Assessing context based learning: not only rigorous but also relevant

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Abstract

Economic factors are driving significant change in higher education. There is increasing responsiveness to market demand for vocational courses and a growing appreciation of the importance of procedural (tacit) knowledge to service the needs of the Knowledge Economy; the skills in demand are information analysis, collaborative working and 'just-in-time learning'. New pedagogical methods go some way to accommodate these skills, situating learning in context and employing information and communications technology to present realistic simulations and facilitate collaborative exchange. However, what have so far proved resistant to change are the practices of assessment. This paper endorses the case for a *scholarship of assessment* and proposes the development of technology-supported tools and techniques to assess context based learning. It also recommends a fundamental rethink of the norm-referenced and summative assessment of propositional knowledge as the principal criterion for student success in universities.

Introduction

The 'post-medieval university mission' (Preston, 2001) increasingly served the economic needs of society, educating for the new professions in science and technology. The present century has brought further needs, associated with information and communications technologies (ICT) and widely referred to as the *Knowledge Economy*. At the same time, economic liberalisation and the growth of a global consumer market in higher education (Scott, 1998) has fuelled demand for vocationally oriented degree courses which are responsive to emerging needs (Jarvis, 2001). It will be argued that the nature of these needs necessitates a more diverse repertoire of teaching, learning and assessment methods than is currently common in higher education.

Context based learning embraces a range of innovative methods which situate student learning in realistic settings and entail what Schön (1983) called *procedural* forms of knowledge – as distinct from the *propositional* knowledge formalised in subject disciplines. Such methods have been seen to be effective in medical and business education (Savin-Baden, 2003), and through the use of ICT-based simulations could be extended more widely in universities to address perceived Knowledge Economy needs. However, a major sticking point has been the problems of devising rigorous forms of assessment for procedural knowledge developed in less formal and controlled settings than the traditional lecture and seminar. This paper takes a strategic view of the current debate on *alternative assessment* (Birenbaum, 1996), contending that it is important in higher education to continue to innovate in context based learning and to confront the problems

of its assessment. It also endorses the case for a *scholarship of assessment* (Price, 2005) and to develop technology-supported tools and techniques to assess context based learning.

It will be argued that maintaining the *status quo* is not an option. The present widespread reliance on traditional pedagogy and norm-referenced, summative assessment locked into external qualifications frameworks seems distant from the skills of information analysis, flexible collaborative working and 'just-in-time learning' which many commentators identify as key to success in the Knowledge Economy. The post-medieval universities took centuries to adapt their courses to the new environment; present-day institutions may not even have the luxury of decades.

External drivers of change in higher education

Massification and marketisation

In their analysis of the context within which universities in many countries must now operate, Moran & Myringer (in Harry, 1999, p.58) identify three main triggers for change in higher education: declining funds, advancing technology, and changing student demography (*i.e.* a move from elite to mass provision with a growing demand for recurrent, lifelong learning). These triggers, they argue, will result in a paradigm shift from conventional to more diverse methods of teaching and learning in universities. Booth *et al.* (2000) also see changing student demography as a major driver of change: both quantitatively, in what they term *massification*, and qualitatively, in the way this move from an elite to a mass system has differently impacted upon academic subjects and institutions – with vocationally-oriented courses such as business management forced by pressure of numbers to radically change their teaching methods. A significant concomitant of massification, they argue, has been an increase in the number of graduates entering the job market, with a consequent erosion of links between university education and the elite status of certain occupations. This trend has resulted in greater competition for student places at those universities considered to have the highest reputations, and a view of higher education as a commodity to be selected in the process of gaining entry to well paid employment.

Needs of the Knowledge Economy

The increasing importance of information processing, in what Machlup (1962) dubbed the Knowledge Economy, puts at a premium workers skilled in the use of ICT for the generation of knowledge from information. Reich (1992) defines three categories of jobs: *routine production services*, *in-person services* and *symbolic-analytic services*. The first category includes repetitive production tasks involving the enforcement of standard operating procedures. Into Reich's third category of symbolic-analytic services fall occupations such as research scientists, civil engineers, management consultants and writers. Their work involves strategic brokering and the identification and solution of problems – services which can be traded worldwide. Typically working in small teams, they make and manipulate symbolic representations of real situations, and for this they are the most highly educated and highly paid of the three categories. Reich takes pains to distinguish between this group and the traditional professions, placing Law into the second category (in-person services) on the grounds that it does

not entail original and creative construction of knowledge. Where in the past professional persons acquired status from their mastery of a specialist body of knowledge, he maintains that the key skills of the future will be the value-added extension of knowledge rather than merely its acquisition and application. Another feature claimed for the 'knowledge intensive services sector' is the need for its workers to continually upgrade their skills. In Britain, the report *Higher Education in the Learning Society* (Dearing, 1997, p.12) made the recommendation:

> …the world of work is in continual change: individuals will increasingly need to develop new capabilities and to manage their own development and learning throughout life.

and empirical support for these ideas has come from the large-scale employee survey *Employment in Britain*, analysed by Tomlinson (1999).

Web 2.0 applications

A related driver of change in higher education is burgeoning growth in the use of what are referred to as *Web 2.0 applications*. 'Web 2.0' is an umbrella term coined in 2004 (O'Reilly, 2007) for a range of Web-based services including social networking, wikis, 'social bookmarking' and collaborative tools (*e.g.* MySpace, 2007; YouTube, 2007). Where the 'Web 1.0' metaphor was the *Encyclopedia Britannica Online* – a subscription service – Web 2.0's flagship is *Wikipedia*, "*a multilingual, web-based, free content encyclopedia project ... written collaboratively by volunteers from all around the world*" (Wikipedia, 2007). The *Horizon Report* (NMC/EDUCAUSE, 2007), which annually provides an authoritative appraisal of the implications of emerging technologies for higher education in the USA, identifies the growth of *user-created content* and *social networking* as the most immediate factors, and discusses their relevance for teaching, learning and creative expression. The Demos report *Their Space* (Green & Hannon, 2007) in the UK draws similar conclusions about the significance of Web 2.0, identifying a growing divide between traditional school curricula and the widespread social networking activities of school students. Two further areas of emerging technology which the *Horizon Report* predicts will have impacts upon universities are *virtual worlds* and *massively multiplayer educational gaming*. 'Second Life', currently the largest online virtual world, is described as "*a 3-D virtual world entirely built and owned by its residents*" (Second Life, 2007), and has already been colonised by educators, as evidenced by The Second Life Education Wiki (SimTeach, 2007). Educational gaming is an extension of computer-based simulations, which have been used in education and training for some years and are part of a large and profitable global industry. An Internet search for "simulation software" using the *Google* search engine located over 88 million hits (April 2007), listing specialist companies and authoring software for simulations in diverse areas including environmental systems, economics, physiology, engineering, pharmaceuticals, business management and education. Paris (2003) claims that "*simulation authoring tools are at the heart of the next generation of e-learning courseware development products*" and in the analysis of the *Horizon Report,* the current high cost of developing immersive gaming environments will be reduced by new authoring tools, resulting in the availability within three years of a far wider variety of curriculum applications.

The significance of Web 2.0 applications as a driver of change is that they in many ways model the symbolic-analytic and collaborative occupations of the Knowledge Economy. Their most enthusiastic uptake has been in the 'teens

and twenties' age group – the generation that Prensky (2001) calls *digital natives* – which is also the modal demographic group for university students. It is likely that the expectations which this age group will have for educational activities which parallel their lifestyles will continue to grow, so that universities which represent themselves as digitally progressive will gain increasing market share.

Forms of knowledge, knowledge in practice and implications for higher education

Forms of knowledge

Gibbons *et al.* (1994) distinguish between two modes of knowledge, which they relate to the needs of the Knowledge Economy. *Mode 1 knowledge* is described as characteristic of systematic corpuses of knowledge contained within subject disciplines. As such it is propositional in form, disseminated through academic journals and conferences, and validated by peer scrutiny. Traditionally, this has been the dominant form of knowledge, but the authors identify an emerging form. *Mode 2 knowledge* is knowledge-in-action, procedural and united with its situation, rather than knowledge existing separately in a codified format which has then to be applied. They consider Mode 2 to be characteristic of knowledge-based work, where what counts is that which helps solve real-life problems – what they refer to as *problemsolving* knowledge. In contrast to Mode 1, they conceive Mode 2 knowledge as exhibiting what they call *transdisciplinarity*, drawing eclectically from traditional subject areas in order to achieve practical goals. Furthermore, they say Mode 2 knowledge is generated typically by groups rather than by individuals: in the context of knowledge-based working, by short-term project teams. This distinction between two facets of knowledge with the view that one of these is of key importance for knowledge-based workers fits well with Reich's occupational category of symbolic analysts.

The view that knowledge may have contrasting facets has antecedents. Schön (1983) made a distinction between *propositional* and *procedural* knowledge. Developing the notion that expertise is realised through the act of reflection upon personal understanding, he stressed the importance of *reflection-in-action* and *reflection-on-action* as essential in professional practice for the development of procedural know-how and repertoire of practice. This working knowledge, he said, is particular to the context in which it is developed, and distinct from the external propositional knowledge of the textbook and training course.

Broudy (1977) goes beyond what he calls the concepts of 'knowing *how*' and 'knowing *that*', to 'knowing *with*' – to a grounding of knowledge in contexts which shape the learner's perceptions and interpretations. Building upon this, Schwartz & Sherin (2002) see the contextualising of knowledge in structures which combine *epistemic forms* – which are knowledge forms and schemata specific to a discipline – with *epistemic games*, which are rules for manipulating these forms. Shaffer (2006, p.223) builds on this in proposing the concept of *epistemic frames*, as

> the ways of knowing, of deciding what is worth knowing, and of adding to the collective body of knowledge and understanding of a community of practice.

Shaffer relates these to the use of simulation and games environments in education, arguing that experiences developed within the rich context of these interactive virtual environments will readily transfer to real world applications.

> Epistemic games based on the ways in which professionals acquire their epistemic frames may thus provide an alternative model for organizing our educational system. Epistemic games make it possible for students to learn through participation in authentic recreations of valued work in the world, and thus give educators an opportunity to move beyond disciplines derived from medieval scholarship constituted within schools developed in the industrial revolution – a new model of learning for a new mode of learning through immersive game technologies. (*ibid.*, p.233)

Thus, parallels can be seen between all these ideas and the Web 2.0 applications discussed earlier, with wikis and social bookmarking exemplifying Mode 2 knowledge, and a theoretical underpinning provided for the use of multiplayer games.

Just-in-time and workplace learning

Nguyen (2004) contrasts propositional knowledge and procedural knowledge in relation to *just-in-case* and *just-in-time* learning (Moe *et al.*, 1999). The former has traditionally been the dominant curriculum model, comprising a large, general and comprehensive collection of information and knowledge for the learner just in case it may be needed at some unspecified point in the future. The latter is a small and highly specific curriculum model, involving learning just in time prior to need. Propositional knowledge, argues Nguyen, is the dominant currency in just-in-case learning. However, in order to meet the needs of organisations in the knowledge intensive services sector (Nguyen takes the example of Electronic Performance Support Systems in the Intel Corporation), appropriate systems and procedures must be employed on a just-in-time basis to access the procedural knowledge which constitutes the organisation's collective memory and which contributes to its market position. In the context of traditional practice in universities, there seems a close relationship between propositional, Mode 1 knowledge and the just-in-case undergraduate course of three or more years' duration.

Context based learning

The value of situating learning activities into appropriate contexts has already been discussed. What is needed is a combination of approaches in which propositional knowledge and procedural knowledge can productively interact and in which a variety of types of learning can result. In the view of Ducatel (1998), both the cognitive abilities fostered by formal education and a range of general and interpersonal abilities are needed in the knowledge intensive services sector. He comments on the core competencies identified by the Eurotecnet Programme:

> This list comprises a mix of both cognitive and interpersonal abilities, which relate to a willingness to take responsibility, problem solving abilities, the ability to work with others and the willingness and capacity to learn. Importantly, several of the categories emphasise synthetic abilities where abstract cognitive abilities and inter-personal abilities come together.

Here we see clearly the need for a merging of codified and tacit skills, but how can this be achieved? (*ibid.*, p.14)

In their notion of *situated learning*, Lave & Wenger (1991) proposed a view of learning as substantially the product of social participation as well as private cognition. Thus, rather than accepting a view of learning as the acquisition of cognitive structures by which the individual makes meaning of the world, they argued instead that meaning is embedded in the structures of human communities of practice and that learning takes place through observation and participation in these specific social groupings. A process of *legitimate peripheral participation*, by which the novice becomes encultured into the norms, routines, vocabulary and knowledge base of a community of practice, requires the learner's involvement as a whole person – socially and emotionally – rather than just intellectually. In many respects this bears similarity to the interpersonal abilities identified by Ducatel as important attributes needed in the knowledge intensive services sector.

Implications for higher education

Considering forms of knowledge in relation to the needs of the Knowledge Economy, some commentators identify an erosion of the dominance of propositional knowledge. Gibbons *et al.* (1994) see a transition from Mode 1 to Mode 2 as "irreversible", and predict that growth in the number and diversity of sites of knowledge production will challenge the monopoly of universities for the certification of valid knowledge. Scott (2002, p.66) speculates

> Maybe we are moving beyond the idea of reliable knowledge, derived from objective empirical scientific research, to a more diffuse (but also powerful) idea of socially robust knowledge, knowledge which is embedded in specific contexts rather than simply being subsequently applied within these contexts.

The view that existing epistemic assumptions and the pedagogical practices of universities may be failing to keep pace with changing needs and the growing importance of procedural knowledge is also expressed in the *Horizon Report*. A key trend identified is that "*academic review and faculty rewards are increasingly out of sync with new forms of scholarship*" (NMC/EDUCAUSE, 2007, p. 4) and it is observed that the growth of digitally-published interdisciplinary and collaborative activities "*continue to move away from the standards of traditional peer-reviewed paper publication*" (*ibid.*). The Internet has radically facilitated the peer-to-peer generation and sharing of procedural knowledge, enabling what the *Horizon Report* calls "*collective intelligence and mass amateurization*" (*ibid.*), and this is evidenced in the growth of Web 2.0. Moreover, with the development of more extensive corporate knowledge bases, just-in-time learning which bypasses traditional taught delivery is now commonplace in some economic sectors, as is the informal (perhaps better referred to as non-formal) learning which is such an important feature of skilled employment (Coffield, 2000). Employers' awareness of these developments is apparent in the report *Towards Maturity* (e-skills UK, 2007) which shows a high value placed upon the flexibility offered by online distance learning to the updating of employees' skills and knowledge.

The implications of all of these trends for higher education are considerable. Universities no longer hold a monopoly over the generation, stewardship and dissemination of knowledge. They must be increasingly responsive to

market demands for up-to-date and vocationally relevant courses, and this implies a greater emphasis on situating learning in context and in embracing a wider curriculum than the traditional dissemination of propositional, cognitive content. And in relation to changing student demography and lifestyle, they must also meet demands for more flexible educational delivery – in time, space and attendance.

There is evidence that departments in some universities are making progress in some of these areas. The support organisations EDUCAUSE (2007) in the USA and JISC (2007a) in the UK disseminate much innovative practice in the use of ICT to support context based learning. However, what has proved the greatest obstacle to progress is what Boud (2000) calls the 'environment of certification'.

> As a society we have become obsessed with certification and grading and public measures of performance and accountability. Whether operating within a norm-referenced or a new standards-based framework, concern about labelling has been paramount. (Boud, 2000, p. 155)

Boud contends that students in a learning society must develop as lifelong learners for an uncertain future, but that in order to do this they must also be able to assess their own learning and to reciprocally assess and support the learning of their peers. Too great an emphasis on summative assessment within an environment of certification will hinder this aim.

> As presently operating, summative assessment acts as a device to inhibit many features of a learning society. It provides a mechanism of control exercised by those who are guardians of particular kinds of knowledge – teachers, educational institutions, professional bodies and occupational standards organisations – over those who are controlled by assessment – students, novices and junior employees. It too easily locates responsibility for making judgements in the hands of others and undermines learners' ability to be effective through simultaneously disguising the criteria and standards of performance being upheld, while convincing them that their interests are being served by increasingly sophisticated assessment schemes. (*ibid.*)

Thus, formal, summative assessment can have the effect of disempowering learners – which clearly is an undesirable outcome in view of the Knowledge Economy needs discussed earlier. Boud proposes the notion of *sustainable assessment*, which acknowledges the need for some degree of certification of present performance, but also accommodates formative assessment as a vital component in the learner's continuing development. Formative assessment thinking, he argues, must be embedded into all learning, and "*We need to do this so that learners can as far as possible undertake their own formative assessment processes using whatever resources they can identify.*" (p. 158). There is a strong resonance between this view and Schön's reflection-on-action, characteristic of the way in which procedural knowledge is developed through context based learning.

The next section explores in more detail the limitations of traditional summative assessment and discusses how methods of alternative assessment, incorporating formative and ICT-based techniques, might be employed in order to more appropriately assess context based learning.

The assessment of context based learning

The limitations of traditional assessment

In their review of research into assessment in universities, Elton & Johnston (2002) make a detailed analysis of what they dub 'the persistence of traditionalism', discussing criticisms made over the last 40 years of the poor validity and reliability of British university examinations. They identify nine "*problems in traditional assessment*" which are "*in urgent need of attention*" (*ibid.* p.10) and point to the absence of research and even general acknowledgement of these significant failings. The continuing reliance on closed-book handwritten examinations – which seem to reward question spotting, cramming and short term retention – is identified as particularly anomalous. But according to Taras (2002, p.501), "*innovation in assessment is no longer an option in higher education*". She notes that one effect of the modularisation and semesterisation of many undergraduate courses has been to increase the frequency of time-constrained assessments and to reduce opportunities for formative assessment and feedback to students. Citing evidence from Black & Wiliam (1998, in Taras, 2002, p.505), she emphasises the educational value of such feedback in the form of continuing tutor-student dialogue, concluding that the upshot of this tension between assessment for learning and assessment for validation is that students are now becoming less well prepared for the needs of the future.

A further shortcoming of traditional assessment practice is that, despite the investment of considerable time and effort in the marking, grading and moderating of the 20-30 assignments which make up the typical British degree course, the end result is usually in the form of a single grade. In 2004/5, 76% of British graduates achieved either an upper or lower Second-class degree (HESA, 2005), so most of this investment would appear to be expended in making fine distinctions within a handful of percentage points. It might be argued that this metrication of assessment is the legacy of a past industrial age and an elite intake, and that universities should instead seek to provide a personalised, holistic description of graduate achievement and aptitude. Although some British universities have started along the road of graduate profiles, the practice is generally at an early stage.

Finally, a growing problem for traditional assessment, particularly in arts and humanities subjects, is Internet plagiarism (*e.g.* Austin & Brown, 1999; Park, 2003). Internet search engines have greatly simplified the task for students of finding suitable text on the Internet to copy and paste – unattributed – into their essays. Once again, much time and effort is expended in the purchase and utilisation of plagiarism detection software and in the application of complex institutional policies and procedures (Baty, 2006). For universities unwilling to consider alternatives to traditional assessment, a tempting solution would be to revert to almost total reliance upon handwritten examinations.

The promise and problems of alternative assessment

Attempts by the proponents of context based learning in higher education to introduce new pedagogic methods have been met with difficulties. Brown *et al.* (1997, p.9) contend *"If you want to change student learning then change the methods of assessment"*, but it is the methods of assessment that have so far proved the greatest obstacle to innovation. Just as the planning and implementation of context based learning require more time, effort and

focused educational understanding than conventional pedagogy, so the assessment of students' context based performance has proved more complex and difficult, and methods of *alternative assessment* have met with limited success. Alternative assessment is an umbrella term including methods which variously may:

- be contextualised in real-world or closely-simulated applications
- involve students in creation / performance / problem solving
- involve students in determining assessment criteria
- involve students in peer- or self-assessment
- focus on process as well as product outcomes
- focus on collaborative skills as well as intellectual achievements
- make formative assessments in stages over time, rather than just summatively
- be criterion-referenced rather than norm-referenced.

It is perhaps the heterogeneity and ambitious scope of these methods which contribute to the greater time and effort involved for their implementation. For example, in a review of fourteen methods of assessing problem based learning, Macdonald & Savin-Baden (2004), observe that methods such as *triple jump* and *patchwork text*, which offer great formative learning benefits, may suffer the drawbacks of being too lengthy or costly for general use. Other problems of alternative assessment may be exemplified in an examination of the use of student portfolios in higher education. A study by Baum, Yorke & Coffey (2004), found substantial differences between the gradings of different portfolio assessors, and in case studies examined by Klenowski & Askew (2006) weaknesses were identified in the ways portfolios were being used formatively to guide students' development. The growing use of digital portfolios creates further complications, as Woodward & Nanlohy (2004) found in the time and cost of providing greater student support. Questions about the value of portfolio assessment may derive from what Elton & Johnston (2002) call the positivist-interpretivist dichotomy. From the positivist position that assessment should be objective, measurable and 'certain' (and therefore that assessments can be made reliable and valid), there follows the assumption that it is possible for 'student ability' to be effectively assessed. However, the interpretivist position argues that 'student ability' does not exist as an independent entity or an external 'truth', but as a constructed quality set within an essentially social context. The main purpose of assessment, from this viewpoint, is the provision of feedback to assist the learner; issues of reliability, validity and external accountability therefore become of lesser importance. Tensions between attempting to include interpretivist judgements within the (positivist) framework of formal accreditation have been accounted by Peters (2005), and Sadler (2005) notes a confusion between 'criteria' and 'standards' in the subjective judgements teachers make in criteria-based assessment. A related position is argued by Maclellan (2004) in a detailed critique of alternative assessment. She points to the crucial need for validity in high stakes, alternative assessment in higher education, and sees the key problems to be task specification and consistency of marking. The framing of appropriate tasks (*e.g.* problems, simulations) is hampered by the difficulty of tuning out non-relevant variables such as generic skills and knowledge, and by the difficulty of separating judgements of task outcome from those of student performance. Consistency of marking is hampered by the difficulty of determining optimal assessment criteria and the difficulty of judging across the variety of complex factors which make up real or simulated situations. Maclellan concludes that

> …while alternative assessment may be instructionally informative, its use for summative and accountability purposes is much less prudent. To this extent, alternative assessment in higher education is not a particularly convincing form for high stakes assessment. (*ibid.*, p.319)

The implication – that traditional assessment should be retained for "summative *and accountability purposes*" while context based methods could be employed for their relevance to changing needs and for their formative benefits – is at first sight a persuasive one; however, it might prove difficult in practice. Students attracted to those courses which proclaimed their affinity to real world applications might in fact be most likely to become 'strategic learners', devoting attention only to aspects of their courses which they saw as directly enhancing their grades. And in any case, despite the considerable problems of alternative assessment, traditional, summative assessment can also exhibit significant deficiencies, as has been discussed.

Improving alternative assessment

The case for continuing to develop innovative methods of teaching and learning is twofold: new methods have been seen to better promote reflective learning and student motivation, and they are also perceived to have greater relevance and utility for vocational needs and lifelong learning. However, more effective and feasible methods of alternative assessment need to be developed in tandem. Price (2005) calls for a *scholarship of assessment*: a community of practice to develop more rigorous and enduring assessment standards than are currently achievable within the time constraints of conventional university practice.

This paper argues for the use of ICT to help manage the size and complexity of alternative assessment. Some benefits of computer based assessment are summarised in the report *Effective Practice with e-Assessment* (JISC, 2007b, p.26):

> In general, e-assessment may be best used to free staff for tasks that humans do best. Administrative functions performed by the computer – scoring, recording, and transfer of data – will ensure greater accuracy and objectivity than is achieved by humans. However, a uniquely valuable attribute that e-assessment can offer to learners and practitioners is an authentic assessment experience. Computer-based assessments can be taken in the workplace, acquiring an immediate relevance. They may also replicate an authentic context through simulations, virtual worlds or use of audio or image files, so that the activity seems more real and purposeful for the candidate. The use of gaming software as a preparation for, or as part of, a summative assessment, increases the stakes in this respect, and, where development funding is available, has the potential to revolutionise assessment practice.

Earlier discussion in this paper has also made the case that the typical, digitally-savvy, student would be likely to welcome such forms of assessment. While e-assessment should not be equated with alternative assessment, the multimedia possibilities of ICT do offer considerably greater scope for assessing context based learning.

Examples of current e-assessment practice fall into two categories: *assessment tools*, and *profiling systems*. Within the first category, Campbell (2005) describes an ICT tool which, in addition to easing clerical tasks involved in the marking and grading of students' work, aids in the refinement of rubrics for assessment and in the process of moderating marks across different assessors. The UK Open University uses a tool called OpenMentor which trains tutors in the creation of high quality, formative feedback to the students of its distance-taught courses (JISC, 2007b, p. 24). Profiling systems have been used successfully at Oldham College to diagnose the needs of students so that personalised combinations of learning materials can be identified for access via its virtual learning environment (*ibid*., p. 34). The use of electronic portfolios of student achievement is growing (JISC, 2006), and e-portfolios are used as the principal form of assessment for a degree course at Anglia Ruskin University (JISC, 2007b, p. 33).

Some of the examples above have the status of innovatory project rather than mature, embedded practice. However, attempts made at Strathclyde and Loughborough Universities in the UK have moved in the direction of institution-wide adoption. The REAP project (Re-engineering Assessment Practices) at Strathclyde seeks to address the problem of poor retention in first-year undergraduate programmes by improving the extent and quality of formative assessment feedback with e-assessment conforming to seven feedback principles (Nicol & Macfarlane-Dick, 2006). At Loughborough e-assessment has been in use for over ten years and over 70,000 such assessments were made in 2006, ranging from objective and multiple-choice tests through to case studies and complex scenarios (JISC, 2007b, p. 39).

The use of *intelligent software agents* to pattern search and collate from large and complex data sets is well established (*e.g.* Pankratius, *et al.*, 2004), and all Internet search engines now incorporate these features. Qualitative data analysis software products such as ATLAS.ti (2007) are used to 'mine' and categorise information for research purposes, and analogues of this idea are being used in the assessment of student work in diverse, but digitally submitted formats. The growing use of *learning objects* (Littlejohn, 2003) provides further potential. Many of these shareable and reusable units of teaching material in digital format incorporate assessed exercises, and such tasks could readily be related to application in real contexts or in the epistemic frames of games and simulations. Moreover, the infrastructure for storage and exchange of such resources within the higher education community already exists in peer-reviewed online repositories such as MERLOT (2007) in the USA and JORUM (2007) in Britain.

Future opportunities for e-assessment could lie in the use of video capture and messaging using digital handheld devices in work settings, and the *Horizon Report* (NMC/EDUCAUSE, 2007, p. 17) lists examples of early developments. Assessment opportunities might also arise from the educational exploration of social bookmarking and immersive virtual environments. It is possible that significant pressure for change will result from various moves to personalise educational provision (*e.g.* de Freitas & Yapp, 2005; OECD, 2006), and the *Effective Practice with e-Assessment* report speculates that "*By 2017, a drive for inclusivity and personalisation in assessment will have challenged the 'one-size-fits-all' assumption that dominated assessment practices in the 20th century*" (JISC, 2007b, p.36).

Conclusion

This paper has presented arguments to support the proposal that universities should adapt their missions to further reflect the changing employment needs of professions within an emerging knowledge intensive economy. The new needs involve ways of flexible and collaborative knowledge creation, and transcend traditional pedagogy centred upon the (largely one-way) transmission of a relatively static corpus of propositional knowledge. In an increasingly marketised higher education sector the case for change is made more urgent by the growing demand for vocationally oriented courses. Context based learning may provide some solutions to these needs by situating learning within real, realistic or simulated contexts. The medium of ICT, which has been such a key feature of the new economy, is also key in the experience of the 'digital natives' who comprise much of today's student population in Western universities. Their orientation to learning by doing and through the active exploration of knowledge-rich online environments makes the use of educational gaming and simulations a natural and easy extension of social networking.

The difficulties encountered in assessing the new forms of context based learning are more intractable. The diffuse nature of these context specific qualities and the difficulties of making reliable and objective judgements in diverse situations remain problematic. However, there is evidence that ICT may be applied further in providing solutions to the problems of sheer scale in coping with the larger and more complex collections of evidence which characterise context based assessment. The use of alternative assessment methods also shows promise in providing the sort of evidence for graduate profiles which would be of benefit to both the graduates and their potential employers. In addition, it seems reasonable that Internet plagiarism is likely to be less of a problem in personalised context based situations than in more generic traditional assessment.

Despite a number of continuing, but largely unaddressed, problems, the norm referenced, summative assessment of propositional knowledge remains the predominant method of arriving at degree classifications. Its claims for (relative) reliability and objectivity are politically welcome in a climate – particularly in Britain and the USA – in which standardised testing is widespread in education at all levels (Hargreaves, 2003; Kohn, 2000). However, these perceived advantages of rigour must be balanced against issues of relevance, eroding the position of traditionally assessed degrees in vocational subjects as valid preparation for the knowledge intensive professions.

A scholarship of assessment is needed, to analyse effective practice in alternative forms of assessment and to inform the development of ICT as a processing tool. The challenge for universities in vocationally related courses is to devise new patterns of sustainable assessment which will include the formative benefits of student performance within relevant professional contexts, with the more objective rigour of (some forms of) traditional assessment – resulting in more comprehensive and detailed appraisal than is currently possible. The greater use of context based, sustainable assessment will also enable graduates to develop as effective lifelong assessors: of their own learning and of the learning of their colleagues. In these ways teaching, learning and assessment in universities will be seen to be at the leading edge of good practice, deploying each assessment approach where and as appropriate, and in doing so, seeking to be not only rigorous but also relevant.

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