Rethinking assessment in a digital age: opportunities, challenges and risks

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While it is frequently argued that assessment sits at the heart of the learning process, in practice assessment often remains narrowly focused on qualifications and reporting achievements, driven by institutional and societal aspirations and tensions such as accountability and economic well being. Yet, the need for assessment to account for the knowledge, skills, dispositions and attitudes necessary to equip young people for a changing and increasingly digital world is also increasingly acknowledged. Based on our recent research review, this article critically examines the role of technology enhanced assessment (or TEA). We argue that while technology offers many potentially creative opportunities for innovation and for rethinking assessment purposes, there are also numerous risks and challenges. In particular we highlight ethical concerns over social exclusion and new forms of digital dividedness and the increasing risks associated with big data and the rise of learning analytics. Finally, we note that much research and innovation happens in silos, where policy, research and practice on assessment, technology enhanced assessment and ethical and political concerns are not linked up. We conclude that there needs to be a much more wide-ranging, critical and nuanced discussion in educational and policy circles so that debates about the potential of technology can be linked to improving assessment in the light of the range of social and political challenges that such progress presents. We end with some critical questions for policy, practice and research communities, which we offer as a starting point for future thinking and ways forward.

Keywords: formative/summative; e-assessment; collaboration; learning analytics; ethics; inclusion; digital literacies

Introduction

Assessment sits at the heart of the learning process. Indeed it could be said that an institution, culture, or society encapsulates its conceptualisation of learning and its aspirations for its future citizens by how it creates and uses assessment. Although it can be argued that the central purpose of educational assessment should be to support learning, in practice, assessment is often more focused on qualifications and the reporting of achievement. The growing importance in many countries of so-called 'high-stakes' assessment in recent years as a policy tool to encourage greater competition and accountability between schools and across the education system as a whole, has greatly increased this focus on periodic, summative judgments of student performance in terms of overall grades and percentages.

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In a world increasingly transformed by technology in the way people communicate, do business and live their daily lives, schools, colleges and universities have been slow to adapt to such changes, particularly in assessment modes and practices (Shute *et al.*, 2010). Although it is still unclear how deeply digital technologies might transform the practices of education, the advent of interactive technologies of all kinds offers significant opportunities for more engaging pedagogy and for new forms of assessment. As Pellegrino and Quellmalz (2010, p. 130) state: 'There is an interesting and powerful confluence among theory, research, technology, and practice, especially when it comes to the integration of curriculum, instruction, and assessment.'

The aim of this paper is to discuss the potential, the challenges and the risks associated with what might be termed technology enhanced assessment (TEA) and its possible role in rethinking the purposes of assessment in relation to student learning. It is predicated on the view that there is a need to better understand how digital technologies can be used to support and transform assessment and learning. The paper is based on a research review carried out by the authors, which examined: the history and scope of technology enhanced assessment; its use within formative and summative assessment and the potential affordances and challenges it brings.

There have been significant changes in terminology as an understanding of the potential use of technology in assessment has evolved—from computer-based testing to computer assisted (or aided) assessment to online assessment to e-assessment.[1] Although this evolution of terminology suggests that understanding of the potential uses of technology in assessment has become broader over time, such terms do not suggest any fundamental transformation of the scope of assessment through the use of technology. We have therefore chosen to adopt the term 'Technology Enhanced Assessment' (TEA) to complement the established use of 'Technology Enhanced Learning' or TEL and to encapsulate the role of digital technologies in supporting or enhancing learning across all sectors of education. This terminology is also in line with the work of the recent EU Network of Excellence on technology enhanced learning—STELLAR (see Sutherland *et al.*, 2012). We define TEA to include any use of digital technologies for the purposes of enhancing formal or informal educational assessment for both formative and summative purposes. In the following section, we outline the aims, scope and methodology of the research review that underpins this paper and our current concerns.

Aims, scope and methodology of the research review

In order to develop a broader understanding of the current landscape of practices, an extended review of the literature on TEA was conducted in 2012 (Oldfield *et al.*, 2012). The aim was to document existing research in order to identify what progress was being made in developing new digital assessment models and the barriers inhibiting their implementation in practice. The review was structured around three key questions:

(1) What do digital technologies offer for educational assessment?
(2) How might assessment be different when knowledge and performance can be represented digitally?

(3) Where is the 'cutting edge' in such developments at present?

The scope of the review covered developments in TEA at primary, secondary, further education (FE) and higher education (HE) levels in the UK and internationally. Although it mainly concerned 'formal' educational settings, it also included some novel examples from 'informal' settings. 'Innovative' or 'cutting edge' practices were defined as those that provide new insights or practices to the field of TEA, particularly those that appear to offer the possibility of genuinely new modes or models of assessment.

The literature review was conducted in two phases. Initially, a broad literature search was undertaken and included both well-established innovations in the field and research that addresses new thinking at the cutting edge of TEA development. Over 150 sources were included; mainly from peer-reviewed, academic publications (primarily since 2000), augmented by grey literature, research and government reports and relevant newspaper articles. An initial draft was then revised following feedback from an expert seminar, convened for that purpose. In a further development, the literature review provided the basis for the publication of a series of six discussion briefings on key topics aimed at policymakers and practitioners, designed to generate further discussion on technology enhanced assessment. These briefings were launched and discussed at a specially convened symposium in 2013 attended by representatives from schools, universities, policymakers, representative bodies and commercial organisations.[2]

This paper takes the findings of the research review (literature review, briefings and associated discussions) forward by focusing specifically on the risks and challenges of TEA and its potential for influencing the wider culture and practice of assessment in education. In the following section, we briefly review the context and rationale for rethinking assessment from the dual perspectives of assessment policy and research on the one hand and the development of digital technologies and digital cultures on the other. This is followed by an overview of how the use of digital technologies in assessment has developed so far. Next we present key areas where we argue technology offers potential for developing new forms of assessment or new opportunities for aligning assessment more closely with learning. This takes us into the main argument of the paper, examining the possible risks and challenges of an increasing reliance of technology in future assessment practice. This analysis provides the basis for our final discussion and conclusions. These argue for a reconsideration of prevailing priorities in educational assessment. Finally, the paper poses a series of questions that are designed to prompt a more wide-ranging, critical and nuanced discussion of these issues across research, policy and practice communities.

Rationale

Assessment in a changing world

There are many critiques of current assessment policies and practices. These include their misalignment to curriculum priorities, an over-reliance on grading and negative impacts on students' confidence and learning aspirations (Attwood & Radnofsky,

2007; Broadfoot, 2007; Schwartz & Arena, 2009; Gee & Shaffer, 2010; Shute & Kim, 2013; Deneen & Boud, 2014). Such arguments are also backed by growing research evidence about what constitutes effective feedback in both schools and university contexts and a recognition that conventional methods of assessment, tried and tested as they have been over more than a century, are increasingly unfit for purpose (Nicol & McFarlane-Dick, 2006; Hattie & Timperley, 2007; Boud & Molloy, 2013).

The world is changing rapidly and with it, the knowledge and skills—even the dispositions and attitudes—that educational systems need to deliver. While previously the focus of education could be predominantly on the inculcation of an existing canon of knowledge, now it must reflect new priorities. The imperative to develop education systems that prepare students for the future is increasingly being pressed in political, business and educational discourses (Claxton, 2009) and through the notion of the 'knowledge economy' that associates national and global economic success with investing in education and the increase of 'skills' (Facer, 2012). Creativity, problem-solving, adaptability, resilience, resourcefulness, even spiritual and moral 'literacies', are found in the curriculum aspirations of countries and organisations across the world where such competencies are seen to be essential for success in future society.[3]

Yet, despite these aspirations and priorities, approaches to the assessment of students' learning often appear lacking in imagination and overly focused on procedures, particularly in highly competitive assessment situations. James (2014) observes that much research on assessment could be categorised as offering a 'technical perspective' where concerns include 'the optimum application of assessment methods, with attention to matters like fairness, transparency, efficiency . . .' (p. 156). This suggests an uncritical acceptance of the current role of assessment in education, which is at odds with those critical voices calling for new assessment thinking more in line with today's educational priorities. We argue that there needs to be a re-evaluation of both the purposes and processes of assessment that will in turn prompt the development of new assessment methods, leading to assessment that is more meaningful and more educationally and culturally relevant for learners and teachers.

Digital technologies, learning and assessment

Over several decades, there has been a growing interest in the use of digital technologies as a means of supporting learning and rethinking how teaching, learning and assessment are configured (Säljö, 2010). The rise of Web 2.0 has further increased opportunities for participation and artefact production in online environments and social networking technologies offer new opportunities for communicating, experiential learning and assessment (Bonderup Dohn, 2009). Indeed, the influence of digitally mediated cultures throughout society means that young people are taking on new participatory and collaborative roles in learning online and outside the classroom and there is increasing interest in incorporating these roles and practices inside formal education (Facer, 2012). Jenkins *et al.* (2006) point to the growing number of young people involved in 'participatory media cultures' that support sharing one's creations and provide greater levels of authorship, autonomy, collaboration and choice for students. Schwartz and Arena (2009) argue that choice is one of the most important con-

cerns for all of us in a democratic society and therefore the capability to make choices and manage the ensuing responsibilities of those choices should be at the centre of assessment.

Central to the international concern to use emerging technologies to help inculcate the skills, knowledge, creative practices and dispositions to learn is the question of how they can be assessed. There is a need to develop assessment tools that are capable of capturing such learning priorities (Honey *et al.*, 2005; Shute *et al.*, 2010; Quellmalz *et al.*, 2012) and widespread agreement about the difficulty of transforming such aspirations into practice (Claxton, 2007). Despite the belief that the use of technology for assessment could become a major agent for change within the education system (Mansell, 2009) and a growing recognition of the potential of technology in this respect, the implementation of genuinely innovative assessment practices using technological affordances appears to remain narrow in scope (Whitelock & Watt, 2008; Beevers, 2011; Mogey, 2011). Critiques in the literature suggest (as with assessment more broadly, see James, 2014) an over emphasis on technology for efficiency and the potential for standardising, grading and recording data. This appears to be limiting the development of more imaginative and creative possibilities. Where innovation is taking place, this is often in isolated pockets or subject to funding constraints on continuation and sustainability. Furthermore, policy discussions and decisions on assessment can contribute to an over simplified view of technology as a 'quick fix' or a means of replicating existing methods rather than seeing its potential to challenge and re-model existing practices and re-imagine the purpose of assessment and its relationship to learning (Thornton, 2012; Shute & Kim, 2013).

In this paper, therefore, we argue that there is a pressing need to understand better how digital technologies could help us rethink both the purposes and processes of educational assessment and the different challenges that are likely to be pertinent. Before we present some of the key areas that we argue offer potential for supporting the re-imagining of assessment, we give a brief historical overview of digital technologies and assessment.

A brief history of digital technologies and assessment

Although the use of computer technologies has been a feature of innovations in assessment for several decades, early applications of technology focused mainly on its use in large-scale testing aimed at improving efficiency and reducing cost (Pellegrino & Quallmalz, 2010). Another early innovation was the introduction of simplified authoring tools and test builders aimed at both schools and higher education, which allowed tests and assessments (particularly multiple choice tests) to be developed by teachers and lecturers themselves. In the UK for example, a 2004 report focusing on the use of computer-based assessment in higher education, suggested that the main purposes (of TEA) at that time were seen to be concerned with the delivery, recording and analysing of assessment data, although the report also shows some awareness of the potential of online portfolios and of harnessing the power of networked technologies (Bull & Danson, 2004).

Within the compulsory schooling sector too, it was anticipated that technology would rapidly become a key part of the delivery of external assessments (see

QCA, 2004), yet this has been slow to materialise. In the USA, there has been more emphasis on large-scale, automated testing and state-wide initiatives (see Levin *et al.*, 2011). There have been a number of national 'roadmaps' aimed at guiding future directions (for example Whitelock & Brasher, 2006; Woolf, 2010). However the issue remains that much of the emphasis is on using technology for efficiency and consistent delivery of assessments rather than the use of technology for rethinking the relationship between learning and assessment. Although there is continuing discussion in the literature of the need to rethink assessment, relatively little attention appears to be being given to the role of technology in supporting such changes. In an attempt to prompt more discussion of this potential, the next section sets out some of the key areas in which TEA is already demonstrating its potential.

Opportunities afforded by technology enhanced assessment

Here we present seven distinct areas of opportunity that digital technologies currently offer for innovation in assessment.[4] Each of these areas will be discussed in turn with reference to relevant examples of technologies, studies and projects, based on our recent research review (Oldfield *et al.*, 2012).

New forms of representing knowledge and skills

The rapid expansion in the available media and modalities that digital technologies offer include text, image, video, audio, data visualisations and haptics (touch). Such new tools provide opportunities for new forms of representation and the use of multiple modalities to demonstrate achievement. They allow assessments to be designed in different forms and to allow students to document achievements and progress in a variety of ways and over different timescales. For example e-portfolios have been implemented for the individual creation of multi-modal artefacts and different forms of documenting achievements (Whitelock *et al.*, 2006; Becta, 2007; Ripley, 2007; Garrett, 2011; Stone, 2012) as well as instances of the collaborative development of e-portfolios (Van Aalst & Chan, 2007; Barbera, 2009). The design and development of virtual worlds and immersive environments can also include integrating assessment into learning activities, for example the work by Gee and Shaffer (2010) on gaming environments; ecological quest environments for school age learners such as Eco-Muve (Metcalf *et al.*, 2010; Winkley, 2010) and QuestAtlantis (Barab *et al.*, 2007; Hickey *et al.*, 2009) where assessment involves solving authentic problems in the virtual world. Ground-breaking simulations using haptics in veterinary science education (Baillie *et al.*, 2005, 2010) have also gained prominence.

Crowd sourcing and decision-making opportunities in assessment

As well as the opportunities that more diverse forms of representation offer, there is also the potential for TEA to provide learners with new or alternative decision-making opportunities in assessment. Being able to capture, review and author multiple forms of representation of knowledge and skills offers new possibilities for peer- and self-assessment and for the learner to exercise more agency in the assessment process.

This can be both as an individual and when working with others, through e-portfolios as outlined above (for example, Whitelock *et al*., 2006; Van Aalst & Chan, 2007; Barbera, 2009; Garrett, 2011; Stone, 2012). The use of electronic voting systems is becoming more widely adopted in Higher Education because of the potential it offers for collective and contingent decision-making and immediate visual feedback on decisions at an individual or group level (Draper, 2009a; Hancock, 2010). In addition, there have been recent developments exploring the potential of crowd sourcing for grading in higher education (Hendry, 2009; De Alfaro & Shavlovsky, 2013). Thurstone's ranking methods and crowdsourcing of grades in schools [see Barton & Heiman, 2012; the Collaborative Learning Assessed by Social Software (CLASS) project, McAlpine, 2012] offers the potential for increased control for learners over what is assessed since crowd-sourced grading alters the control of who makes the decisions on grades.

However, this does not mean that other forms of assessment may not also allow learners control over assessment. The argument here is that through the social affordances of digital technologies such as social media, blogs, wikis, e-portfolios and electronic voting for assessment, there are opportunities for extending decision-making in assessment, in particular by sharing assessment challenges or problems across a wider group, by providing mechanisms for aggregating collective, crowd-sourced grades and enabling learners to decide on which artefacts they present for assessment to which audiences. These opportunities of increased agency in assessment are also likely to enhance the decision-making skills of learners, which are important in preparing young people to participate effectively in a democratic society (Schwartz & Arena, 2009).

Increasing flexibility

Digital technologies also offer the potential for assessment to be less time critical and location specific. They can make it possible to vary the location, timing and length of assessments to suit individual needs and preferences. When, where and how frequently work is assessed can be scheduled according to the needs of particular groups of learners such as part-time students or those learning in the workplace. Assessments can take place in multiple locations and over different timescales using mobile devices, as demonstrated, for example, by the Personal Inquiry and Nquire out of school science projects (Sharples *et al*., 2015) and the Alps project on accessing assessments in the workplace for health and social care in higher education (Coulby *et al*., 2010). Assessments can also be designed to be taken over longer time periods using online systems where individual or collaborative work can be developed longitudinally such as the Diagnoser project in Physics (Thissen-Roe *et al*., 2004) and various initiatives of the Educational Testing Service in the USA (Bennett, 2008).

TEA also offers potential for the increased integration of formative and summative assessment, where classroom assessments are linked or integrated with summative assessment data. This makes it possible to combine feedback for students with feedback on results to teachers. Shute and Kim refer to this as 'stealth assessment' (Shute & Kim, 2013), which is also found in some immersive simulations and online envi-

ronments (Barab *et al.*, 2007; Hickey *et al.*, 2009; Quellmalz & Pellegrino, 2009). As a result, assessment can be more adaptive, incremental and sustained, making it possible for a greater measure of integration into the process of teaching and learning.

Supporting and enhancing collaboration

Digital technologies, including mobile devices and tablets can also support collaborative learning and assessment practices such as, co-evaluation and peer-to-peer assessment. Networked and Web 2.0 technologies provide opportunities for peer-to-peer sharing of data and the collaborative construction of knowledge (Van Aalst & Chan, 2007; Barbera 2009; Barton & Heiman, 2012) and peer review (Hamer *et al.*, 2007). Data can be jointly collected, shared, added to and commented on through the use of synchronous and asynchronous technologies. As discussed earlier there are also opportunities for crowd sourcing of grading (Hendry, 2009; De Alfaro & Shavlovsky, 2013) and whole group assessments using electronic voting systems (Draper, 2009a; Hancock, 2010; Bennett & Barker, 2012). Equally, as discussed above, the use of mobile and tablet devices can support learners working together in different contexts within and outside formal educational settings. Employing digital technologies that support social interaction and collaborative knowledge building across contexts can thus help make assessment less individual and more closely related to real-world problem-solving.

Assessing complex problem-solving skills

The use of TEA can create opportunities to assess more complex skills, such as hypothesis-testing, role-playing and problem-solving through the use of simulations and immersive environments, for example the SimScientists project (Quellmalz & Pellegrino, 2009; Quellmalz *et al.*, 2012) and EcoMuve (Metcalf *et al.*, 2010; Winkley, 2010) discussed above. Immersive and game-based environments are often highlighted when discussing the potential of digital technologies for learning and assessment. Quest Atlantis, for example (Barab *et al.*, 2007), is a well-known and widely used example of a game-based virtual environment designed to support inquiry-based learning in ecological sciences. It enables teachers to participate by giving feedback online and to capture assessment data through the medium of the game. There is evidence that such an approach can increase both student achievement and engagement (Hickey *et al.*, 2009).

Yet, such approaches remain relatively underdeveloped with standardised, multiple choice question formats continuing to predominate (Stödberg, 2012). This results in what Pellegrino and Quellmalz describe as 'an over-reliance on simple, highly structured problems that tap fact retrieval and the use of algorithmic solution procedures' (Pellegrino & Quallmalz, 2010, p. 122). However, as shown in the examples above, TEA is beginning to be used for 'exploring the presentation and interpretation of complex, multi-faceted problem types and assessment approaches' (Pellegrino & Quellmalz, 2010, p. 121). Thus TEA can provide more powerful ways of assessing complex skills and make it possible to assess performance in the context of scenarios that are difficult to create in the classroom, for example dangerous or complex scientific experiments, natural phenomena or imaginary scenarios.

Enhancing feedback to students

There is now widespread evidence that improving the quality of feedback and the way in which it is delivered, is critical to improving the use of assessment for learning (see Nicol & Macfarlane-Dick, 2006; Boud & Falchikov, 2007; Shute *et al.*, 2010). Further to this, the importance of students giving, as well as receiving, feedback and encouraging students to act upon this has been highlighted as a means of sustaining learning, in schools (Black & Wiliam, 1998, 2006; Hattie & Timperley, 2007) and higher education (Nicol & Macfarlane-Dick, 2006; Boud & Molloy, 2013). Peer-to-peer feedback can be online, embedded within systems or take place in physical settings such as classrooms where digital technologies are in use. Techniques in this respect may include the use of online discussion tools, immersive environments and social media such as blogs and wikis as discussed in previous sections. TEA also offers the possibility of novel forms of feedback for individuals and for groups of learners, through interactive or rich media elements (Winkley, 2010) or stealth assessment where feedback is integrated into learning activities (Shute *et al.*, 2010) for example in immersive environments such as Quest Atlantis (Barab *et al.*, 2007) highlighted above. TEA can also enhance the capacity for incremental feedback and adaptive assessments, where feedback and assessments can be changed or adjusted for individuals, contingent on their progress. The possibility of tracking learning over time also offers the potential for understanding how such feedback is mobilised by learners (Beevers *et al.*, 2011). Increasingly too, technology is making it possible for performance indicator data to be aggregated and fed back to teachers, institutions, stakeholders and governments as a means of diagnosing institutional strengths and weaknesses as we discuss in more detail below.

Innovation in recording achievement

There are some recent, innovative developments also taking place in the recording of achievement. In particular, an assessment initiative increasingly found in gaming environments and more recently in the context of MOOCS,[5] is the use of online badges. The badge system is an alternative accreditation system that uses communities to validate the skills and knowledge of its members who are then awarded virtual badges (or online visual icons) that recognise skills or achievements. Mozilla is developing an Open Badges Infrastructure that will allow the creation and hosting of badges, including a 'badge backpack' that individuals can use for storing and moving their badges.[6] However, understanding of the use of badges as a viable alternative form of accreditation is at an early stage. Its implications for enhancing learner motivation and whether or not it promotes greater equality have yet to be investigated.

Exploiting learning analytics locally and nationally

Digital technologies also offer ways of combining different datasets at both local and national levels, to provide aggregated assessment data. Teachers, learners and other stake-holders are able to access data on student progress and a range of other aspects of institutional performance. Through the interrogation of increasingly large and

complex data sets even specific assessment interactions, individual learner characteristics and their past history can all be used to understand individual learner needs better. This growing field is now known as 'learning analytics' and can be defined as 'the measurement, collection, analysis and reporting of data about learners and their contexts for purposes of understanding and optimising learning and the environments in which it occurs' (Ferguson, 2012).[7] Feedback from such systems, for example through dashboards (which allow students to monitor their own activities and behaviours), can suggest adaptations, improvements and recommendations for learners, teachers and institutions as a whole. Such tools could potentially offer learners more control over their data and their progress. However, there are also many ethical, social and pedagogical challenges and risks associated with learning analytics and what is often referred as 'big data'. These are discussed further in the section below.

At a national level, governments are increasingly concerned about the educational performance of their young people in relation to international comparators.[8] This has increased the importance of national monitoring, which can be considered as another form or level of learning analytics. It can be argued that digital technologies also have the potential to improve the design, delivery and targeting of national monitoring where tests can be delivered online and adapted to particular needs. In the Netherlands, for example, different digital editions of tests are made available to support students with learning difficulties (Eurydice, 2009) and provide greater efficiency in administration, marking and reporting (Morris, 2011). However, national testing is primarily used for providing information on pupil performance for external purposes—notably for judging the perceived quality of individual institutions and to inform consumer choice. At present there is relatively little use of this kind of assessment for improving learning. Indeed it can be argued that the growing reliance on standardised international measures of achievement actually works against the creation of systems that are aimed at supporting learners and their learning (Hutchinson & Hayward, 2005).

The challenges and risks of technology enhanced assessment

In the previous section we explored some key areas where TEA offers the potential for innovative approaches to assessment to be developed. We argued that TEA has the potential to support the re-imagining of assessment purposes and practices by facilitating new opportunities for participation, expression and collaboration and through providing opportunities for the assessment of complex skills. We also suggested that TEA offers scope for the creation of large data sets, which can become the basis for national monitoring and international comparisons of achievement. Such developments, however, bring with them both challenges and risks, which are discussed below.

Challenges to the implementation of TEA

We have argued that despite the examples above of innovative practice and the potential they embody, the role of technology in assessment continues to be dominated

by its use for on-screen testing typically using multiple choice questions and the automated marking of student tests (Winkley, 2010). Even on-screen testing is still not commonly used for external school examinations (Mansell, 2009). Mansell also notes that incidences of innovative practice are relatively well known among the TEA community of enthusiasts and little known beyond it. Initiatives tend to be isolated and driven by a single person or institution. As a result, argues Whitelock (2010, p. 2), assessment largely relates to a 'transmission' model of teaching and learning, rather than acknowledging the role that students have in the construction of knowledge. TEA has also tended to be spread unevenly across knowledge domains and phases of education. Historically its use has been focused on particular subjects such as mathematics and science. Although there are indications that the use of TEA is increasing in terms of both scope and breadth across subjects (Whitelock & Watt, 2008), particularly in higher education, such progress is slow.

There are a number of possible reasons for this. First, even in areas of acknowledged innovation, designers of more innovative digital learning environments tend not to focus on the role of assessment. Shute et al. (2010, p. 3) recognise that current 'immersive games lack an assessment infrastructure to maximise learning potential'. Moreover, the technology used in simulations can both vary widely and be expensive to develop. In both immersive environments and educational computer games, assessment can often lag behind the design of the environment and learning tasks. Gee and Shaffer (2010) argue that the focus on developing games for learning should focus on designing games for testing as well. Winkley (2010, pp. 11–12) notes that assessment in games 'can also become "too implicit" and learners don't necessarily think carefully about the detail of the outcome they've achieved'.

Second, where technology is used to support collaborative learning, the assessment aspect is often underdeveloped. Van Aalst and Chan (2007) suggest that in the field of computer supported collaborative learning (CSCL), little emphasis has been placed on how such collaboration can be assessed, with the result that the assessment practices associated with these activities can often feel incongruent. They argue that what is needed is an assessment culture that emphasises collaboration in which learning and assessment are integrated, rather than a focus on individual competition. There is little evidence of progress in this respect, especially in the compulsory schools sector (*ibid.*). Cultural norms, educational policies and institutional practice still focus on individual performance. This, together with the perception of many institutions, teachers and students that collaborative or peer assessments may not always be fair and equitable, represents a significant barrier to the development of more creative forms of collaborative assessment (Falchikov & Goldfinch, 2000; Prins *et al.*, 2005; Ferrell, 2012).

These problems of culture, expertise and inertia are arguably further exacerbated by a lack of engagement between the innovators, designers, educators and researchers who between them could help to push the agenda forward. However, perhaps the most significant concerns are the risks associated with TEA, which we discuss in the following subsection.

Risks associated with implementing TEA

There is a perceived risk that developments in digital technologies will drive assessment that will in turn drive teaching and learning practices. Technological determinist views start from the premise that the technology alone is the agent of change and that such changes are pre-determined by the existence of the technology. These views are very prevalent in the media and can lead to a great oversimplification of the issues and challenges surrounding the use of technology in education by policymakers, practitioners and commercial providers (Jones, 2013). This perspective can lead to a technology-centric focus in the design of assessments as illustrated, in the work of the European interdisciplinary network STELLAR, which focused on advances in Technology Enhanced Learning (Sutherland *et al.*, 2012). The experience of Sutherland was that colleagues with a background in computer science tended to be driven by innovating with technology (particularly in the area of learning analytics) with very little consideration of the educational purpose of such technologies. STELLAR demonstrated that one way to decrease the risk of technology driving educational and especially, assessment practices, is for interdisciplinary teams to work together, to foreground the inherent tensions in their different beliefs with respect to technology enhanced learning and to recognise that it is out of the tensions and conflicts between different disciplinary perspectives that solutions to problems can arise (*ibid.*).

Rather than taking a technologically determinist perspective as discussed above, a number of scholars have stressed the need to look at any particular innovation in terms of the unique cultural, social and institutional context that will influence its use and outcomes (Zhao & Frank, 2003; Jenkins *et al.*, 2006; James, 2014). Others argue for novel assessment practices to be based upon an understanding of the principles and theories that underpin learning, particularly the role of feedback in assessment, in conjunction with robust and valid research (Hattie & Brown, 2008; Draper 2009a,b; Boud & Molloy, 2013). Such authors argue that innovations should be based on a 'pedagogically driven model' that 'can allow students to take more control of their own learning and become more reflective' (Whitelock & Watt, 2008, p. 152), as opposed to new forms of assessment being driven by the possibilities of the technology itself.

Perhaps an even more insidious risk is the widespread adoption of the use of digital data as a mechanism for school improvement and for measuring and benchmarking school performance in a high-stakes context. In many countries the use of digital data is now considered to be a key management tool for school improvement. Schools focus close attention on the analysis of such data, believing that it leads to objectively determined and deeper understanding of student progress than more subjective judgments of learning (Sutherland, 2013). The widespread assumption that learning analytics—the collection and interpretation of large data sets—is a good thing is now subject to growing debate. There appears to be an increasing awareness of the threats inherent in this growing use of digitised assessment data. Foley and Goldstein (2012), for example, question whether this 'data deluge' is necessarily a wholly positive development and demonstrate how educational data analysis (such as that related to league tables and exam results) can be skewed and misleading.

Ethical issues associated with implementing TEA

It is also important to recognise that the often utopian discourse associated with the potential application of technology in education also has a darker side. One such aspect concerns the ethical challenges related to 'big data'—those of consent, of data protection, of ownership and of the control of information, all of which are associated with the ethical responsibilities educators have towards children and young people (and more mature students). Additionally, TEA raises the ethical challenge of how educational institutions will address the inevitable dilemmas emerging from new digital practices (Jenkins *et al.*, 2006), which cross over into related ethical issues in assessment. How should the world of education, for example, deal with the issue of new online identities, both real and assumed? What are the implications for data protection and ownership of making, mixing and publishing media online? The growing prevalence and sheer volume of digital data now being generated, thus raises complex and important ethical concerns about consent and about how such data should be collected, used and stored.

Issues around data management, ownership and sharing are likely to multiply for both individuals and the organisations and networks they belong to (Facer, 2012). Indeed, data flow within the education sector, at classroom, institution and national levels is already prolific. Not only does this raise ethical issues about the degree of consent students may have over the collection of such data and its use, equally important is the issue of how they can access, own or control their own personal data. Facer (2011) contrasts this proliferation of data and the issues raised by the steadily increasing use of surveillance technology and constantly expanding 'digital footprints' for the auditing and management of educational performance with the much slower pace of technologies that share control with students through, for example, the use of portfolios and social software. Such trends in the use of TEA, in all kinds of educational institutions, embody the very real risk that they will lead to the development of educational environments based on control, rather than on democracy and young people's agency. A related issue concerns the type of data that are deemed relevant and useful for supporting learning and educational decision-making. As TEA makes it increasingly possible to assess more affective skills, attributes and dispositions, this raises questions, concerning whether such personal characteristics should be evaluated at all and, if so, how that information ought to be protected.

The risks of social exclusion associated with TEA

The rise of social networking and digital cultures, in particular among young people, also raises issues for educational institutions that are not necessarily equipped or prepared to manage the associated risks such as labelling and social exclusion that could exacerbate existing inequalities. For example, the use of social networking tools may raise complex social identity issues that some students may find challenging or divisive and that can reinforce feelings of exclusion (Timmis *et al.*, 2015 in press).

As discussed earlier, Web 2.0 technologies offer new opportunities for the active participation of learners in content creation, media authoring, information sharing, communication and collaboration. However, not all students are likely to benefit in

equal ways from such practices. Boyd (2011) for example, argues that such online networks often replicate the types of social divisions that exist offline. There is arguably a need too, for students to feel a sense of trust in the learning spaces in which they are participating; in their peers and in their teachers if they are to feel safe enough to learn from failure without being overly concerned with the consequences. Jenkins *et al.* (2006) refers to this as the 'participation gap'. Although as argued previously, the availability of multi-media forms of assessment can facilitate the possibility of combining formative and summative assessment; increase the potential for self- and peer-assessment and provide for progress in the assessment of group work, it needs to be recognised that such tools may not necessarily be transformative for all students. The 'participation gap' also relates to technology enhanced assessment, where assessment is integrated into online group activities such as through wikis or discussion boards. In such spaces, contributions are usually visible to everyone in the group, which can lead to more limited participation in formative assessment (Timmis *et al.*, 2010). Equally, where participation in summative assessments online is required in shared online spaces, this can make differential levels of achievement more visible and reinforce existing social divisions (Dawson, 2010). As Losh (2012) suggests, such spaces can be exposed places in which to make errors.

Hughes (2009, p. 298) stresses the need to be wary of the rhetoric of learner empowerment through tools like social software, which do not guarantee more autonomy or choice. Equally, they do not guarantee spaces, which will improve participation for all students (Timmis *et al.*, 2015 in press). While social software like wikis may assess a wider range of activities in various representations, it is unlikely to unsettle current inequalities 'without transparent assessment criteria and high quality formative feedback' (Hughes, 2009, p. 302). Thus the evidence suggests that not all students participate online in equal ways or gain the same benefits from such participation whether this is inside or outside formal educational settings. It cannot be assumed that all students possess the requisite skills and experience necessary to take full advantage of such technologies, or that technology alone can remove pre-existing inequalities. It follows that an awareness of the risks of social exclusion needs to be part of the agenda for any implementation of technology enhanced assessment.

Discussion and conclusions

In this paper, we have shown that across a range of educational sectors, digital technologies have the potential to be used to change the purposes of assessment, how these processes happen and what students are expected to know and demonstrate. The examples of new tools and practices discussed earlier have shown that TEA has considerable potential to enhance the educational process in a variety of different ways. It can provide rich, dynamic individual or group feedback, which can support motivation and engagement in the learning process. It offers ways of integrating formative and summative assessment to make it more relevant to learners and support collaborative and peer assessment. It can allow learners multiple ways of representing their progress and achievements over longer or more flexible timescales and support new forms of crowd-sourced grading and decision-making in assessment so enhancing the validity of assessment. We also showed how TEA offers potential for assessing

complex problem-solving skills, new ways of recording and valuing achievement and exploring learning analytics. It may even lead to a beneficial 'wash-back' effect on curriculum priorities and design. However, we have also identified the considerable challenges and risks associated with such developments.

In this final section of the paper, we consider three important questions that emerge from our analysis, which we argue need to be addressed. We also offer some suggested ways forward for future research and steps towards the necessary increase in dialogue between policymakers, practitioners and researchers concerning the development of TEA.

Question 1: How can TEA move beyond patchy, incremental change?

Although technology is sometimes seen to have the potential for disrupting the status quo, social and institutional rules and boundaries (Blin & Munro, 2008), it is also clear that the use of technology for enhancing assessment (TEA) is still largely confined to particular projects and initiatives. Changes in assessment practice in this respect remain gradual and subject to multiple constraints. We suggest that it is the conservative character of most current assessment policies and practices that remains one of the key factors inhibiting institutions from making more radical changes (Shute *et al.*, 2010). This is linked to the way that the purposes of assessment are not interrogated and often go unchallenged. James (2014) also notes that there is very little critique of the underlying structures and policies governing assessment. We return to this issue in discussing our third question.

There are other reasons for a lack of incremental change in TEA. First, it can be difficult to anticipate what new types of assessment will be most valuable for various purposes. Digital technologies change very rapidly and it is also almost impossible to anticipate developments in technology even five years ahead (Robinson, 2006). This raises fundamental questions about future priorities in assessment and the competencies, knowledge, skills and dispositions that will be needed for both individuals and society to flourish. Second we have argued that working across disciplinary and practice/research boundaries is challenging because computer scientists, educators, psychologists and commercial software designers will have very different purposes and starting points and often work in isolation from one another. These 'disciplinary silos' result in limited opportunities for dialogue and collaboration that are clearly necessary for more progress to be made. A key goal therefore must be that future research be conducted as a collaborative project between researchers in assessment, researchers in technology, educators and technology developers. Such interdisciplinary teams should address not just how to design assessment projects to exploit the potential of the technology but should engage more fundamentally with rethinking the purposes of assessment, and associated challenges including ethical and social justice issues.

Question 2: How can we address the ethical and social risks that TEA brings forward?

Although there is clear evidence that TEA has the potential to bring significant benefits to the assessment process and that it has already begun to do so in a variety of settings, we have suggested that the picture is not all positive. There are risks that TEA

may lead to new sources of social and educational disadvantage as a result of differential access to the relevant technology, or as a result of differences in engagement with technology associated with age, gender and social background. As Jenkins *et al*. (2006) and Barton and Heiman (2012) argue the current spectrum of digital participation and production by young people does not guarantee participation or flatten hierarchies. Similarly, access to online networks does not necessarily change the types of social and educational connections students have offline (Dawson, 2010; Timmis *et al*., 2015 in press). Using such platforms for assessment could make some of the social divisions more visible.

It is also surprising how little discussion of ethical risks and challenges have arisen so far in the emerging field of Learning Analytics. Data collection and the tools used are not neutral and will reflect the values and assumptions behind the assessment practices for which they are aligned (Buckingham Shum, 2012). The purposes to which learning analytics are being put are also critical. As the existing ability of businesses to capture patterns of data about individual shopping behaviour has already made clear, the creation of a digital footprint provides the raw material for 'data-mining' that is both hugely powerful and difficult to control. The same is likely to be true in educational applications. Already Programme for International Student Assessment (PISA) studies are demonstrating that the possibility of conducting tests on a substantial international scale is leading to the generation of comparative assessment data, which could profoundly affect national educational policy priorities. Were such data to be available internationally on individual student achievement, for example, the control of personal data would be at significant risk. If, as Facer (2012, p. 98) has argued, 'the potential for young people to challenge, question or reshape the futures they are being offered is invisible', it will be important to consider in what ways TEA might be able to challenge this lack of agency and control of personal data and make assessment data more visible to learners.

To address some of these issues, we argue that emerging digital tools need to be aligned with an explicit set of pedagogical and ethical principles to cover the purpose, access, ownership and control of data. While learners may gain a sense of control from some 'dashboard type' systems, they also need to understand for themselves how to derive meaning from any of the systems they are asked to use (Siemens, 2012). Institutions and teachers will need to ensure that interventions are both value-driven and valuable for learners themselves. It is therefore critical that both ethics and social justice issues become an integral part of the design and planning of new assessment methods and programmes especially those using new technologies. It is important too that the profile of these issues is raised with policymakers and practitioners through new research programmes that investigate the effects, including unintended consequences, of the use of learning analytics and big data on social inclusion and exclusion in online assessment environments.

Question 3: How can TEA overcome the constraints of policy conservatism?

Despite a growing recognition of the importance of feedback, assessment for learning and peer assessment, we argue that the concerns of summative and particularly, high-stakes assessment, continue to predominate in driving the prevailing discourse and

culture of assessment. We have indicated at various points in this paper that while the benefits of new approaches are widely acknowledged, the assessment field remains rather conservative in character and that the purposes of current assessment regimes are not frequently questioned. We suggest that where such discussion does take place, conservatism is attributed to the educational policy directives that constrain or require particular assessment methods or regimes. We concur that educational policy is likely to continue to play a key role in driving assessment priorities and practice with the result that, as James (2014) argues, there will continue to be a tendency for an uncritical and overly technical view of assessment to predominate and thus for the suitability of particular assessment methods to go unquestioned. Traditional assessment methods all have a role to play. However, so far, there appears to have been limited critique about why they are used, what alternatives there might be and how these could be practically implemented.

We have also argued that assessment policy and practice is often out of step with the needs of twenty-first century society, the knowledge economy and global citizenship (Claxton, 2009; Facer, 2012; Reimers, 2013). As a result, we suggest, there is currently more interest in assessment as an institutional and national accountability tool than in the progress and outcomes for learners as individuals. We argue that more needs to be done to convince policymakers of how TEA could support both the needs of learners and accountability, and that TEA designed to support learning can also provide cumulative evidence on assessment trends and outcomes.

The discourses of policymakers in relation to technology and its role in education tend to oversimplify the debates. A key argument of this paper is that it is important not to divorce technology from the social and cultural dimensions of educational change (Buckingham, 2013; Bayne, 2015), which has tended to be the case with initiatives aimed at 'harnessing technology' (Becta, 2008). However politicians who make a play on traditional values may also perhaps underplay the potential for rethinking assessment and the new possibilities that digital technologies offer. This has been shown in the frequent political derision of media studies as inconsequential compared with traditional disciplines (see Gatten, 2010) and the moral panics and scepticism that surround young people's use of technology and its value (Facer, 2012; Buckingham, 2013). It follows that researchers need to engage more directly with policymakers in these debates and to provide stronger evidence of the potential of TEA, particularly to enhance the quality and relevance of learning.

One way of addressing this would be to develop a co-production approach (Durose *et al.*, 2011) based on partnerships between researchers and teachers at all levels of education aimed at rethinking assessment. New approaches including TEA can be co-designed and evaluated through intervention projects, similar to the pioneering work of the Interactive Education project (see Sutherland *et al.*, 2009). Such initiatives would complement the wider TEA research programmes we argued for in question 1 above and support local implementation in practice settings.

Recommendations for research and practice

In order to begin to address these questions, we offer the following five recommendations that we hope will stimulate both discussion and action:

(1) Research in technology enhanced assessment should explicitly address the need to focus on the purposes of assessment especially with regard to integrating with and supporting learning;
(2) Research programmes should address the need for interdisciplinary design teams and participatory approaches in technology enhanced assessment research;
(3) Research should be conducted to investigate the ethical and social justice dimensions of technology enhanced assessment in practice, in particular in learning analytics;
(4) There should an international review of technology enhanced assessment to focus more specifically on ethical and social issues, implementation and sustainability;
(5) A series of wide-ranging policy-focused debates should be initiated to involve all stake-holders and directly address the challenge of rethinking assessment purposes and the role of digital technologies in contributing to such changes.

In conclusion, we have shown that digital technologies have the potential to be a powerful force for change in assessment thinking, policy and practice, but perhaps their most significant potential is as a catalyst to prompt a more fundamental change in the priorities and practices of education itself. Such changes will involve addressing the significant challenges and risks we have highlighted and probably others that we have not. We offer this paper as a starting point for opening up a dialogue on rethinking assessment in the digital age.

Acknowledgements

NOTES

[1] In the USA this is generally known as Computer Aided Assessment and this terminology is still in use today.
[2] See http://www.bristol.ac.uk/education/research/sites/tea/publications/.
[3] Though versions are found in many countries and international organisations, notable examples can be seen in the US Partnership for 21st Century Skills (www.p21.org), the UK curriculum's Personal, Learning and Thinking Skills, as well as the EU's Key Competences for Lifelong Learning (http://ec.europa.eu/dgs/education_culture/publ/pdf/ll-learning/keycomp_en.pdf).
[4] As digital technologies evolve at a fast pace, this is an ever-changing landscape, so examples are illustrative, not definitive.
[5] Massive Online Open Courses—see https://www.coursera.org/ for examples.
[6] https://wiki.mozilla.org/Badges.
[7] For further discussion on Learning Analytics, see our briefing paper at http://www.bristol.ac.uk/education/research/sites/tea/publications/learninganalytics.pdf.
[8] See OECD's annual 'Education at a Glance'—and PISA (Programme for International Student Assessment) at http://www.oecd.org/.

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