New assessment scenarios

Contents

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We also take the opportunity to remind the reader that, although the individuals consulted informed the research process, the final responsibility of everything stated in this report rests with its authors.

Executive summary

This report outlines some of the main challenges and opportunities that lie ahead in the field of technology-enhanced assessment. Our primary aim was to identify some of the main trends in school assessment and situate them within current developments in policy and academic research, in the UK and internationally. Some of these trends are associated with technological innovation, but more often they relate to wider aspects of pedagogy and policy.

The findings of this study can be summarised in two high-level points:

- Assessment can benefit from a number of innovations that, if embraced, can have a positive impact on all other aspects of teaching and learning. Such innovations are clustered in the three scenarios which constitute the main outputs of the study. They are pedagogical, institutional and technological in nature and include: use of different sources of data to complement basic attainment; introduction of notions of interpretive validity; increased emphasis on instructional design to support formative assessment.

- There are calls for assessment methods in schools to keep pace with major shifts that are taking place in society, and which are reflected in the ways people participate in a variety of technology-enhanced contexts.

Scope

The report does not provide an extensive review of e-assessment in all sectors where this is implemented (eg vocational training or work-based learning) as this was beyond the scope of the study. Moreover, this report is not aimed at a specialist audience of assessment or e-assessment experts, but mainly at practitioners, school leaders and policy makers, hoping that it will contribute to the ongoing, national debate about the need for and the modalities of assessment reform.

The ideal outcome of this study is to facilitate a reflective process of social learning around documented trends; the next logical step in this process would be to engage decision makers and stakeholders in a debate about the factors and the choices that might empower or frustrate the trends, thus opening up a space for action. Such activity of public engagement was also beyond the scope of the project, but we see it as its ideal continuation.

Although we set out to investigate both formative and summative assessment, the suggestions made by the experts and the practitioners we consulted tended to focus on innovation in formative assessment. The reasons for this are likely to be sought in the nature of the regulatory environment in the school sector, which favours experimentation in the area of low-stakes assessment, but tends to constrain the adoption of more innovative approaches in high-stakes, summative assessment. These points will be further clarified in section five of the report.

Methodology

The study used methods developed in the field of futures studies. Our aim was to create plausible scenarios of future assessment practices, in order to stimulate critical thinking and debate around documented trends. More specifically, the methodology was based on a mixed approach combining elements of Delphi technique, Futures workshop and Future Technology Workshop. These methods are all based on the systematic analysis of expert input and opinion, and their application will be described in more detail in the Methodology section of the report. The timescale of the project was June - November 2010.

Outcomes

The outcomes of the project are three scenarios:

- Multi-data assessment. In this scenario, accountability is increasingly organised around different types of evidence and the ability to gather such evidence.
- Enhanced instructional planning. In this scenario, teachers act as instructional designers, using research-based, sometimes semi-scripted techniques to shape learning and to encourage formative assessment in a structured way.
- Interpretive assessment. In this scenario, aspects of assessment are based on the notion of interpretation, and on a different paradigm of validity that tries to reconcile standardised measurement with an understanding of how learners behave in authentic contexts.

Each scenario is not a prediction but describes a hypothetical future for assessment. An important assumption common to all scenarios is that high-stakes summative assessment will not disappear, but there will be more latitude for schools and individual teachers to gather evidence of learning and act accordingly. The timeframe considered is five to ten years.

Another output of the project is the documentation of four case studies that illustrate effective practice in technology-enhanced assessment.

Finally, our consultations and interviews highlighted general technological opportunities and challenges common to all scenarios, these are summarised as follows:

- Technology can help in many fundamental assessment areas: improving reliability, scalability and efficiency, and even authenticity[1].
- However, there was consensus amongst our interviewees and stakeholders that current technology cannot remove the role of the human element if assessment is to focus on the evaluation of complex, multidimensional skills, like problem solving and critical thinking.
- Too much emphasis on technology as a means to capture 'authentic' performances runs the risk of turning assessment into a superficial exercise that tends to favour presentation skills.
- There is a need for technology-enhanced assessment to provide instructionally tractable material, that is, material that reflects progression along a continuum or trajectory, so that once teachers know where a student is, the very nature of the continuum helps them determine what kinds of instructional experiences should follow. The inability to develop such structured, and scalable, approaches is a barrier to a more meaningful and effective use of technologies in assessment.
- Where teachers and schools are free to identify and select tools and resources according to their own needs there are generally high levels of interest in the adoption of more innovative methods for formative assessment.

1 Authenticity in this report does not refer to tackling plagiarism, although this is an area where technology can provide many benefits. By authenticity we mean a focus on tasks that reflect real, meaningful engagement in **authentic**, economically and socially relevant tasks, where basic content knowledge is still necessary but no longer sufficient.Authenticity can also mean an emphasis on activities that mirror the natural process of learning, as opposed to standardised testing, which as noted often in the literature has destructive effects on education (eg Nichols & Berliner, 2007).

Introduction

Assessment is widely considered as one of the most crucial dimensions of the educational process. Its universally acknowledged importance is only matched by its resistance to reform.

As noted by Keri Facer in a Futurelab review[2] a few years ago:

> Anyone with an interest in how we create equitable, engaging and relevant education systems needs to think long and hard about assessment (...). If we wish to create an education system that reflects and contributes to the development of our changing world, then we need to ask how we might change assessment practices to achieve this.

Assessment reform is challenging because it requires changes at all levels of an educational system: teaching and learning, accountability, teacher professional development, school governance, policy and so forth.

For instance, examining the possibility of effectively integrating formative and summative functions of assessment, Black and Wiliam (2005)[3] identified eleven educational, public and political variables influencing chances of success:

1. beliefs about what constitutes learning
2. beliefs in the reliability and validity of the results of various tools
3. trust in the objectivity of formal testing
4. a preference for and trust in numerical data, with bias towards a single number
5. trust in the judgements and integrity of one's children's teachers
6. trust in the judgements and integrity of the teaching profession as a whole
7. belief in the value of competition between students
8. belief in the value of competition between schools – the market model of education
9. belief that test results are a meaningful indicator of school effectiveness
10. fear of national economic decline and belief that education is crucial to improvement
11. belief that the key to schools' effectiveness is strong top-down management.

In line with most research and current discourse on assessment, this report assumes that formative and summative assessments are in no way exclusive, and that their differences are not ontological but mainly pragmatic: they serve different purposes and both need to coexist in an optimal educational system[4].

With this in mind, we set out to consult experts and practitioners in order to outline some of the main challenges and opportunities that lie ahead. The main point which emerged from our consultations is that assessment can benefit from a number of innovations that, if embraced, might have a positive impact on all other aspects of teaching and learning. Often such innovations are not even 'innovative' in the strict sense as they rely on ideas that have been

2 Ridgway et al, 2004.
3 Black & Wiliam, 2005.
4 Black at al, 2010.

around for a long while (eg the method of comparative judgements to assess e-portfolios[5]), but they are usually accompanied by the need to rethink deep-rooted practices and notions on a wider scale. Often, but not always, they are based on specific technological affordances; in all cases they seemed to be associated with calls for assessment systems to keep pace with major shifts that are taking place in society, and which are reflected in the ways people participate in highly dynamic and technology-enhanced contexts.

These shifts have been investigated in Futurelab's Beyond Current Horizons research programme, which explored the future of education beyond 2025[6].The aim of the programme was to help the British education system develop an ongoing and sustainable response to the challenges it faces as society and technology rapidly evolve. It did so by documenting a number of socio-technical trends and raising some very fundamental questions about the aims and the methods of education. Some of these trends, those arguably more relevant to this report, are[7]:

- increasingly blurred boundaries between formal and informal context
- massive decreases in cost and massive increases in computing power available to individuals and organisations (Moore's law continues)
- the shift from networked to ubiquitous computing
- advances in semantic web technology may enable individuals to significantly augment capacity for intelligent analysis and synthesis of information, but distinctively human intelligence will continue to have value.

These shifts are by all means contested; nonetheless we believe that we should be engaging with them in the context of a public debate if we are to shape the future of education to suit our collective aspirations and needs. In this respect, school assessment arguably represents one of the main platforms for a discussion about possible, probable and preferable scenarios in education.

5 See project e-scape, information is available online at www.gold.ac.uk/teru/projectinfo
6 Further information is available online at www.beyondcurrenthorizons.org.uk
7 For other trends see Facer & Sandford, 2009

Methodology

This project used methods developed in the field of futures studies[8]. Our main aim was to create plausible scenarios of future assessment practices, in order to stimulate critical thinking and debate. The approach used in Beyond Current Horizons was also a source of inspiration[9].

The primary objective of our scenarios is to draw attention to current trends that have an impact on a range of futures. The main assumption behind this approach is that people make the future now, and although safe predictions are impossible, there are possible alternatives that can be envisaged. This approach has been explored by a number of authors and thinkers[10].

The ideal outcome of such an endeavour is to facilitate a reflective process of social learning around documented trends; the next logical step would be to engage decision makers and stakeholders in a debate about the factors and the choices that might empower or frustrate the trends, thus opening up a space for action. Such activity of public engagement was beyond the scope of the project, but we see it as its ideal continuation.

More specifically, the methodology was based on a mixed approach combining elements of Delphi technique[11], Futures workshop[12] and Future Technology Workshop[13]. The timescale of the project was June - November 2010. We suggest that readers refer to the original literature for a more detailed discussion of such methods. In this context, we wish only to emphasise that all three methods listed above are based on systematic techniques and tools to gather 'expert input', and that their combined use represents an effort towards triangulation of qualitative data[14]. Triangulation is an attempt to secure an in-depth understanding of the phenomena analysed. In this sense, it is not a tool or a strategy of validation but it represents an alternative to validation. Combining multiple methodological practices, empirical materials and perspectives, triangulation configures a strategy that adds rigour and complexity to a qualitative inquiry.

The experts and practitioners included in the final 'long-list' were identified via literature review (which unfortunately could not be systematised and presented in this report as it was beyond its scope), and conversations with our sponsor Becta. An initial panel of 12 experts met at the beginning of the project to lay the foundations and to set the initial agenda. This was followed by a period of consultations and interviews with additional experts (seven in total), which culminated in a consultation workshop to which 19 representatives from different stakeholder groups were invited. The groups were policy, awarding bodies, industry and practice. The first phase of the project resulted in three draft scenarios, which were presented in a poster at the 2010 E-Assessment conference held in Dundee, Scotland[15]. The three scenarios underwent a further critique and refinement process through the final, iterative cycle of data gathering which targeted a selected group of international experts and 'innovative' practitioners (12 in total). This cycle was based on an online questionnaire followed up by in-depth interviews. The final step was a Future Technology Workshop that involved seven technology experts from different backgrounds: computer science, immersive technologies and e-assessment.

8 Bell, 2003.
9 The "worlds" developed in BCH already present some of the elements which are at heart of our scenarios; those more closely associated with our findings being probably Trust Yourself and Loyalty points: www.beyondcurrenthorizons.org.uk/scenarios
10 Slaughter, 2002; Bussey & Inayatullah, 2008.
11 Beretta, 1996.
12 Jungk & Müllert, 1987.
13 Vavoula et al, 2002.
14 Denzin and Lincoln, 2000.
15 Perrotta, 2010.

The outcomes of the project are the three scenarios described in the following section. The scenarios are:

- multi-data assessment
- enhanced instructional planning
- interpretive assessment.

Each scenario is not a prediction and only describes a hypothetical future for assessment, not by presenting visionary developments removed from current practice, but more by describing conditions in which certain innovations or ideas, which undoubtedly are already happening in more or less large 'pockets', have scaled-up and become more systemic. The timeframe considered is five to ten years. We also recommend that the scenarios are not viewed as mutually exclusive, as between them there are several connections and areas of overlap. In keeping with futures research, their development was achieved by striking a balance between empirical observation, the analysis of certain events and trends and 'aspirational' thinking. Still in line with such research, we believe that scenario methodology can help people engage in conversations about the future, by producing images of possible, probable and preferable futures which can act as catalysts for reflection and action[16]. Another output of the project is the documentation of four case studies that illustrate effective practice in technology-enhanced assessment.

16 Bell, 2003.

The scenarios

Multi-data assessment

In this scenario attainment data is still prevalent, as high stakes national assessment is unlikely to disappear in the next five to ten years. However, accountability processes have become more distributed and "local" and more open to different types of evidence. This allows schools to account for the ecological factors that influence performance at different levels, from the student level to the community level. In England, CVA (Contextual Value Added) data and other similar measures have become more relevant, not just for struggling schools in deprived areas. CVA is a measure of school performance that uses statistical models to balance pupils' attainment with other factors such as the level of deprivation they experience, their special educational needs, and ethnicity and gender[17].

Accountability is increasingly organised around different types of evidence and the ability to gather such evidence. Amongst the main drivers, there are key policy developments in the UK and abroad that have increased the independence of schools, or clusters of schools, from the influence of local authorities[18], and have eased their access to funds to initiate and manage their own improvement plans[19].

Schools are required to systematise and present different types of evidence according to shared and transparent standards, but they are also given freedom as to how to collect data and who to involve in the process.

Local inquiry processes are initiated in which schools take ownership of their ongoing improvement. Methodological expertise becomes more relevant and needs to be fostered within the school community[20]. Crowdsourcing[21] and social networking are used as tools to engage stakeholders in the local community and contribute to data gathering[22].

In this scenario, technology is not only used to gather a diverse range of data but also to organise and visualise such data in ways that support collective Data-Driven Decision Making (DDDM). Such evidence is then used as the basis for remedial action or for further improvement, engaging the whole school community and possibly other stakeholders, such as local businesses or public sector agencies who are likely to employ more people with direct links into communities. The process involves all aspects down to the pedagogies and instructional methods used in classrooms.

17 See Ofsted, Using Data Improving Standard, 2008 available online at www.ofsted.gov.uk
18 The Academies Act was approved by the UK coalition government on 29 July 2010. The move towards academies in the UK meant that schools could opt out of local authority control and being given funding directly, including the extra money usually given to the local council to provide educational services.
19 In 2010, the US Institute of Education Sciences awarded grants to 20 state education departments for the design and implementation of state-wide longitudinal data systems. These grants, funded through the American Recovery and Reinvestment Act (ARRA) of 2009, were intended to "support states with the development and implementation of systems that promote the linking of data across time and databases, from early childhood into career, including matching teachers to students, while protecting student privacy and confidentiality" consistent with applicable privacy protection laws. Source: US Department of Education. Available online at www.nces.ed.gov/Programs/SLDS
20 See, for example the Data Wise model (2005). The model consists of three steps which are further subdivided into eight steps. The main assumption behind the model is that school improvement efforts are likely to be more effective if responsibility for data interpretation is shared amongst school community members. The model suggests that members should develop 'assessment literacy', an understanding of how to read and interpret different types of data (quantitative and qualitative) about learners and the school. Although this can be initially supported by outsiders, such knowledge needs to become part of the larger community's repertoire (see also Moss et al, 2006).
21 See en.wikipedia.org/wiki/Crowdsourcing for a definition of Crowdsourcing.
22 See, for example, hive.arkansas.gov. The goal of this project was to develop a visualisation tool that would allow educators to more easily manipulate data. The tool allows teachers and head teachers to upload their own local data and use the same visualisation tools for analysis of local data. To help alleviate problems associated with educators having little time to come together for data analysis, it was decided that social networking tools be included in order to facilitate asynchronous collaboration (Gibson and Talburt, 2010).

New models like the Support Model are implemented to increase responsiveness and to support formative assessment[23].

Part of this scenario is also the use of serious games and simulations capable of collecting complex data about learners in real time, as they perform tasks and solve problems. According to one of our interviewees:

> "This is where digital media become really useful. I think of this through the way in which video games teach people by the way they assess. In any digital learning, whether it's in a game or a virtual world, you're collecting copious information on the person, and you know what they're doing moment by moment, and you're organising that data for multiple purposes: to resource the learner, to tell stakeholders how this person is doing. Since you know what they are doing moment-by-moment, then assessment should become about trajectories of development".

One interesting, current example is Quest Atlantis (QA)[24], an online/offline multiplayer game in which children aged 9–15 can immerse in meaningful inquiry tasks. The project aims to encourage "transformational play" and comprises both online and off-line learning activities based on an engaging narrative.

Assessment is embedded into the system, and works by asking students to make informed choices in critical fictional situations, which are recorded by the system for assessment purposes. To successfully solve the problems they encounter, students need to demonstrate causal reasoning skills, subject knowledge in physics and chemistry, and be able to understand how systems work at both a macro and micro level. When playing the game, teachers are also encouraged to use formative pedagogies to support students' learning. For instance, in some cases players are required to produce systems-diagrams to show how all the different features of a system relate to each other. Subsequently, the software allows teachers to superimpose their diagram with that of an 'expert' and students can reflect on their approach to the task.

Enhanced instructional planning

In this scenario, the challenges of implementing formative assessment, despite widespread consensus about its effectiveness, have highlighted the need for more effective professional development for teachers. This has led to significant changes in the nature of pre-service and in-service teacher training, which are now beginning to provide practitioners with the skills and the support they need to successfully implement formative practices such as:

- classroom dialogue
- feedback through marking
- peer and self assessment
- formative use of summative tests[25].

The teacher is now more central then ever: an expert orchestrator managing complex learning situations, where students, resources (including technology) and the curriculum interact dynamically.

23 "In any context when we need to assess understanding it is possible, at least in principle, to replace the difficulty model with the support model, to measure how much help students need to succeed instead of how often they fail. Instead of measuring how high a high jump bar they can clear without help, we propose to measure how high a level of support they need to clear any bar, however high it seems at first" (source: Ahmed & Pollitt, 2010).

24 Information available online at www.en.wikipedia.org/wiki/Quest_Atlantis

25 Black & Wiliam, 2006.

According to research, the term orchestration refers to the teacher playing a key role in designing and conducting 'integrated' learning scenarios, that is, scenarios that combine individual activities (reading, summarising, etc), team activities (arguing, explaining, problem solving, etc) and class-wide activities (lecturing, debriefing, etc)[26]. In this scenario, formative assessment is indistinguishable from 'good' pedagogy, which requires robust instructional planning. It has also become much clearer that teaching and learning, and the assessment practices that they entail, are situated within particular social contexts.

> "'Assessment' is not a special kind of process or event that stands outside the normal cultural life of a classroom... Attempts to mark assessment as 'different' from learning may serve only to confuse learners and reduce the power of assessment to drive learning in desirable directions." (Carr & Claxton, 2002: 28)

The change in role from presenter of content to orchestrator of active, self-directed learning means more demanding professional tasks for teachers, and the need to develop and implement clear pedagogic strategies. Teachers draw on the latest methods to encourage argumentation and rich formative interactions between them and the learners, and amongst learners: feedback is distributed and free-flowing.

For instance, in this scenario teachers know how to choose and implement micro and macro-scripts to support learning. Scripts have been developed in the field of CSCL (Computer Supported Collaborative Learning), and they originated as a metaphor to equate sequences of tasks and interactions in a computer-supported environment to the behaviours prompted and coordinated during a staged performance[27]. These scripts can vary from rather psychology-oriented scripts (micro-scripts) to rather pedagogy-oriented, larger-grained scripts (macro-scripts). A micro-script models a process that needs to be internalised by students. For example, a micro-script will make a student state a hypothesis and will prompt a peer to produce counter-evidence. On the other hand, a macro-script is more like a broader pedagogical method that can be used by a teacher to encourage desired interactions, hence setting the conditions that can support formative assessment activities, such as elaborating on content, explaining ideas and concepts, asking thought-provoking questions, constructing arguments, resolving conceptual discrepancies or cognitive modelling.

As for the role of technology, teachers in this scenario take advantage of automated processes that do the "heavy lifting" of assessment for them, identifying relationships between performance data, and presenting them in automatically generated reports for the final, interpretive evaluation. According to one of our interviewees:

> "automating a lot of the processes (will be important) because teachers everywhere are overwhelmed, and to add anything new to their platter would be absurd. If you can develop something that will free up some of their time, which is what a lot of these systems do, for example Bayesian models and machine learning capabilities – these are automated processes which do the heavy lifting for the teachers, leaving them able to see reports which show where the kids are probabilistically with regards to these different competencies".

26 Dillenbourg, 2010.

27 Tchounikine, 2008.

Interpretive assessment

In this scenario, teachers routinely perform holistic judgements of 21st century skills. Popular frameworks for such skills are, for example, those provided by the US-based partnership for 21st Century skills[28] or the UK Personal Learning and Thinking Skills (PLTS)[29]. Skills included in such frameworks generally include:

- critical thinking and problem solving
- independent inquiry
- creativity
- communication
- collaboration
- information literacy
- flexibility and adaptability
- initiative and self-direction.

In this scenario, teachers are afforded the opportunities and the technological resources to make complex evaluations of learners' performances and traits. New types of assessments complement traditional testing, and technology provides ways to support and standardise the process of holistic assessment, ensuring validity and reliability[30].

Amongst the key developments, there is the new-found importance of 21st century skills, highlighted by new research that has succeeded in increasing international consensus on how to identify and support such skills[31].

Thanks to this research, it has become apparent that complex dimensions like creativity and critical thinking need to be assessed in context and within authentic tasks. This puts a different type of expectation on teachers and learners alike: teachers are required to draw on more sophisticated repertoires for their judgements; learners are expected to actively generate and present evidence about themselves, contextualising it in meaningful, real-life situations. E-portfolios have become widespread and they are filled with rich and complex data about achievements and aspirations in a range of contexts, not only in school.

The holistic assessment performed in this scenario is largely an interpretive activity, based on the ability to read and understand

28 Available online at www.p21.org
29 Available online at curriculum.qcda.gov.uk

30 See, for instance, the already mentioned e-scape project, in which dynamically generated e-portfolios were judged holistically in pairs, through an automated process that guaranteed rigour and reliability across judges. Information is available online at www.gold.ac.uk/teru/projectinfo.
31 Cisco Systems Inc, Intel Corporation and Microsoft Corp unveiled plans in January 2008 to sponsor a major research project to develop new approaches, methods and technologies for measuring the success of 21st century skills. Five "founder countries" agreed to take part in the research and deployed pilot projects over subsequent years. The five were Australia, Finland, Portugal, Singapore and the United Kingdom. The project operated through five working groups, each of which reviewed the current state of development and proposed research and development activities to address deficiencies. Together, the working groups comprised individuals from more than 60 research institutions. OECD and IEA, the leading global assessment agencies, are both planning to use the research findings in their major rounds of assessments: OECD in Program for International Student Assessment (PISA) 2012 and IEA in 2013. atc21s.org/home

whole bodies of evidence rather than de-contextualised bits of information[32]. Teachers and learners equally contribute to the definition of criteria and to the development of flexible, adaptive frameworks. This helps them draw inferences and negotiate IDAs (Interpretations, Decisions, Actions) about the next formative steps.

An interesting take on the value of interpretation in evaluating 'learning outcomes' can be extrapolated from the work carried out by the MacArthur Digital Media & Learning research group[33]. The group suggests that an ethnographic, interpretive approach could be an effective and valid method for assessing technology-enhanced learning in authentic, real life settings. Ethnography would be necessary to understand how media and technology are meaningful to young people in the context of their everyday lives. From this perspective, the content of the media and the media platform are not the most important variables for determining social and cognitive outcomes; what counts is to observe whether and how media literacy practices are part of social lives, beyond the boundaries of formal, institutional contexts like schools. From an ethnographic point of view, outcomes are not only whether a child can technically master a certain medium, but also in things such as the ability to negotiate status amongst peers, gaining autonomy from parents, and developing interest-driven knowledge in specific domains. According to the authors, "the strength of this approach is that it enables us to surface, from the empirical material, what the important categories and structures are that determine new media practices and learning outcomes" (Ito et al. 2010:4-5). Such theoretical insights cannot probably help create specific assessment procedures but they can be useful to challenge current paradigms in assessment and curriculum development.

32 The new emphasis on holistic interpretation is supported by a rediscovery of 'hermeneutics', the theory of interpretation, and its more practical implications. "At the most general level, hermeneutics characterises an integrative approach to combining sources of evidence in developing an interpretation. In this approach, judges seek to understand the 'whole' body of evidence in light of its parts and the parts in light of the whole [...] this iterative process is known as the hermeneutic cycle. As new sources of evidence are encountered, developed and brought to bear, the cycle expands, thus allowing a dynamic approach to interpretation". Source: Moss et al, 2006, p 109.

33 Ito et al, 2010.

Technology: opportunities

There are relevant technological considerations to be made which are common to the three scenarios. Our consultations and interviews suggested that technology can help in many fundamental assessment areas: increasing reliability, scalability and efficiency, and even authenticity[34]. Instances of how technology can support the assessment of authentic performances have been provided in the scenarios: the 'pairs engine' developed for e-scape, which allowed teachers to streamline the otherwise long and complex process of comparative judgements of creativity and innovation[35]. Another interesting example previously discussed is the use of serious games, simulations and 'epistemic games' capable of collecting complex data about learners in real time, as they perform authentic tasks and solve problems. Epistemic games are those where players solve real-world problems in simulated contexts that recreate the conditions of specific professional and disciplinary fields, so that learners can address the same challenges that, say, real engineers or urban planners face in their work[36].

Another suggestion which emerged from the findings is that mobile, ubiquitous hardware will be one of the main solutions to evidence-capture in the near future, allowing users to fulfil many functions simultaneously at a fraction of the cost, and enabling them to document authentic performances as they happen in real contexts, both formal and informal.

However, there was consensus amongst our interviewees and stakeholders that current technology cannot remove the role of the human element if assessment is to focus on the evaluation of complex, multidimensional skills, like problem solving and critical thinking. As suggested in the Interpretive Assessment scenario, the main component of this role is the ability to develop, analyse and integrate different types of evidence, through a dynamic, holistic process of inquiry that involves teachers and learners alike, allowing them to consider dialectically how interpretations lead to decisions and then to specific actions[37].

An interesting example of a very innovative approach to pedagogy and assessment, where technology and the human element coexist, is the work carried out at by the AAA lab at Stanford University[38]. Previous research that informed this approach includes studies on artificial intelligence, combined with two different traditions that strongly emphasise self-regulated learning and critical thinking skills:

- Learning by teaching - based on the literature about graduate students who improved their own learning by becoming teaching assistants, hence developing process skills to tackle the sort of challenges teachers face on a daily basis. These include: managing small group interactions, tutoring peer-assisted tasks, developing explanations, anticipating what needs to be assessed and taught, and managing conflict and uncertainty.

- Learning by programming - based on substantial research and educational practice carried out since Seymour Papert's work on Logo[39], which suggested that learning to program can be conducive to the development of high-order thinking skills (eg planning and problem solving) as well as domain-specific knowledge, such as mathematics or physics.

34 See also: Emerging technologies for learning report on e-assessment for other opportunities. Available online at **emergingtechnologies.becta.org.uk**
35 **www.gold.ac.uk/teru/projectinfo**
36 See **epistemicgames.org** for information and publications.
37 The nature of so called '21st century skills' calls into question many established notions about validity, and tends to favour a more holistic, flexible perspective. The work of Pamela Moss on interpretive validity is very relevant in this respect, see Moss at al. 2009.
38 More information is available online at **www.aaalab.stanford.edu**
39 Papert, 1980.

The AAA researchers brought together these ideas into the notion of TA (Teachable Agent) Computer Environments, in which fictional characters require knowledge of disciplines such as mathematics, science or history to solve problems. If the agents have been taught properly they solve the problems they confront; otherwise they need to be further 'educated'. Learners and teachers collaborate in the programming of the learning environments in which the TAs operate, using tools and techniques (eg graphs and formulas) to represent complex knowledge and illustrate relationships that affect the outcomes of the simulations. Assessment is built into the system, for instance when students and teachers identify sub-goals (ie specific measures of performance, for completing a challenge), and each sub-goal creates a need to learn domain-specific notions. Students experiment with different plans and receive feedback on the plan's success, hence determining whether they need to revise their understanding. During the testing sessions, researchers noticed that students showed a great perseverance in teaching/programming the TAs, effectively using resources and revising their own understanding without losing interest. The researchers' measures indicated that students (supported by their teachers who provided a fundamental role to interpret and facilitate activities, and helped define criteria of what constituted good performance), viewed assessment as an opportunity to critically evaluate their own learning and plan the next steps.

Technology: challenges ahead

Issues and challenges were identified both at the micro and the macro level. At the micro level, too much emphasis on technology as a means to capture 'authentic' performances runs the risk of turning assessment into a superficial exercise that tends to favour presentation skills. One solution that was proposed is the development of a 'viva model', by which students are interviewed about their work and are provided with opportunities to demonstrate their understanding. This interaction could then be recorded and included in an e-portfolio, alongside other types of evidence.

However, many of the experts and practitioners we consulted reminded us that the type of evidence captured, with or without technology, depends first and foremost on the design of the assessment activity. This activity needs to provide instructionally tractable material, that is, material that reflects progression along some kind of continuum or trajectory, so that once teachers know where a student is, the very nature of the continuum helps them determine what kinds of instructional experiences should follow[40]. The inability to develop such a structured, and scalable, approach is a barrier to a more meaningful and effective use of technologies in assessment. As one of our interviewees noted:

> "Formative assessment only happens when the assessment itself is instructionally tractable. When the teacher sees the results of the assessment, the teacher should know what to do. You could give (teachers) a framework for the analysis of data, but that would never be more than diagnostic".

On a more systemic level, research commissioned by Becta suggests that there is a strong growth in the uptake of technologies for assessment in schools, but mainly in the context of low-stakes formative assessment, something that is not mirrored in the area of summative high-stakes assessment[41]. According to this study, which was also based on interviews with experts and other stakeholders, reasons for this are economic and political at the same time. Where teachers and schools are free to identify and select products according to their own needs there are generally high levels of interest in the adoption of more innovative tools for formative assessment.

However, the regulatory environment for summative high-stakes assessment means that standard models of technology adoption simply do not apply in this area. A 'standard' model of technology adoption is, for instance, the one described by Everett Rogers[42] in 1962, based on the progression from innovators and early adopters to the majority, and eventually to the 'laggards' (Fig.1).

As already mentioned, the current regulatory environment in summative assessment (in the UK, but there are probably similarities in other educational systems around the world) is impeding innovation adoption according to the above model. Such an environment is characterised by the reticence and concern of awarding organisations about fairness, potential impact of change at all levels, including that of public opinion, and about the high upfront investment required to offer summative e-assessment. This is often the case despite the high levels of enthusiasm and expertise that some of these organisations possess in relation to more innovative assessments.

40 Wiliam, 1993.

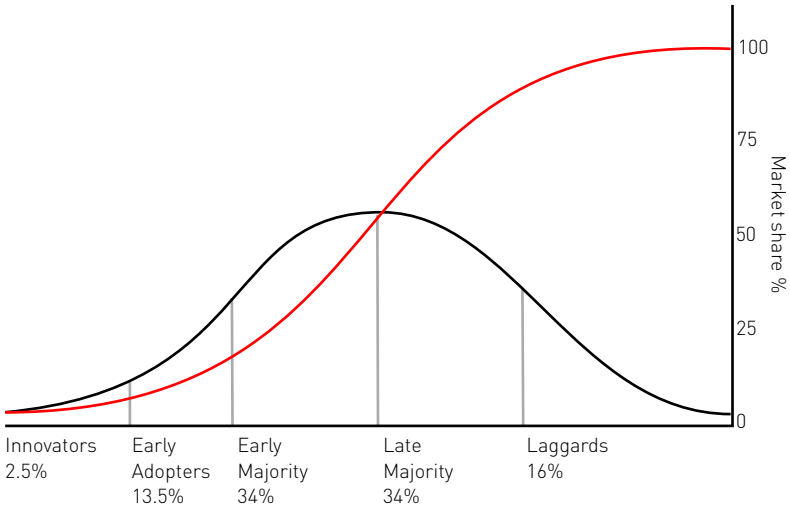
41 Winkley et al, 2010 (unpublished).
42 Rogers, 1962.

The study highlights the current leadership and the enthusiasm of awarding bodies as a necessary condition for a wider uptake of summative e-assessment in UK schools; but also points out that this needs to be matched by stronger encouragement from policy makers, as well as by a reorganisation of summative examinations. In fact, these still require exams to be sat by all candidates at the same time which, the study argues, is a fundamental barrier to a more systemic and sustainable adoption of e-assessment, as least with the current technological infrastructure.

One final, valuable comment with respect to technological opportunities and challenges in school assessment (both formative and summative) comes directly from our interviews. Perhaps a 'word of warning' that somewhat manages to sum up a number of very relevant considerations which were discussed with experts and stakeholders at several points throughout this project.

> "The technology is only as good as the use you make of it. You can do more damage with technology than you can do without it (...) There are loads of potential pitfalls. All the learning we've been talking about is ironically espoused by both liberals who want to change our system, and by big businesses like Microsoft who want to sell products, and Intel who want to make products that are information intensive. They see that they can sell customised 24/7 learning tools to wealthy people but also they see this copious gathering of information on development as a form of supervision; as a much better way to supervise people and have bosses and principals and managers be able to police people. This technology can either liberate, by being really focused on resourcing the learner, or it can be a much better way to manipulate people."

Figure 1. The diffusion of innovations according to Rogers (1962)



Case studies

Introduction to the case studies

There is a high level of dissatisfaction with current assessment practices within academic discourse, and this programme of research intended to address some of these issues by providing scenarios of effective assessment practices based on what is probable, possible and preferable. However, despite such negativity, it must be remembered that there are many positive examples of innovative assessment practices happening in classrooms around the country at this time. The following case studies highlight a small selection of such examples, where teachers are providing valuable and creative learning and assessment experiences for their students, often aided by the use of digital media. The stories below demonstrate that effective formative assessment can happen within the tight accountability and data-driven frameworks found in today's schools, and that a culture of risk-taking ought to be encouraged in order to foster and promote such practices.

The case studies were sourced from a combination of desk research and in-depth interviews with practitioners, and served as a theoretical starting point for the construction of the three scenarios. One key point to note is that the majority of these narratives represent the activities of a select number of teachers within individual classrooms. It has been difficult to find examples of more widespread innovations on larger scales, whereby whole schools or local areas have engaged in strategic transformation of their formative assessment practices, or where national initiatives have served to trigger the development of innovations. This point alone reflects the restrictive nature of current accountability frameworks, and demonstrates that much work needs to be done on a larger scale to overcome these cultural and political barriers if the scenarios are to be achievable.

As such, the case studies were not designed to exactly mirror the scenarios; indeed, they were identified before the scenarios were fully formed. Rather, the case studies represented instances of current practices through which we were able to identify common themes and priorities, which taken together worked as an interesting starting point for the development of the three scenarios. It is hoped that themes such as holistic assessment, 21st century skills, continuing teacher professional development, peer assessment and the use of technology are recognisable throughout the final scenarios, as they are in the stories below.

Beyond the 'snapshot'

Oliver Quinlan, a Key Stage 2 teacher in the Midlands, recognises the need to go above and beyond the restrictive culture of summative testing in the primary sector. The small snapshot of a child's performance, captured by SATs tests and converted into numerical data, neglects much of the richness of a child's school experience and development. He makes the suggestion that teachers of KS2 can learn a lot from the practices in Early Years settings, where observation, holistic assessment and an emphasis on skills development rather than attainment, are key, and ubiquitous. Many Early Years practitioners are embracing new technologies and utilising a variety of methods to document the process of a child's development rather than just the end result. The evidence is presented in a digital portfolio, and provides a rich picture of a child's progress, by focusing on how children respond in different situations, what they are interested in and what they can do.

Oliver has tried to adopt a similar approach to assessment in his classroom on a day-to-day basis. He provided one example of using Google docs as a tool for a collaborative writing exercise, but rather than just marking the final document, he was able to view the history of the document's development and therefore track the

process by which the children collaboratively constructed their work. He said that this allowed him to draw interpretations about the children's understanding in a way that went deeper than just viewing the final piece of work. Though Oliver recognises the need for numerical attainment data for accountability reasons, he is careful to collect and provide interpretive reflections on his pupils' development alongside this information, and suggests that there are a myriad of freely available technology tools which can assist in doing so. Oliver recognises that such practices require a supportive environment: "I'm lucky to work in this school because there is a culture of risk-taking and peer-support and sharing, so new practices and techniques can emerge".

Oliver Quinlan - www.oliverquinlan.co.uk/blog

Elsewhere in the world, Joe Bower, a high school teacher in Canada, has taken drastic steps to ensure that his assessment practices provide his students with learning experiences which help them see value in their learning for their own personal development: he has abolished grading entirely in his classes. Joe has a long-held dislike for the behaviourist foundations on which current assessment systems are based, and thinks that "students should experience success and failure not as reward and punishment, but as information", an approach which is also advocated by Dylan Wiliam. With this in mind, he has fostered a classroom environment that has been free from grading for six years, and he periodically reflects on and shares his practice by writing a blog. He bases his regular formative assessment on three categories of action: what he sees, providing suggestions, and asking questions. In each of these stages, he is careful to avoid reward, punishment and judgment, and instead fosters a two way dialogue with a student about their work which encourages them to make their own judgments, based on observation and description, as well as insightful questioning to encourage them to reflect on their learning. Though they were wary of the abolishment of grades at first, particularly high achievers, students have come to relish the freedom afforded by their teacher's practices, and they value the emphasis on their whole personal development, rather than on achieving certain grades. Gradually, Joe has noticed his students moving away from asking questions such as "does this count towards my grade?" towards being attracted to learning for the sake of learning.

Joe Bower - www.joebower.org/p/abolishing-grading.html

Broadcasting evidence

Alessio Bernardelli is a physics teacher at a secondary school in South Wales who strives to promote a culture of independence and responsibility within his classroom, by taking the role of orchestrator of learning, rather than a presenter of knowledge. His lessons are underpinned by the belief that deep learning only happens when students are motivated and enjoying themselves, and are given ownership of their own learning. Alessio acknowledges the affordances provided by new technologies to meet these aims, and he described one recent project which exemplified these aspects. Year 10 students were introduced to the topic of the Electromagnetic Spectrum, and their task was to collaboratively produce activities and presentations that would be broadcast live on an online 'TV Channel' to a wide audience. Alessio gave his students complete freedom in their choice of whom they worked with, the activities they designed, the digital media they utilised, and how it would be presented. They were responsible for researching and selecting relevant information, ensuring their work was scientifically valid and in line with the AQA specifications, and they were encouraged to think carefully about how to present the content in an appropriate way for the audience of online viewers. Alessio reported that the project was a resounding success, with students collaboratively producing high quality engaging work in a variety of creative

formats, with examples including songs, comics, documentaries and news reports. The live broadcast attracted a large audience, with students, teachers, parents, and even science experts around the world tuning in to watch the students' presentations on the online stream. Students reported that they thoroughly enjoyed the project, and relished the chance to be independent and produce outputs that would be seen by a wide audience. One student said "the benefits are that we are in control of our learning, and the research that we did to produce the TV show allowed us to take everything in and understand all about what we were learning."

Alessio acknowledges that he took a big risk with this project, in that his role in the students' activities and learning was minimal. In a culture dominated by an emphasis on attainment data, high-stakes examinations and accountability, to allow your students to take responsibility for their own learning, rather than spoon-feeding them information or "teaching to the test", is to open yourself up the possibility of failure. However, Alessio was confident in the project, and he reported that he noticed an increase in test results in this knowledge area. Informally, though, Alessio noticed a great improvement in his students' interest in learning – he noticed that they were logging on to the school's online space and using the chat facility to talk about their work. This was evidence that the students were enjoying their work, which for Alessio is as important a result as any attainment data. The greatest achievement, he said, was one particular boy who was unmotivated and underachieving before the project, but who became highly motivated, coming into the classroom to continue his work during lunchtimes, and produced astounding results, with his final production being among the best in the class.

After the success of this, and other projects, Alessio is currently on secondment at the National Grid for Learning in Wales (NGfLW), where he is supporting the development of further teaching and learning resources, particularly in relation to physics. His focus is also developing the practices of other teachers in his local area, by sharing examples, resources and ideas through his blog and local networks.

Alessio Bernardelli - alessiobernardelli.wordpress.com/2009/12/18/do-kids-learn-much-from-a-tv-show-well-yes-when-its-them-producing-it

Serious games

Quest to Learn is a pioneering school in New York. It was set up in 2009 after a year-long research and development project carried out by the Institute of Play, and its innovative new pedagogies and curricula are based on principles of game design and 21st century skills. The school's founders recognise that games are effective learning and assessment engines, as they can provide authentic problem solving scenarios which gradually increase with difficulty, so that players are continually working at the cutting edge of their ability. Games, by definition, constantly formatively assess players, testing their current knowledge and skills, providing instant feedback which motivates players to improve, and tailoring the level of difficulty according to players' progress through the game. Importantly, within gaming, failure is not negative – it is an inherent element of the gaming experience, and adds to a player's development, rather than being seen as a setback.

The Quest to Learn school has attempted to replicate these elements of the gaming experience in the design of its curriculum and assessment. As such, learning tasks are organised into quests and missions, points are received, rewards are unlocked, and every term culminates with a boss level, in which students use the skills they have gained from the term to collaboratively complete a substantial mission. Formative assessment is enshrined in the

whole learning process, and students receive constant feedback on their work and skills development, in order that they might reflect on how to improve. The tasks are aligned to US testing standards, but are designed in such a way that is interesting and engaging for the children. There is an emphasis on learning skills of design thinking, time management, systems thinking and collaborative skills, and a culture of innovation is deeply rooted throughout the school.

As well as learning tasks designed with gaming principles in mind, the school also utilises off-the-shelf video games to develop skills of systems thinking, problem solving and collaboration. One such example is the use of a game set in the fictional Taiga Park, which is part of the Quest Atlantis series of games. Players take on the role of the park ranger, and must deal with a scenario in which the park's fish are dying. Players must use research skills of scientific inquiry to identify the cause of the problem and take appropriate actions to restore the fish population. Players can take water samples, conduct interviews with other members of the Taiga Park community, and take photographs. To successfully solve the problem they need to demonstrate causal reasoning skills and be able to understand how systems work at both a macro and micro level. In order that teachers can assess the students' understanding of the systems in the game, they are then asked to produce a systems-diagram to show how all the different features of the virtual park relate to each other. Teachers then superimpose students' diagrams with that of an 'expert' and students can reflect on their approach to the task. Assessment is integral to the task, because the only way it can be completed successfully is by mastering certain skills.

Quest to Learn - q2l.org

Peer Assessment

The benefits of encouraging students to assess their own and their peers' work have long been recognised nationally. When effective, students are provided with the opportunity to learn from themselves and one another by carefully reflecting on the quality of others' work, and relate this to their own performance in the task. The rise in freely available social media tools has allowed for innovative approaches to peer assessment to emerge.

Within a primary setting, teacher Tim Handley designed a learning activity in which pupils used the free web tool Primary Pad to collaboratively write a story, allowing the children to peer assess each other's contributions throughout the task. Primary Pad is a wiki tool, in which up to five users can write on and edit one 'pad' at the same time. Different users' contributions are colour coded so that it is easy to identify individuals' involvement in the document's production. The text on screen is synchronised so that everyone viewing the page can observe the real-time changes, as they type. Once the activity is complete, the site allows any of the users to view a time-slider, showing the development of the document from start to finish.

In the lesson, Tim set up four pads, and split his class into four groups. Within each group children worked in pairs, with each pair assigned a section of the story to write (eg introduction, build up, problem, resolution, ending), with the aim being that each group would write their version of the whole story on their pad together. Throughout the task, children were encouraged to read what the other pairs in their group were writing as well as focusing on their own section. Tim reported that the activity was a great success. The children were highly engaged in the task, enthusiastically producing impressive quantities of creative writing, and showing a keenness to continue their work at home. They enjoyed being able to see what

their fellow group members were writing in real-time. Towards the end of the lesson, Tim asked the children to read the other sections that had been written on their pad, and give two stars and a wish (two positive comments and one suggestion for improvement) for each section they read. He reported that they instantaneously gave thoughtful, insightful feedback. The combination of the use of a collaborative web 2.0 tool and peer assessment practices resulted in high quality work and a valuable learning experience for the children.

Free web tools have also been used to great effect in a secondary setting. Dan Roberts, a science teacher in Cornwall, fosters a culture of peer assessment in his classes in order that his students might become independent learners, while becoming effective users of digital technology. In order to achieve this, he set up an online social network for each of his classes using the free website Ning (note: Ning is no longer free). Within each network, students are able to make their own profile, write blogs, contribute to discussion forums and add photographs and other media, which can be seen by all the other members of that network. Dan has found this to be a great way of sharing students' work in a format that is familiar to young people and that inherently encourages social activity. In one lesson on water balance and the kidneys, students used the web tool Photopeach to create presentations based on their independent research into the topic. One advantage of the tool Photopeach is that as well as creating a picture slideshow with text and music, students can also add a multiple choice quiz to the end of their presentation, enabling them to either test their fellow students on the content of the presentation, or use their presentation as a revision tool. After they had completed their work, students shared their Photopeach onto the class's Ning network, and each student was encouraged to comment on their classmates' presentations, using the two stars and a wish format. They were reminded to think carefully about how the presentations aligned with lesson objectives. Dan reported that his students enjoy the use of social networking tools in the classroom. By promoting a culture of peer assessment in his lessons, Dan hopes that by developing the ability to assess others' work thoughtfully will also enable students to reflect on their own work and personal development.

Tim Handley - classroomtales.com/2010/01/23/collobarative-writing-using-primary-pad-my-reflections

Dan Roberts - chickensaltash.edublogs.org/2009/10/18/can-you-tell-what-it-is-yet

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About Futurelab

Futurelab is an independent not-for-profit organisation that is dedicated to transforming teaching and learning, making it more relevant and engaging to 21st century learners through the use of innovative practice and technology.

We have a long track record of researching and demonstrating innovative uses of technology and aim to support systemic change in education – and we are uniquely placed to bring together those with an interest in improving education from the policy, industry, research and practice communities to do this. Futurelab cannot do this work on its own.

We rely on funding and partners from across the education community – policy, practice, local government, research and industry - to realise the full potential of our ideas, and so continue to create systemic change in education to benefit all learners.

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Key to Themes

Futurelab understands that you may have specific areas of interest and so, in order to help you to determine the relevance of each project or publication to you, we have developed a series of themes (illustrated by icons). These themes are not intended to cover every aspect of innovation and education and, as such, you should not base your decision on whether or not to read this publication on the themes alone. The themes that relate to this publication appear on the front cover, but a key to all of the current themes that we are using can be found below:

Digital Inclusion – How the design and use of digital technologies can promote educational equality

Teachers and Innovations – Innovative practices and resources that enhance learning and teaching

Learning Spaces – Creating transformed physical and virtual environments

Mobile Learning – Learning on the move, with or without handheld technology

Learner Voice – Listening and acting upon the voices of learners

Games and Learning – Using games for learning, with or without gaming technology

Informal Learning – Learning that occurs when, how and where the learner chooses, supported by digital technologies

Learning in Families – Children, parents and the extended family learning with and from one another