our fundamental understandings. Bottom up and top down are contributing and intersecting. Change means professional development, but of course change also alters and evolves what professional development might be.

This workgroup focussed on the need for teachers to develop and exchange clear, evidence based strategies for using digital technology, improving their skills to use it effectively.

Education leaders, heads of institutions, governors, teachers and lectures, indeed everybody is faced with tough decisions and finite, tight, budgets. Digital technology should help them solve their problems, not bring more.

If at all levels of leadership there was recognition of the need to invest in innovation, with the expectation of rewards in the longer term, not necessarily within the budget year, current exam cycle or by the next inspection, then they might be enabled to move forward more easily.

Education is a complex system of global, national, local and institutional stakeholders, multiple forces, public, private and charitable institutions, with a broad range of professionals. Every student's journey through informal and formal education should enable them to attain their best learning potential, for the benefit of both individuals and society. For that to happen, everyone has to play a part. And for THAT to happen the enablers, as well as the supporters of change, have to play their part.

That is complex, and the complexity is spelled out in the link below, but as has already been explained complexity is not difficulty. Lots needs to be done, but none of it is particularly difficult.

In particular the "self-help" initiatives of face to face local events like TeachMeets or regular social media discussion spots like #UKEdChat, with their extensive archives, and the new delivery models of on-line mass courses, together with the global communities of practice all contribute already to burgeoning all-but-free professional development for those already connected and participating.

There is of course a distinction to remember between first order innovation of the truly new and adoption of innovation which has an established track record. Reaffirmation through communication with peers on both counts moves us forward and helps vouchsafe quality.

Key recommendations

Building on this analysis (see link to detail below), the following actions could make a significant difference, to putting the education system onto a track of continual innovation, sharing and improvement, if we take the time it needs, given that the funding is likely to be minimal:

5. Invite each agency responsible for the main drivers in the education system to reflect / report on how it would change its approach to ensure that teachers, lecturers, institutions and their own staff prioritise the adoption of proven and promising innovation with digital learning technologies. The innovation of new approaches to learning with digital technology should also be supported, with the sharing of both successful and unsuccessful innovations for the sector to learn from and influence wider adoption across the education system.
6. Set up an expectation of "online learning CPD", linking to current organisations and associations, with perhaps an overarching CPD directorate as an organisation to collate and share the teaching community's knowledge of research and effective practice with digital learning technologies, and to reward, showcase, celebrate and recognise high quality and effective teaching innovations across all sectors. In particular such a CPD directorate might look outside England too for exemplar practice.
7. Define a "digital experts' programme" to inspire students to develop their digital skills across the curriculum, with the successful Digital Leaders initiative at its heart. We could imagine something like a nationwide "digital Duke of Edinburgh scheme" with collaborative and mixed age digital student leaders at its heart.
8. The DfE should lead by example, asking 'how can new digital technologies help?' focus on the part of strategic leadership at all levels, seeking the optimal use of digital technology to help solve the most challenging issues in education. For example, in all our ETAG visits we have yet to see young learners regularly inputting to policy in the way that we observe in the front running learning institutions.

Please see Annex B for detailed reflections on leadership and professional development recommendations.

Workgroup 3: Assessment and accountability

Short summary

The areas of assessment and accountability seem to offer the greatest potential (and also the greatest barriers) to change in education. They both act as drivers of practice (including curriculum and pedagogy).

Government policy, in the form of the National Curriculum and the strategic direction set for assessment and accountability, is a critical lever for influencing educational practice therefore.

Big Data is a rapidly developing area in education, which could radically enhance the effective use of data in education, including helping to address some of the challenges of assessing knowledge age skills and attributes.

This section is divided into three major subsections: Accountability, Assessment, and Big Data. For each, Workgroup 3 provide a brief summary of the issues followed by some indicative recommendations.

Accountability

Education providers' practices are driven by the accountability frameworks within which they have to operate. For Early Years, schools, FE and skills and Initial Teacher Education (ITE) this is the respective Ofsted Framework. There is a general move for greater coherence and commonality across these four Ofsted Frameworks. For Higher Education the QAA sets the accountability expectations.

A key challenge in this area is to ensure that accountability frameworks remain relevant in regards to how digital technology is used. Given the rapid pace of innovation and changing learner expectations, providing specific guidance regarding technology is not generally helpful in the long term. Instead an approach that encourages reflection and strategic planning to enhance learning, teaching and assessment with the use of digital technology could be adopted across sectors.

Accountability recommendations

9. Government should make it a statutory requirement for all education providers to describe and justify how they use digital technology to enhance learning across the curriculum (including for assessment) **as part of the teaching and learning policies** on their public website by September 2015. This should not be an additional burden. It should just be always a part of existing reports.
10. The relevant accountability frameworks, such as the Ofsted frameworks/criteria for Early Years, Schools, FE and Skills, and ITE should be evolved so that they require providers to explain and justify

how they use digital technology across the curriculum to enhance learning. It should not be possible to obtain a rating of Good or Outstanding from Ofsted or the QAA for HE without having provided a good or outstanding justification for your use of digital technology to enhance learning across the curriculum from September 2015.

11. The criteria for employment as an Ofsted or QAA inspector should include a requirement to maintain a sound understanding of the ways in which digital technology impacts on their subject area(s), pedagogy, and other aspects of education within their sector expertise.
12. Ofsted and QAA should ensure that all inspectors engage with regular professional learning opportunities, including recent and relevant experience, in order to be able to meet the specific requirement in Recommendation 11 – ETAG member organisations could support this effort.

Assessment

Digital technologies have changed much, from the way we work to the way we shop, from the way families communicate to the memberships we enjoy. This results in a double edged sword for assessment. On the one hand the capabilities and skills sought are far more than knowledge retention, including for example the critiquing and collaborating capabilities that PISA is now embracing. On the other hand if digital technology allows us to do things differently, it is time to take a critical look at how we currently manage high stakes testing. Two years ago a meeting of european education ministers warmly debated open, internet connected examinations for example.

This is yet another area where being clear about where we are going helps to guide small steps today, and wastes less resources pursuing blind alleyways. Digital technology-enabled assessment is certainly not the screen based analog of paper based. Moving a multiple choice paper to a multiple choice screen misses the opportunity, and need, for what can be done. There is potential for digital technology-enabled assessment to enable the rich learning experiences that traditional assessment is often presented as reducing[1].

Assessment recommendations

13. The DfE should set a strategic goal for General Qualifications (GQs) across the majority of subjects, including English, Maths and Science, to move towards utilising digital technology-enabled assessment.
14. The DfE and Ofqual should actively support and encourage the Awarding Bodies to develop digital technology-enabled assessment for GQs, starting with pilots across a range of subject areas in 2015/2016.
15. The JCQ should develop a framework for the implementation of digital technology-enabled assessment for GQs in 2015.

Please see Annex C for a more detailed explanation of this workgroup's thinking on assessment.

Big data

In education, as in other areas of life, the way we use technology increasingly generates large amounts of data. The collection, analysis and use of this data, either in real time or in the long term, is transforming every aspect of our lives - often empowering us as individuals as we have seen for example in Health.

Making intelligent use of data for learning and teaching is beginning to demonstrate real impact for three key stakeholder groups:

- Learners (and their families): learners need access to and clear information about their own data;
- Teachers, trainers and employers: they need to make use of analytics to improve learning design and delivery;
- Providers, national agencies and industry: here we can encourage nation-wide, and international use of analytics of key data sets to respond to market demand, employer needs and competition.
- Put simply: better data, for individuals, institutions and policymakers will be essential if everyone is to play their part in making learning better.
- A simple example: students' phones know how fast they come into, or leave, educational establishments - a helpful marker for engagement on "special" Yet that data and its aggregates are currently unavailable either to institutions of individuals. There is also a flip side: should we, for example, have no practical control of intimate data being collected about learners, particularly children by technology already in use? Or should young adults leave education without being aware what data employers use in recruitment? Should we not encourage responsible use of technology and learning analytics to inform and support learners when it comes to managing their personal information online or interacting with others? Industry will step up its use of sophisticated tools for data collection/analysis. We cannot afford to do nothing.
- This applies across all sectors of education and informal/adult/work-based learning. There are a number of things that are brought together under this heading including use of 'big data', (social) learning analytics and education analytics (see OU definition of terms).
- Although big data has the potential to move all sectors forward, there are perhaps particular challenges in schools. In our consultations concern was repeatedly expressed that around 80% of schools are tied to a single management information system (MIS) from a single supplier. Many felt that more robust competition - and perhaps data exchange protocols - might be needed to deliver the kinds of new analytics that schools, teachers and students need now.

Big data recommendations

16. The government should make data science and analytics a funding priority.
17. All educational organisations should be required to put in place clear public statements about their collection, use and analysis of data and for students to be informed about this (including the role played by third party services).
18. The government should establish a task force to develop proposals for a national framework for sharing key data across education, including between students, that addresses issues of data protection and ownership.
19. The concern about lack of effective MIS competition should be addressed.

[1] For example, there is much evidence to suggest that digital technology-enabled assessment systems based on 'comparative judgement' are not only more flexible, but actually more robust than traditional systems. Comparative judgement allows genuinely open ended and problem based tasks to be used for robust assessment. There is a strong need to examine both the reliability and validity of traditional assessment. Paper based, standardised tasks are often seen to be very reliable, we can rely on them providing the same measure repeatedly. They stand up less well to scrutiny when we consider whether they are valid, ie whether they actually measure what we think is valuable. There is little point in reliably measuring understanding and competencies that we do not hold to be valuable. Much promise exists in more cutting edge systems for assessment such as comparative judgement, which research suggests not only allows tasks that demonstrate more valid measures of learners, but are also actually more reliable. See: Pollitt (2012) Available at: **http://www.tandfonline.com/doi/abs/10.1080/0969594X.2012.665354**

ETAG Membership

ETAG's core members have been chosen to reflect a vast range of experience from across the education and technology sectors.

- Professor Stephen Heppell (Chair) – Bournemouth University
- Mark Chambers – Naace
- Ian Fordham – The Education Foundation
- James Penny – European Electronique
- Maren Deepwell – ALT
- Professor Diana Laurillard – Institute of Education, University of London
- Stephen Wright – Federation of Awarding Bodies
- Phil Richards – Jisc
- David Hughes – NIACE
- Bryan Mathers – City & Guilds
- Bob Harrison – Education adviser for Toshiba Information Systems UK Ltd
- David Brown – Ofsted National Lead for ICT
- Professor Peter Twining – Open University
- Pauline Odulinski – Education Training Foundation
- Professor Angela McFarlane – College of Teachers
- Karen Price and Niel McLean – E-Skills UK
- Geoff Mulgan – Nesta
- Dominic Savage – BESA
- Dawn Hallybone – Oakdale Junior School
- Lizzie Noel – New Schools Network
- Gary Spracklen – IPACA
- Ben Rowland – Agilis Arch
- Oliver Quinlan – Nesta

Annex A: Detailed reflections on infrastructure and advice recommendations

Three Key Recommendations

Infrastructure

1. Schools, Colleges and Universities should provide learners with an entitlement to a substantial minimum level of fast broadband connectivity which is based on number of learners and a rising expectation of increasing, institutional and personal use.
2. Schools, Colleges and Universities should provide learners with a minimum entitlement to a safe, secure, resilient and robust organisation-wide Wi-Fi system for all their devices with access to both use, and contribute to, all learning resources when learners are not on the premises/campus.
3. School, Colleges and Universities should build BYO (Bring Your Own) approaches into their immediate and medium term digital technology strategies. There are implications for VAT in this as education and domestic VAT rates are different. For a roll-out of BYO to be VAT neutral the VAT paid by family providers would need reviewing. This is an urgent task.

The advantages of higher bandwidth plus ready access to mobile devices are significant for providers and students. It allows Cloud computing (bringing with it savings in running costs), it allows for highly inclusive teaching practices to be adopted such as blended learning or flipping the classroom and enables on-line assessment. It makes the local education providers more attractive partners for local industry.

The British Educational Suppliers Association (BESA) annual survey reported that 65% of primary schools and 54% of secondary schools considered themselves under-resourced in Wi-Fi connectivity. A significant number of surveyed schools also reported that they were under-resourced in broadband provision (42% of primary schools and 31% of secondary schools).[2]

It is not possible to make a hard and fast recommendation about the levels of bandwidth needed or Wi-Fi provision. Each establishment will have differing requirements and face particular challenges. However, the bandwidth, Wi-Fi and digital technology provision not only needs to be suitable for existing needs but include a high margin for development and expansion – demand for bandwidth only ever increases.

A too simplistic crude “recommended” level based on existing usage would be for education providers in England to have around 1Gbit/s bandwidth. That isn’t good enough. Going forward we note that one of the metrics the UNESCO digital technology infrastructure survey uses is changing from bandwidth per establishment to a per head measure i.e. bandwidth per user (student), and it is quite possible that in future

particular courses or disciplines may be accompanied with a recommended bandwidth/student requirement.) A more appropriate initial figure therefore would be 8Mbit/second per student.

Jisc (which runs the Janet network connecting all HEIs and FEIs) estimates to upgrade all Further Education Colleges in England to 1Gbit/s would cost around £6m. If HMG were to fund this on a one-off basis, it would send a very strong signal of Government's commitment to the use of technology and enable and underpin a whole range of digital activities. We would urge all education providers to prioritise investment in higher bandwidth, both to make the most efficient and effective use of teaching staff but also to drive cost savings though use of Cloud technology and online content.

At present the EFA has developed standards setting out the minimum technology required for new build. There is no such guide for existing schools wishing to upgrade or expand. We would call upon the EFA to adapt their new build standards and make these freely available so as to provide a rough and ready guide for existing schools looking to enhance their technology infrastructure.

What's happening elsewhere?

- The US has announced plans to provide 99% of schools and colleges with high speed broadband by 2017. This is part of the ConnectED Programme. The aim is for all schools to have at least 100Mbit/s now and a target of 1Gbit/s within five years[3]. As part of the US ConnectED programme, private companies have pledged up to US$2 billion, including provisions of technology and equipment: Adobe, Apple, AT&T, AutoDesk, Esri, Microsoft, O'Reilly Media, Prezi, Sprint, and Verizon.[4]
- All 10,013 schools in Malaysia must have a minimum connection of at least 2Mbit/s as part of the broader Malaysia Education Blueprint, 2013-2025, which aims to ensure that "all Malaysian students learn how to use ICT, and can leverage it to enhance learning"[5].
- Closer to home the Welsh Government has made £39m available to provide all schools in Wales with enhanced broadband and ICT equipment[6] and have supported a Welsh common platform, Hwb, including substantial Welsh language content on iTunes U.
- Under the Connected Schools programme, the French Government is providing EU€5m to improve broadband connectivity for 9,000 primary and secondary schools.[7]
- In Ireland, broadband is provided to schools via HEAnet (the Irish equivalent to Janet). All 780 post primary schools now have 100Mbit/s as part of a three year €30m Government programme.[8]
- A shift to provision of mobile devices for staff and students is becoming the expectation in **other key countries**. For example, through the Australian Federal Government's Digital Education Revolution Programme funding was available for every student to have their own mobile device, and there is now an expectation in Australian schools that 1 to 1 provision is the norm (e.g. Jamieson-Proctor et al. 2014; Clark, Twining & Chambers 2014; Fluck & Twining 2014; Newhouse et al. 2014).
- In the Lebanon, the Open Your Tomorrow programme will provide Lebanese students ages 6 to 18 with 3G-enabled tablets for educational and recreational purposes at a heavily subsidized fee. This is a joint programme supported by the Ministries of Telecommunications and Education, Triple C, Intel, BDL, Blom Bank, the two telecoms operators Alfa and Touch as well as Lebanon Post. The scheme aims to distribute 400,000 tablets in the first two years.[9]

Advice

4. Schools Colleges and Universities should have access to an independent, objective help/advice/support service for technology procurement and deployment.

Free independent advice on digital technology is already available to universities and colleges through JISC. This allows colleges to make digital technology investment decisions based on sound impartial advice and get the best digital technology solution for their institution. No such service is currently available for schools in England.

Schools on the other hand have embraced online communities like #UKEdChat and face to face exchanges like the many TeachMeets.

Anecdotal evidence reported to ETAG suggested a number of problems for schools resulting from a lack of reliable independent advice including:

- Poor broadband provision and inadequate Wi-Fi
- Schools unsure of strategic budgeting and planning for the recurrent cost of basic technology infrastructure
- Schools running obsolete and now unsupported computer operating systems
- Old and out of date server systems
- Schools not having suitable, up to date and adequate technical support
- Schools unsure how they compare with other schools in their use of technology
- Schools basing their digital technology on what is used at neighbouring schools and not on what they themselves need

All schools have control over their own budgets, including for digital technology. However for many schools budgets are small in real terms which rules out buying in expert consultants for all but the biggest projects. We want schools to be able to make decisions on digital technology based on proper impartial advice to get the best solution and achieve real value for money. There is advice available from membership organisations (e.g. NAACE, CLEAPSS) but there is a need for open, reliable advice.

This advice can be quite simple and in many cases FAQs are all that is needed. There is a mass of existing advice on You Tube and the wider internet and a simple guide to the most reliable sources on general issues such as Wi-Fi, tablets, apps, broadband resilience and online security would be suffice in most cases – often the key is knowing what questions to ask. DfE should work with Jisc, EFA and the sector in developing FAQ advice.

There is also a need for more bespoke advice to support the larger digital technology projects, although this does have a resource implication. DfE should work with Jisc and the EFA to identify possible options for providing bespoke advice including a contestable pot.

Three recommendations to think about

Connectivity and costs

- Schools/colleges should be given priority in any state-funded broadband rollout.

Since 2010 the Government has provided some £500m of funds to support broadband rollout, particularly in rural areas. Pupils and students at schools and colleges in these areas suffer twice over from poor broadband. Poor connectivity at school means they do not have access to the same types of online opportunity as elsewhere; this is exasperated by poor connectivity at home which in turn added to the inequity in access.

If Internet Service Providers (ISPs) were to ensure that any roll-out or upgrade of broadband prioritises schools and colleges this would achieve two things. First it would mean that all pupils at that school would have equal access to enhanced broadband at the same time. And second this would send a clear signal on the importance of broadband to education.

Wherever practical, Internet Service Providers (ISPs) should prioritise those exchanges serving schools and colleges in any roll-out.

- The internet service providers (ISPs) should be encouraged to offer schools/colleges discounted rates for broadband. This might include using the collective power of learners to drive their 4G connectivity / device personal rates down. A company with 850 employees would get an aggressively good deal on devices and data. So should a school on behalf of its families.

As noted the Government has spent significant funds on broadband. For the ISPs this has provided income but also has allowed them to offer services to a new set of customers – enhancing their on-going revenues.

We also note that schools are billed in the same way as any other company although most of their usage is daytime and, for several months of the year during holidays, usage is zero. In several parts of the US and Europe, ISPs offer schools a reduced rate or zero cost of broadband. We have not been able to find any examples of this in the UK, although some equipment and software providers do offer discounts for educational establishments.

We acknowledge that the cost of broadband in the UK is among the lowest in the EU but for a school or college this still represents a significant cost and barrier to innovation. We recognise that ISPs are companies and have duties to their shareholders but feel this is an area where they can make a real difference in enhancing the use of technology in education.

Annex B: Detailed reflections on leadership and professional development recommendations

Key work is focussed on developing ideas around better sharing of evidence-based use of digital technology. This strand has focussed on the need for teachers to develop and exchange clear, evidence based strategies for using digital technology and improving their skills to use it effectively.

In particular, there is a clear need for better use of evidence. The challenge is to identify how digital technology should fit into the wider picture of increasing professionalisation of the teaching profession. How might something relating to digital technology fit with the work (for example) to develop a college of teachers or existing initiatives to share ideas and information.

We concluded that the use of digital technology in education is not optional. Competence with digital technology to find information, create and share knowledge is an essential contemporary skill set. It belongs at the heart of education and learners should receive recognition for their level of mastery.

Education leaders, heads of institutions, are in a difficult position, juggling impossible demands with little funding, and are too hand-to-mouth to invest properly in innovation. They need to be aware that digital technology can help them solve their problems, if they could have time and support to think it through, and find a way to invest. If at all levels of leadership there were recognition of the need to invest in both adoption of innovation and development of innovative new approaches, with the expectation of rewards in the longer term, not necessarily within the budget year, then they might be enabled to move forward.

A systemic analysis

Education is a complex system of national, local and institutional stakeholders, public and private institutions and forces, and a broad range of professionals. It takes responsibility for conducting every student through the formal education that should enable them to attain their learning potential, for the benefit of both individuals and society. The complexity of this system means that developing and embedding any radical change requires a clear understanding of how it operates, because its complexity makes it highly resistant to change.

To gain some traction on this complexity, it is useful to think in terms of how teachers and leaders prioritise their work and practice, because the comparative strength of all the competing influences determines the success of any one initiative for change and innovation. The principal ‘drivers’ are the elements of the education system that determine how the teachers and leaders are likely to prioritise activities. Unfortunately, innovations in ICT are not demanded by most of the drivers. These are, roughly in order of decreasing power (though not necessarily importance):

- funding imperatives,
- assessment requirements,
- stakeholder demands,
- quality assurance,
- strategic plans,
- curriculum requirements,
- students' individual needs and skills,
- teachers' career opportunities (Laurillard, 2013).

If, for example, there were a funding imperative to adopt innovations or develop and share new practices in teaching, then this would become a priority for teachers.

The drivers in a system define the influences a professional cannot ignore, so they will act to prioritise activities that respond to them. But they are not sufficient for effective action without the 'enablers', i.e. the mechanisms the professional cannot do without if they are to respond effectively to the drivers.

If we consider the balance between drivers and enablers for the case of innovation in learning technology, the relevant enablers are those that best support teachers and leaders in the change process. These are:

- leadership support for innovation,
- teacher professional development,
- learning technology tools, systems and services,
- communities of practice,
- shareable resources,
- evaluation and research evidence.

Figure 3 illustrates the relative strengths and weaknesses of these influences on the actions of teachers and leaders.

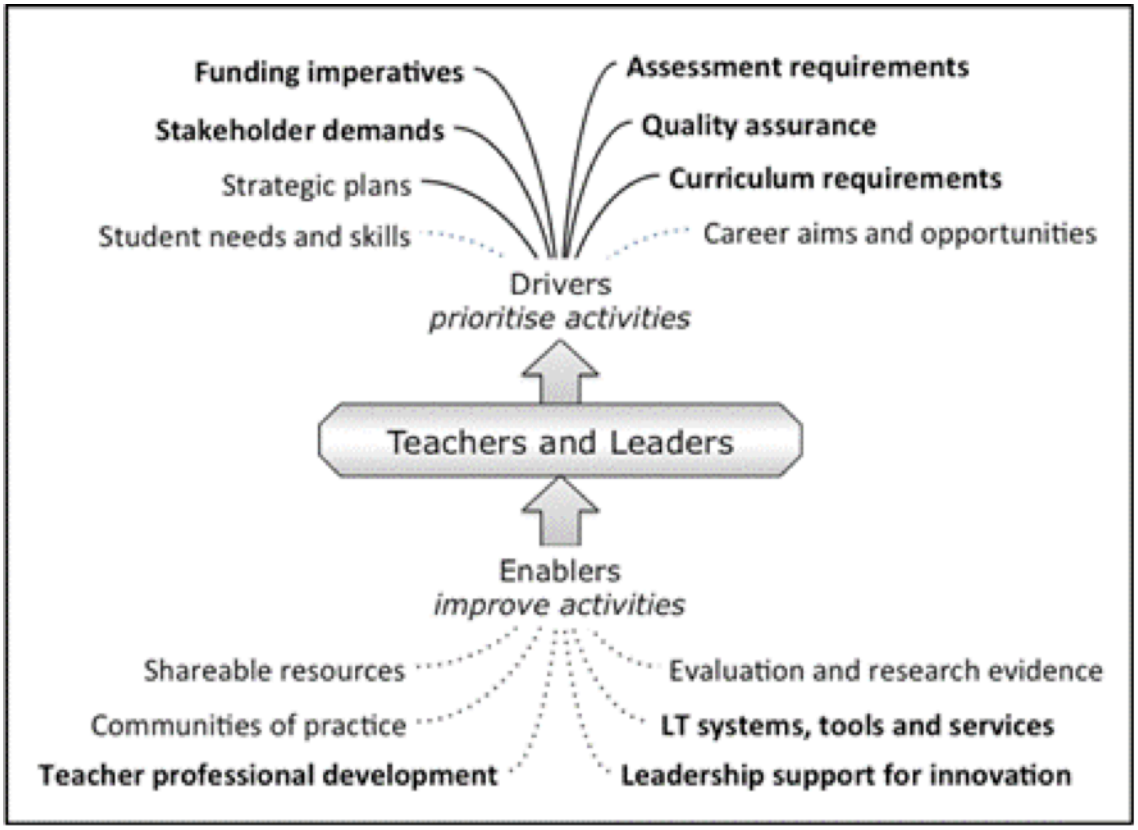

Figure 3 - The drivers of professional activity in the education system balanced against the enablers for innovation in learning technology (bold indicates the more powerful ones)

The question is: are the drivers sufficient to prioritise innovation in learning technology, and are the enablers in place to support it?

None of the principal drivers demand that teachers prioritise adoption or development of innovations in teaching, whether with digital technology or otherwise. So a powerful way for the Minister to promote change, therefore, would be:

to require each agency responsible for these drivers to report on how it would change its approach to ensure that teachers prioritise innovation with learning technology.

Similarly, the enabling mechanisms remain starved of funding, and with little or no strategic priority for developing and sustaining them. They will continue, and given the absence of any clear drivers for learning technology innovation they will remain its main source in the future, but being so localised, they cannot be a force for system change. This systemic analysis suggests two systemic actions: to update the drivers, and develop the enablers. The first is in the hands of the agencies and leaders responsible for the drivers, and the second could be developed as a holistic system working in support of teachers and leaders who wish to innovate.

The alternative is that the system will continue to rely on piecemeal local innovations in teaching and learning that have no large systemic effect. At institutional level and at national level, education leaders must consider their own responsibility for innovation.

Updating educational drivers and enablers to keep pace with the digital world could be sustainable and progressive over the long term, and would make innovation affordable as a natural part of how institutions operate.

Learning technology and the teacher

Teachers who move to online teaching will be aware of a significant, but only initial, increase in their workload, if they are setting out to make optimal use of the technology. It involves several new kinds of teaching activity:

- Planning for how students will learn in the mix of the physical, digital and social learning spaces designed for them
- Curating and adapting existing digital content resources (for reading, listening, watching)
- Selecting the online tools and resources for all types of active learning (for inquiry, discussion, practice, collaboration, production)
- Designing and developing the independent learning activities for all these types of learning
- Developing the personalised and adaptive teaching that improves on conventional methods
- Scheduling for flexibility in blended learning options
- Managing the tutor role in online discussion groups
- Using technology to improve the efficiency of qualitative feedback
- Designing, monitoring, interpreting and using the new and more sophisticated learning analytics, which can give the teacher a clearer representation of where the teaching needs to improve.

There are several resource repositories but very few tools to support teaching design. Too often, teachers in all sectors are given inadequate opportunity to develop these skills. As a professional community teachers could be building our practical knowledge of how to optimise teaching with technology. This could also be part of ‘a holistic system working in support of teachers and leaders who wish to innovate’.

Learning technology and the student

Teachers are increasingly aware of the prodigious digital skills of some of their students, who barely need their help in working with technology. The problem is that these students do not necessarily understand how to *learn* with technology, and for this they do need help. There is also the problem that there are still some 800,000 students with no home access to a digital learning environment, and many more who are not digitally skilled. But teachers are finding ways of managing both ends of this spectrum very effectively, through the ‘digital leaders’ programme. Digital Leaders are students chosen for their high level of interest and digital skills, and their ability to support class teachers in their use of learning technologies. This has become common practice in primary and secondary schools in the UK.

These students sometimes help the younger classes, or are responsible for the distribution, collection, charging and storage of devices, or support teachers in lessons that use technology. The programme creates a broad range of learning benefits:

- By supporting learning technology activities they begin to realise they have to be able to give instructions fluently and be flexible in social negotiation.

- They practice their ability to provide instructions and explanations for a variety of student colleagues.
- They are scaffolding the learning process for other less able students.
- By explaining to other pupils, Digital Leaders can model and remodel the knowledge they have acquired and refine it by the process of having to explain and teach others.
- They reflect regularly on their practice and implementation in training sessions with each other and with the teacher.
- Self-confidence and independent working is increasing among the Digital Leaders, because of this use of their skills, even though some are below average in other core subjects.
- They enable teachers to use mobile devices more often in their lessons since they do not have to ensure that they are charged, or collected, they merely have to book them out.

The teacher is then able to focus on the general classroom organisation and overview of the students' work, orchestrating and intervening where necessary to facilitate learning, to tutor the basic knowledge, to ask pertinent questions, open or closed where appropriate, and spend more time on assessment for learning.

Harnessing students' skills and imagination in the use of learning technologies, managed carefully across the curriculum, will bring real advantages to every school if the programme is now adopted universally.

The role of government and official bodies

Every organisation must invest in order to adapt to its changing environment. We cannot ignore the imperative to invest in teaching, especially when learning technologies present such impressive opportunities for improving the way we do it.

At every level of the education system its leaders must find ways to invest in the innovation that will create effective and sustainable models for conducting education, and achieve our ambitions for higher attainment, and students' continuing access to and commitment to learning. In an adverse financial climate this is hard, but if we can harness the professional interest, capability and digital skills of all teachers to contribute to and learn from collective innovations, then the profession as a whole, and students in particular, will benefit. Some will be innovation leaders, others will be adopters of others' innovations, but it is feasible for every teacher to be a specialist technology innovator with respect to some topic, or skill, or learning approach. The challenge is to bring them together in a coordinated long-term programme of collective innovation.

Figure 4 imagines a rolling programme of innovation and adoption, building towards a system in which every school, and every teacher, is both specialist innovator and generalist adopter, enabling education to become a learning system that can adapt to what will certainly be an ever-changing environment.

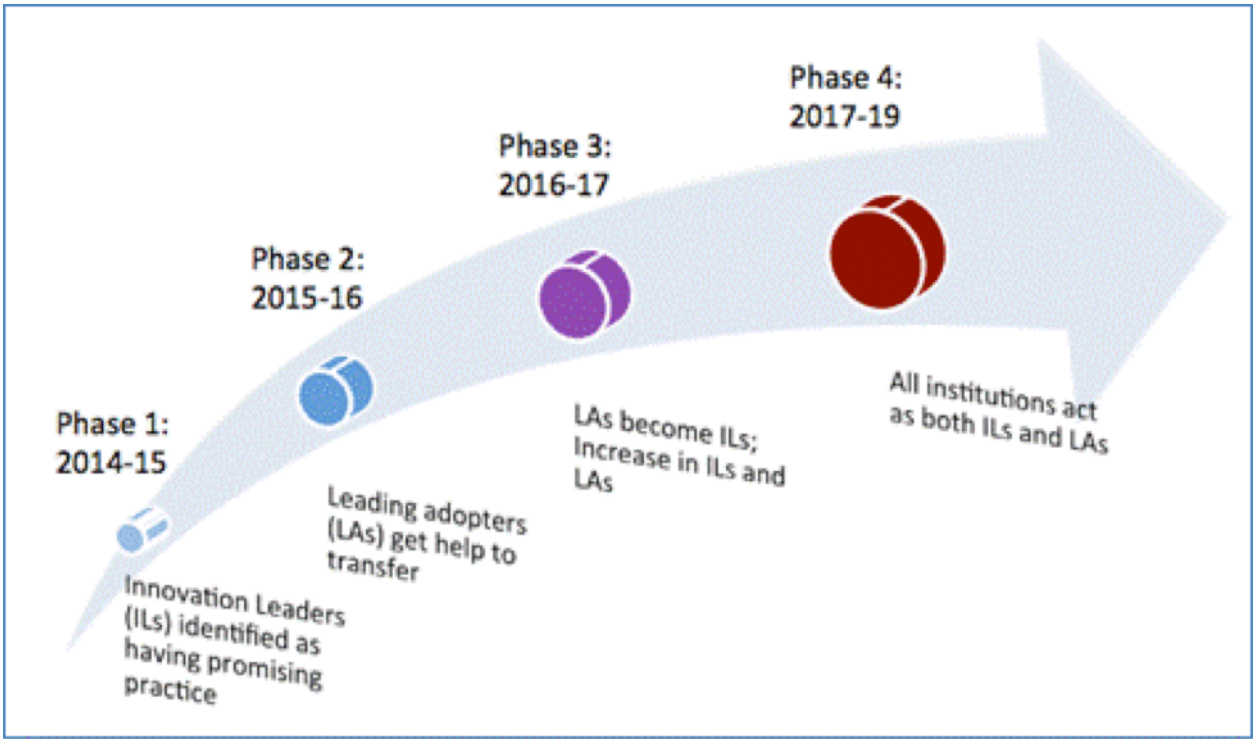

Figure 4 - Timeline and milestones for increasing teaching innovation in a sustainable way

Teachers, Heads and schools need the signal from government and official bodies that it is important and valuable to invest their time and energy in learning technology innovations. At present the drivers they are responsible for prioritise the conventional, and have not adapted to prioritising the new and the digital. The ideas and innovations will develop bottom-up, but the recognition, incentives and rewards can only be top-down.

Annex C: Detailed reflections on assessment recommendations

Paper-based tests cannot assess the new discipline knowledge and new skills and competences that are made possible by digital technology, which is why Luckin et al (2012 p.64) identified that "Much existing teaching practice may well not benefit greatly from new technologies". Referring to paper-based assessment Jencks (1972 in Gardner 1999 p.97) noted that "there is ample evidence that formal testing alone is an indifferent predictor for success once a student has left school"; this lack of authenticity has been exacerbated by the changes that digital technology has had on society. Digital technology-enabled testing is being adopted in many sectors, including HE and FE, but has had very little impact on high stakes assessment in schools in the UK (though it is being implemented in the USA, Finland and Australia).

Twining et al (2006 p.20) discussed problems with current (paper-based) assessment models in their report for Becta on the Harnessing Technology Strategy:

> There is strong support for the view that we are using the wrong 'measures' when it comes to evaluating the benefits of ICT in education (for example Hedges *et al* 2000; Heppell 1999; Lewis 2001; Loveless 2002; McFarlane 2003; Ridgway and McCusker 2004). Heppell has long argued that the ways in which we assess learning that has been mediated by ICT is problematic, and has illustrated the problem using the following analogy:
>
> 'Imagine a nation of horse riders with a clearly defined set of riding capabilities. In one short decade the motor car is invented and within that same decade many children become highly competent drivers extending the boundaries of their travel as well as developing entirely new leisure pursuits (like stock-car racing and hot rodding). At the end of the decade government ministers want to assess the true impact of automobiles on the nation's capability. They do it by putting everyone back on the horses and checking their dressage, jumping and trotting as before. Of course, we can all see that it is ridiculous.' (Heppell 1994 p154)
>
> It seems clear that current assessment practices do not match well with the learning that ICT facilitates (for example Ridgway and McCusker 2004; Venezky 2001) and there is strong support for the need to change how we assess learning in order to rectify this problem (for example Kaiser 1974; Lemke and Coughlin 1998; Lewin *et al* 2000; McFarlane *et al* 2000; Barton 2001; ICTRN 2001; Trilling and Hood 2001).

Assessment is linked to accountability in schools, which results in assessment being a key driver of schools' behaviours and practices. Evidence from the 22 Vital Case Studies in English schools (Twining 2014a) and the 13 Snapshot Studies in Australian schools (Twining 2014b) indicates that current (paper-based) high stakes assessment inhibits the use of digital technology in schools. Schools that were making extensive use of digital technology reported that there was a mismatch between what they were doing and what their students would be assessed on. This meant that they reduced their use of digital technology and moved back to traditional forms of teaching about three months before high stakes national assessments. At the most

basic level this was to allow their students to develop their hand writing muscles so that they could write for up to six hours per day during the exam period. More fundamentally they needed to teach their pupils how to write exam answers on paper, as the process is different to word-processing your answers (even if the spell checker and grammar checker are disabled). This provides a disincentive for schools to invest in digital technology (as it will not be fully utilised for a high proportion of the time).

A great deal of work on digital technology-enabled assessment in schools took place in England prior to 2010. However there has been little growth in digital technology-enabled testing in schools since then. This reflects changes in the political and regulatory climate that increased the risk to exam boards of carrying on working in this area. However, with active support from the DfE and Ofqual exam boards would be keen to progress on-screen testing for GQs in schools.

Preliminary discussions to explore the issues surrounding the development of technology enabled summative testing in secondary schools have already taken place with representatives from the following stakeholder groups: the Department for Education (DfE), Ofqual, Exam boards (e.g. AQA, Pearson), DRS (a company who handle over 9 million GCSE scripts per year on behalf of exam boards), the British Educational Suppliers Association (BESA), educational suppliers, providers of computer based assessment systems (e.g. BTL; Pearson), organisations in other countries who are exploring this area (e.g. The German Institute for International Educational Research, who developed and implemented computerised assessments for PISA).

We have been liaising with Andrew Fluck who developed the Tasmanian eExam system and have prototypes of demonstration exams. We have also obtained copies of Digabi (the system being developed in Finland). In both these cases computers are booted up from the flash drive, which runs a version of Linux and prevents access to the hard drive, the Internet and other ports. This reduces the risk of students cheating and ensures that they all have access to 'the same' environment and software on their machines. Both these flash drive based systems need further development, particularly in relation to demonstration examinations and the logistics of how they would be deployed at scale in schools in the UK. BTL and Pearson already have expertise and systems that could address many of the logistical and pedagogical challenges associated with digital technology-enabled testing in schools.

One of the problems with previous attempts to implement digital technology-enabled testing in schools is that they attempted to address too many issues simultaneously. The eExam system includes a successful change management strategy that allows schools to initially focus on the technical and logistical challenges, before having to deal with the pedagogical issues and concerns about the reliability and validity of new forms of assessment. Figure 5 provides an overview of the stages that the Tasmanian Department of Education went through when they trialled the eExam system in high stakes exams (specifically Information Technology and Systems) in their secondary schools. The eExam approach builds on the use of students' own technology, reflecting the growth in Bring Your Own (BYO) strategies in schools. Complementing this with a paper-replication strategy, in which the same exam can be taken on paper or on-screen goes a considerable way to addressing concerns about the technical infrastructure in schools, and risks associated with technology failure. This is a transition phase to simplify the challenge of moving from paper-based to digital technology-enabled testing that utilises the full potential of the digital technology.

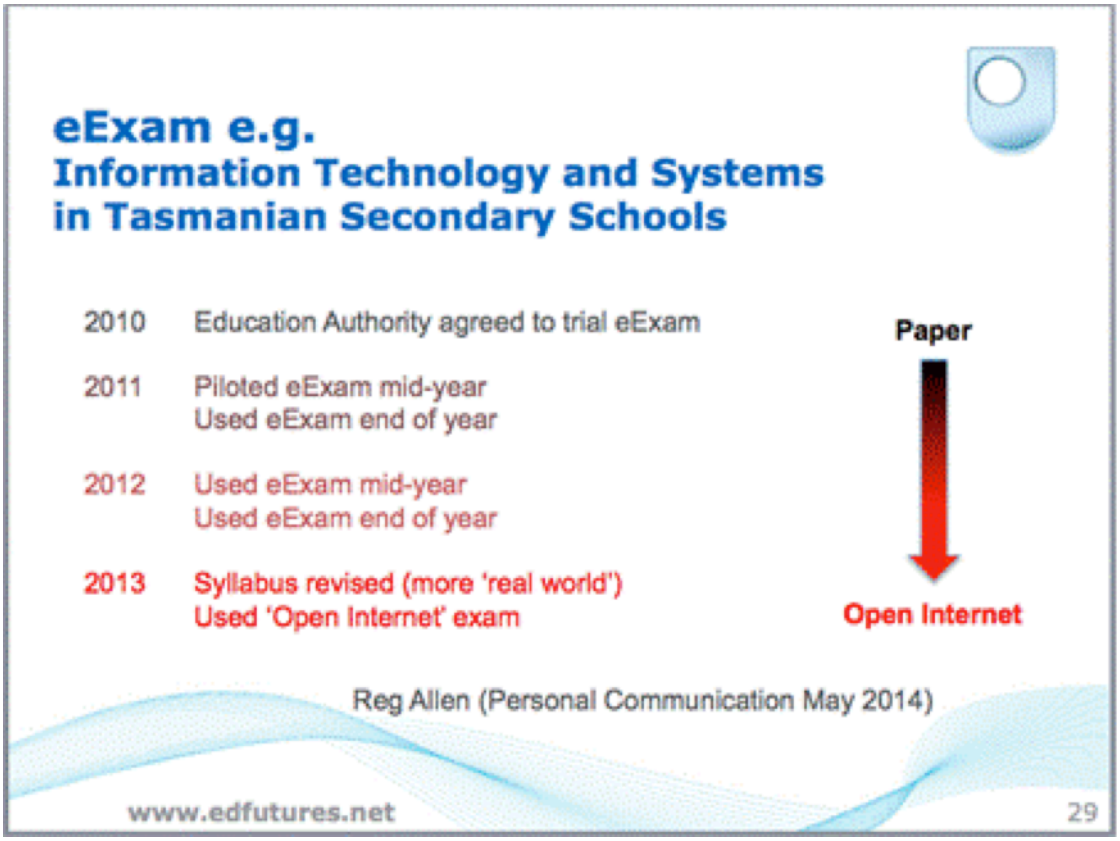

Figure 5 - Overview of the development of the Tasmanian pilot of Andrew Fluck's eExam system (Twining 2014c)

Evidence from the Tasmanian trials and from the Your Own Technology Survey in England (see **http://www.yots.org.uk**) suggests that a significant proportion of secondary school students already have access to mobile devices that they could use in school. This reduces the burden on schools to provide computers for the digital technology-enabled exams, however, there would continue to be a need for them to support students who did not have their own devices and who wanted to take the paper-based exam. The paper-replication approach also makes it possible for some students to do the exam on paper if they prefer. Indeed, one of the fail-safe elements of the approach is that should there be a technical problem with a machine then the student can continue the exam on paper (and the answers they have already provided will be saved on their flash drive). Where spelling and grammar are important the spelling and grammar checkers on the computers can be disabled.

As already noted, paper-replication is not the intended end-point, and there is a danger that the move to effective digital technology-enabled assessment might stall at this point. This risk needs to be balanced against the practical challenges of moving directly from paper-based to full-blown digital technology-enabled assessment in schools.

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