The RDA of Standards for a Healthy e-Learning System

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Abstract

Standards for learning technologies and their implementation have long been a topic of scholarly debate. The focus previously lay on research and development of common specifications and their usage in describing learning objects or learning designs. More recently, discussions arose around the socio-economic role of standards, whence business processes related to the creation and promotion of e-learning standards came under criticism. This is all the more important as especially at universities the big push towards standard-based e-learning is still missing. Despite the often declared benefits of e-learning standards, universities, unlike commercial learning and training providers or the military, have made little progress towards implementing standard-based editorial and production processes into their daily workflows. We would like to argue that standards are neither pedagogically nor economically neutral and that this is a barrier to full and cohesive implementation in daily workflows. With Casey et al. (2006a) we see the true challenge for e-learning not in the adoption of technology, but in managing structural and cultural change in institutions.

The article will therefore take a holistic management approach of standards applied in universities with a view of their multi-faceted role as both producers and consumers of learning content as well as system developers.

1 Introduction

The major challenge institutions are currently facing is in being required to teach greater numbers of students in more flexible ways within fixed resources, while being increasingly called to account for quality of service. The introduction of e-learning technologies has served to highlight the tenacity of traditional ways of delivering education - where existing structures and patterns of behaviour have been projected onto the new technologies, thus preventing their fullest utilisation.

The arrival of interoperability standards, together with their related concepts and methods, marks a radically different educational philosophy – where organised design activities and reuse of content components play a central role in supporting large-scale sustainable delivery of flexible learning opportunities. It requires a move away from the current dominant model of teaching, that of the individual subject specialist, to a team teaching model, which is slowly beginning to happen. This simple, but profound change in how teaching is conducted and organised is the critical enabling factor in using progressive teaching methods and technology to meet our educational challenges. In this process, traditional orthodoxies about the structure and organisation of our institutions and the professional cultures of those working in them are being challenged. In return, some of the conventions in the fields of interoperability standards, learning technologies and educational research are now being called into question and subjected to scrutiny. In this article we explore the tension between these different forces, some of their origins and some possible resolution between them.

2 Thesis – The strategic necessity of implementing standards

Efforts to develop standards for e-learning have led to the establishment of a number of special interest organisations and working groups who dealt with the creation and articulation of specifications and standards. For universities there are three compelling reasons for why the use of standards is inevitable:

- sustainability and securing investment;
- quality assurance;
- e-Learning architectures (SOAs).

We need to analyse and deconstruct these drivers, before arriving at the critical observations concerning practical implementation.

2.1 Sustainability and securing investment

Universities invest large amounts of money in e-learning. A major part of this goes into infrastructure, hard- and software, another large chunk goes into the development of teaching content, the planning of online delivery, as

well as the training and support for staff and students. Due to increasingly stretched budgets it is self-evident that investment should not take a short term perspectives but follow longer term strategies.

Within this context, e-learning standards appear to offer three major advantages that benefit long-term sustainability (Friesen, 2004a): transferability, reuse, and interoperability. To these we can add scalability (cf. Rehak, 2003) as another potential economic benefit. These criteria, when met should secure the return on investment in content production and in the choice of compliant production systems.

Transferability provides independence of content and presentation from the platform. This allows teaching content to be used in virtual learning environments (VLEs) of different generations or makers. It also allows materials to be served to different output technologies, e.g. mobile technologies. This gives universities the liberty to change their VLE or learning objects repository without having to re-create all the content.

Our own experience with content migration out of commercial systems such as WebCT and Blackboard are sadly in line with the unsuccessful pilot migration described by Mohan (2004, p.5) and show that in practice there is still a long way to go as specifications are interpreted differently by different vendors.

Interoperability facilitates the data exchange between different systems, allowing them to communicate in order to provide aggregated services to satisfy more complex needs of the end users. This is of vital importance for enabling service-oriented architectures (SOAs) by linking different modular interoperable components. The exchange of data requires shared data structures based on agreed formats.

It is important to emphasise at this point that universities (HEIs) are not only customers of systems, they are arguably the biggest drivers in systems development. A large number of e-learning applications emerged either as in-house systems or as spin-offs from HEIs, e.g. e-portfolio developments in the UK (Strivens, 2007). To grow beyond the internal user base, interoperability services need to be well understood and implemented, but in many cases are retrofitted rather than pre-planned. The challenge for universities as system development hot-houses is to show a multi-dimensional standards awareness for implementation. This may require a prioritisation of one specification over another (e.g. IMS LIP, UK LeaP, PAPI, ePortfolio, etc.). The multiple dimensions arise from different service demands to a single system, e.g. shared authentication, learner information, course description data, course membership, learning content data, instructional designs, metadata, archival and retrieval profiles, and so forth. As we shall discuss below, the realisation of compliance with these data models is currently beyond the

reach of most institutions.

To secure long-term investment and sustainability we also need to consider *reusability*. The more a costly digital production is used the better its return on investment for the institution, thus paying for its creation. This opens opportunities for selling and trading online learning products and services, including non-commercial open content publishing along the lines of Open Course Ware (OCW). Again, shared content standards like LOM are a vitally important enabler of these trans-institutional business processes. But, as Hodgins (2006), Chair of the IEEE LOM Team, admits, modular content standards are not enough to guarantee reusability of learning content, and initiatives to standardise context and process descriptions are to date still not mature enough to be usable by a broader than the specialist community (cf. Casey, 2006a).

Reuse in our opinion can only happen when content and processes are designed to be reusable from the outset. There is increasing evidence that current teaching practice in higher education is not supporting such a culture. Fernandez-Young et al. (2006) give a strikingly candid account of their encounter with the concepts of SCORM Learning Objects and the requirements to author their course and materials to fit the 'doctrines' of granularisation and decontextualisation. Not surprisingly, they found this difficult and were not convinced of the underlying rationale. One of the common learning object orthodoxies is that they should be free from internal contextual content to make reuse easier. This presents severe problems for 'general practitioner' lecturers who are increasingly clear about the need for meaningful contextual information about the resource to enable them to assess and reuse it (Feldstein, 2003).

Scalability largely follows the principles laid down above for reusability. Again, the priorities need to be designed in from the beginning using the appropriate standard for the intended priority. For example, to scale up longevity of some learning object, the archival standards for long-term storage and retrieval need to be considered more closely, whereas when intending cross-disciplinary scaling the granularity and abstraction of the metadata and content need to be adjusted. Impact and success of the implementation depend on the chosen strategies. These strategies for the use of e-learning technologies are shaped by deeper philosophical positions which are rarely examined or articulated (Goodyear, 2001).

2.2 Quality assurance

Implementation of e-learning standards does not by itself assure the pedagogic quality. Good and bad didactical approaches can equally be captured

in standards-compliant transferable formats. However, it is important to note that standards can play an enabling role in the institutional development of teaching from a cottage industry method to that of a mature mass education system (Mason, 2005, 323f.). Standards-induced predictability of content may be seen as an indicator for quality editorial processes. Introducing standard conformant authoring processes enables institutions to harmonise their productions into a transparent and consistent product range which bears quality hallmarks that do not distinguish between learners thus removing internal dividers that are upheld through existing ad-hoc structures and inconsistencies and make students dependent on the digital competences and didactic quirks of their course leaders.

Specifications and standards thus allow greater transparency that can be seen as a useful quality mechanism because it allows comparison, evaluation, and improvement. The coherent implementation of such approaches into the authoring and reviewing processes is again a challenge that most universities currently find hard to cope with.

2.3 Service-oriented e-learning architectures

SOAs allow institutions to build complex modular learning environments. This meets more learner needs and enables more efficient administration and data processes. Most universities have started to build such component-based architectures. They tie together a number of institutional services and transactions to manage and administer learning. One example of the common shared services supported by component-based architectures is user authentication using the single sign-on principle. At the same time components can be accumulated and combined to organise multi-faceted personal services.

In order for a SOA to work, the individual components need to communicate using common protocols, specifications and standards (OASIS, 2006). Technical interoperability standards therefore quite rightly claim the facilitation of such e-learning architectures. Nevertheless we see in practice that especially in self-made in-house applications ad-hoc and in-time programming prevails and often would require substantial retrofitting to comply with international standards – especially as the ‘standards’ are constantly changing.

Our own institution – as most other universities do – uses a blend of technologies comprised of proprietary, open source, and self-made systems. For a better understanding we divided the areas of coverage into four fields: person, assets, services, and tasks. When we x-ray a typical HE SOA from inside outward it looks like this (Fig.1):

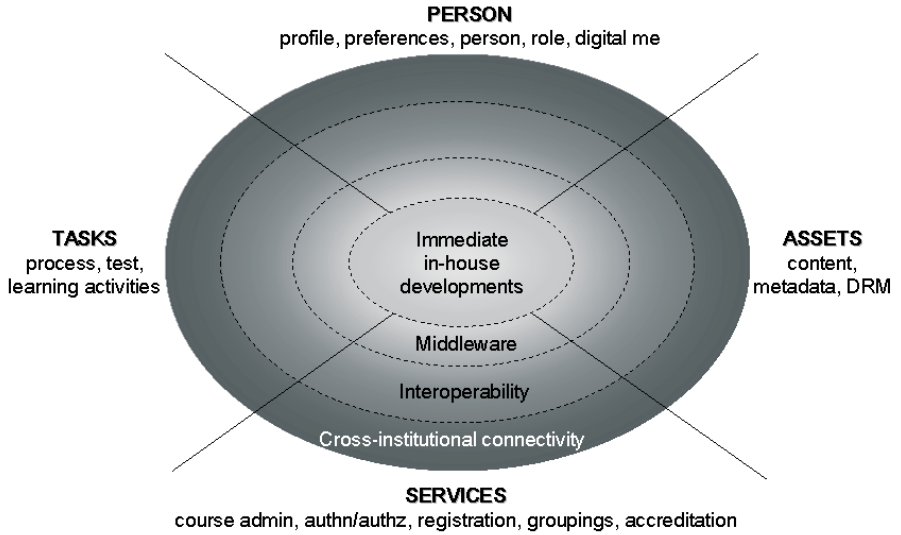

Fig. 1

One thing that is apparent is that the importance of standards grows the more externalised the services are conceived.

3 Antithesis - Challenges and tensions in real world education

The above three reasons for implementing e-learning standards lead to institutions considering various approaches at great length. Nevertheless, there are practical difficulties in the realisation which partly originate from the particularities of universities as entities, partly from the complexity of the standards landscape.

So far, institutions have proved remarkably resistant to change induced by e-learning. At this point it is important to differentiate between the nature of mainstream post-secondary education and those that are already embracing interoperability standards. Those most involved in the use of standards are the industrial and military training providers, and the open and distance learning sector (ODL). The experience of these 'early adopters' cannot simply be projected onto the mainstream tertiary institutions. The reason is that mainstream education does not function in the same way, the structure of the organisations and the cultures of those working in them are quite different and their actual missions are poles apart. Teaching and learning in the mainstream is a less controlled and contingent enterprise than in industry, the military and ODL. And the mainstream education sector is

more affected by social and political agendas – as Mayes (1995) pointed out over 10 years ago:

"Thus, there are good reasons for supposing that today's learning technology will this time lead to radical change in education. Yet doubts remain. For one thing education is a social and political system, and the checks and balances that keep the system working may not be shifted by any technology."

Friesen (2006) has observed that domains of education and learning can be understood as being especially local, heterogeneous and contextual in ways that few other organized activities are. As a result of a failure to understand this situated nature of education the various proponents of learning technology have been largely ineffective in generating change on the ground. Instead, Learning Objects, Learning Design and their implicit organisational and pedagogic models are colliding with the deeply entrenched pedagogic values and attitudes of the mainstream sector. In this process orthodoxies from both sides are being challenged in the new and emerging teaching practices and learning communities appearing at this interface.

3.1 Strangers in a strange world?

Since the beginnings of standardisation efforts in the mid 1990s the development and maintenance of standards has become a growth industry, involving not only commercial enterprises but also many academic developer teams and public bodies. A multiplicity of organisations and sub-organisations has since become involved. Among the most prominent ones are IEEE LTSC, IMS Global Consortium, ADLnet, AICC, ISO/IEC JTC SC36, CETIS, CEN/ISSS, BSI, etc. (more agencies can be found at CETIS: W001, and Friesen, 2006). Most recently, the establishment of yet another governing body called LETSI (*Learning, Education & Training Systems Interoperability)* has been debated. It can not be ignored that with this much attention and increasing distance from the actual users and their needs there is a danger that developments become dependent on a self perpetuating industry governed by self-interest that loses contact with daily practice.

The recent growth in self-importance of the educational standards community has been accompanied by an unrealistic, elitist, and often libertarian self-image of a tech-savvy user that is then projected onto the user community and their potential uptake of the specifications and standards. Too often the customers are conceived of as specialist workforce that is simply not available in most institutions and rarely can be afforded through public funding schemes. Building the in-house capacities to this end is an expensive and risky venture that few institutions have the financial means to undertake.

Sophisticated editorial processes as exist in the open learning sector with publication design teams coordinating the production of learning materials in a sustainable manner are virtually non-existent in traditional higher education institutions. They also assume a centralised and corporate approach to education which is hitherto not a chief characteristic of university provision (Greller, 2005).

Friesen (2006) reminds us that standards originate from the industrial era and are based on the eco-political principles of the mass-market. That the leading standardisation efforts for e-learning too have their foundations in the special training requirements of the American aviation industry (AICC) and US military (ADLnet) is therefore no coincident. While these industrial training schemes may work well in a commercial or military training environment, the mass-production of individualised learning is a contradictory concept for higher education (Freund, 2003). Friesen (2004b) critically calls this tension "education in a militarised zone". It implies that standards are built on a specific ideological and pedagogical model which is alien to the largely unregulated teaching structures in universities. It is questionable whether we should aim to cross cultural divides and need to seek approximation of pedagogical cultures. In any case, the claim that "this standard is pedagogically neutral, content-neutral, culturally neutral, and platform-neutral" (IEEE LTSC, W002) can no longer be maintained.

Casey et al. (2006a) observe that these implicit models on which standards and learning technologies are based, are a common source for confusion and failings in application. They see the real challenge in e-learning not in implementing technology, but in the little understood cultural processes of organisational change. The implementation of standards can have two effects: on the one hand it could lead to a deep reanalysis of business-, teaching-, and production processes; on the other hand it may emerge that higher education is simply incompatible with industrial criteria and measures that have evolved from different enterprise cultures. As we shall see further below, alternatives to overcome this impasse may emerge in due course and could provide viable alternatives to controlled processes and vocabularies.

3.2 The nature of standards

Standards by their nature are prescriptive and assume generic applicability. At the same time they also embody an inherent philosophy and perspective. A typical example is the IMS Learning Design specification where the underlying paradigm is the theatrical metaphor dividing roles into actors and activities into acts (Koper, 2005, 7ff.). While this is a powerful and useful metaphor for the purpose of describing didactic scenarios, we also find competing different

modellings cast into other specifications like IEEE CMI (computer managed instruction) or IMS SS (simple sequencing). As Botturi et al. (2006) elaborate, this is further complicated by a plethora of instructional design models and expression languages as well as the tools they are implemented in. Parallel developments, overlap and competition between standards are not always avoidable (Friesen, 2004a).

Against the general image of permanence and unanimity of standards there is a further challenge in the fact that specifications and even standards do not reach a stable state of being but are in flux and continuous development (Friesen, 2004a). This is partly due to the dramatic speed of change in technological developments, partly because of a lack of clear scope and universally accepted definitions, and perhaps more seriously – clearly articulated purposes. This leads to institutions and other software developers being confronted with moving targets and version numbers which when implemented necessitate maintenance and continuous costs. An example of this is the large investment in 'learning objects' for education by the UK NLN (National Learning Network) that saw considerable amounts of public money invested in the early 2000's in the creation of learning materials that were packaged up into versions of SCORM and IMS CP but later needed expensive remediation to be made to work. The diverse implementation of IMS CP in different commercial and open source learning platforms as described by Mohan (2004), and matched by our own experiences not only leads to failure of standards in the real world, it also results in loss of faith within the user community in the capabilities and benefits of a standards conformant production. For new developers of extension software (e.g. Course Genie) often the only way to deal with this issue is to provide multiple parallel interpretations for their tools.

3.3 Implementation strategies

Specifications are rooted in their respective cultural communities as described above, such as computer-based training, the IT sector, the Library and Archive community, and so on. Museums, archives, libraries and other parts of the cultural/education sector have had a longstanding tradition of having their objects used in teaching and learning. However, these materials are treated quite differently by their digital curators than those working with learning objects. This sector specific treatment can challenge institutions when deciding the appropriate mechanisms for producing, curating, and sharing their digital assets.

When considering the implementation of e-learning standards into the daily business processes and work flows it seems best to prioritise what aspects are most important to observe. If we look at a content resource as a

focal point we can apply a variety of strategies according to chosen preferences. Here is an indicative sample of possible approaches (Fig.2):

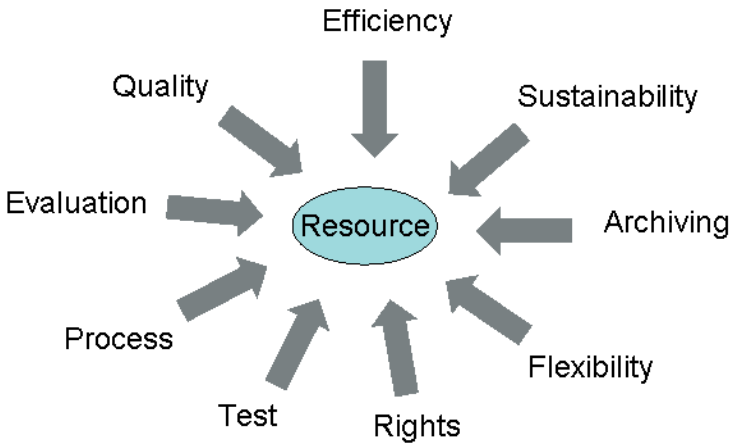

Fig. 2

The individual strategies can be connected to a set of specific goals which may be helpful when selecting appropriate data models and standards and when designing the necessary implementation workflows:

Efficiency: search and retrieve for reuse
Sustainability: transferability of resources
Archiving: long-term preservation
Flexibility: adaptability, localisation, aggregation
Rights management: copyright and IPR protection, controlling use
Test: question and test databanks
Process: using the resource in context
Evaluation: attention metadata[1], ratings
Quality: special attributes, accessibility

Evidence from projects like aLFanet (Van Rosmalen et al., 2006) shows that universities and other educational organisations find it difficult to cope with the complexity of multi-specification environments. Orientating production processes, be it programming, content, or curriculum development, towards available specifications in a complementary and conformant fashion requires new workflows, involving experts and practitioners alike, as well as a full understanding of the purpose of individual specifications. It comes as no surprise to us that aLFanet while trying to use five complementary IMS specifications found that there are substantial technical and functional differences between the theory of standards application and the real world. The human and organisa-

1 cf. Hodgins, 2006

tional component emerged as the greatest source for weaknesses in application (ibid. p.81).

Even if in an ideal world reference models would seamlessly fit each other, one challenge that remains is the embedding into daily practice of academic teachers. Although this might only concern a small number of standards relating to content and curriculum development, it affects a large number of staff which makes a coherent roll-out an expensive and potentially disruptive affair that few institutions would be prepared to invest in. The development of team workflows between practitioners and experts (e.g. metadata experts, digital rights experts, learning designers etc) has hitherto been from slow to non-existent due to the decentralised nature of academic production processes. The hope is that improved authoring tools will be able to make standards a mere technical challenge that will become invisible in daily work.

4 Synthesis - Emerging alternative approaches

Universities have to balance cost effectiveness, practicability and conformity against each other. In many cases this leads to compromises. Standards, however, do not lend themselves to half-way solutions but more recently new ways appear, which may fulfil the above mentioned institutional goals of sustainability, quality, and component-based architecture without the full rigidity of standards and controlled vocabularies.

4.1 Resource Description Framework

The IEEE LTSC LOM team and Dublin Core Metadata Initiative work together on the so-called Resource Description Framework (RDF). In contrast to the LOM standard and other specifications this does not depend on a centrally controlled vocabulary and provides greater flexibility (Kraan, 2003). It allows objects to be described in different ways and is independent of the object, i.e. does not necessarily appear together with the object. In this way, the RDF breaks with the limitations of the metadata standards that require adherence to a controlled vocabulary and taxonomy by enabling context-sensitive descriptions. The example that Kraan (ibid.) provides is colour, which dependent on the context of use can be described differently as hue, gray-scale, 24bit, HexCode, ‘mahogany’ or simply as ‘brown’.

4.2 Social metatagging - a myth?

Under the heading of Web 2.0 more and more interactive online applications harness the power of communities to create semantic tags for various types of resources. A good example is the Music Genome Project (W003)

where listeners can categorise and add attributes (e.g. moods) to individual pieces of music. Approaches like these aggregate inter-subjective and open categorisations into a scaled approach that would not be possible under the traditional expert categorisation processes slotting items into predefined controlled taxonomies and catalogues.

There is considerable advantages in this method as there is higher tolerance for errors (one misspelt tag does not render the item irretrievable), broader attribution (item attributed to a variety of semantic fields), and inherent evaluative indicators (e.g. by the number of people tagging a resource in a particular way). It can provide more complex descriptions than would be the case in simple cataloguing procedures e.g. in a record store.

Such an approach is also feasible for learning resources and would save on cataloguing processes and reduce time delays in publishing, making the resource available immediately. Social description models are built on subjective components in opposition to the authoritative approach used in the industrial model. The latter, which is underlying the application of standards lacks the personalisation of the resource description, which Hodgins (2006, p.15) calls 'attention metadata', that enable personal statements on quality, recommendations, semantic connections, and open groupings.

Having said that, this Web 2.0 approach is not risk-free either. There is little likelihood that assets in an institutionally owned and managed collection of learning objects will be tagged in such a way that makes them findable over the long-term. Of course, this highlights another assumption that underlies the use of standards – that the university will somehow start managing *all* the teaching and learning materials used by academic staff in a central shared repository. Besides the contentious issues of ownership, control and access that this raises – it is sobering to realise that this has not been attempted before with the possible exception of specialist ODL institutions. The tendency to conflate personal tagging with long-term institutional information management needs to be rejected. It is not a question of traditional cataloguing activity versus social tagging – the most promissing way forward is to use each to their best advantage where they are most suited. One is geared towards management and the other to maximising use – they are different functions that need to be understood (cf. Kipp, 2006, DublinCore, 2007). A positive example of a combined approach can be found at the Powerhouse Museum web site in Australia (W004).

4.3 Natural language

The better the text mining and search tools and methodologies, the more they can bring machine language closer to humans which may render metadata

less important. An integrated text analysis based on e.g. the number of occurrences and synonyms in a text can in most cases provide more accurate search results and ratings than keywords from metacontent.

Downes in a much noted presentation (2003) rejects controlled and limited vocabularies. Instead he suggests to follow human code which allows us to do what metadata claim to enable: to describe and create connections. In natural language terminology is created through use in the appropriate context. In our observations we noted users of the institutional learning platform to develop a shared vocabulary based on the tool. This enabled sharing ideas and teaching strategies, rather than adapting their behaviour to a theory based learning design language. Free text descriptions of objects, context and process may help save on long training and monitoring mechanism that are currently the corner stone of standards implementation.

4.4 Automated metadata generation

Hodgins (2006) views the future of metadata as an automated combination of context and object information, by identifying in which context a particular content is located and used (e.g. forum post, news article, weblog entry). This allows statements about the object itself. Context recognition produces better cultural descriptions than cataloguing, for example by communities of practice. In this way even the problem of "when is a learning object a learning object" (Downes, 2003; and Friesen, 2004b) may become irrelevant.

An economic aspect to auto-generated metadata is that this potentially leads to a reduction on human efforts (Mohan, 2004), which may eventually bring them within affordable reach of institutions. However, the techniques described here are still in the research labs. At the moment the kind of metadata required to reference any asset of worth is still created 'by hand'.

4.5 Disposable and informal content

Last but not least we would like to raise the question whether reusability of learning resources is a myth rather than a goal, especially as there are very few indications of an emerging culture of sharing in higher education to date (Casey et al., 2006b) – this despite the perpetual efforts by funding bodies to encourage sharing. Mohan (2004) gives a series of reasons why critical mass for reuse of content is so difficult to achieve, including legal barriers that limit localisation and adaptability. Friesen (2006) concludes that education is a deeply localised activity, whereas Littlejohn (2003) states: "designing for reuse means designing with multiple users in mind and this is a new experience for most teachers in all sectors of education".

If we take current practice as a starting point we should note that content is most often designed for one-time and own use. Resources are in first instance conceived as ad-hoc objects to serve run-time activities. Due to pressures to innovate continuously the half-time and life expectancy of knowledge creations has been dramatically reduced so that longer term use is precluded right from the planning phase. Learner expectations too are increasingly focussed on fresh new content instead of established materials.

Additionally, the production methods are becoming increasingly cheaper and simpler, and are more widely available than ever before. The demand for high-quality professionally edited resources such as teaching videos we note as decreasing, in part due to the new do-it-yourself trend in Web 2.0. It has become quick and easy to spontaneously produce audio recordings (podcasts) or videos and to distribute them. At the same time they become quickly obsolete.

Under these circumstances institutions must ask themselves whether the creation of complex and lengthy standards processes in relation to content development do make economic sense for what are essentially short term products.

5 Heresies – Some conclusions

It is clear to us that standards will remain an alien feature to higher education practice as long as they are not realised and justified fully in business processes and behaviour. In our opinion it is mainly the different cybernetic structures, the pre-industrial Socratic transmission model to learn from a “lone scholar” as opposed to centrally managed instruction, teaching teams, and editorial processes, and weak change management that create an environment hostile to the implementation of standards.

On a continuum of unrealistic “military” implementation and impractical metadata anarchy, higher education practice therefore is to be found nearer the latter end. As much as the former may be a wishful goal to achieve in standards theory and though the latter is inconvenient, there are emerging alternatives and ways which will not eliminate standards completely but may reduce them to a mere technical discipline. The grass-root revolution of Web 2.0 may, in time, provide serious business support that allows institutions to achieve their goals.

To date, the interest generated by the work on standards in the educational and e-learning fields has been considerable and this has helped to encourage a re-consideration and exploration of how teaching and learning is conducted in the mainstream. The research that has been going into this has been split between the two related communities of educational researchers

and technical developers.

So far, the relationship of both, researchers and developers, with the mainstream has been unsatisfactory; they effectively exist within different 'ecosystems'. As a result, some of the difficult systemic characteristics of the mainstream are not comprehended or engaged with ineffectively. This leads to, the largest cause of failure in software engineering and arguably e-learning projects – a lack of understanding of the user requirements (Standish, 1994).

The reality of improving our higher education systems is a rather more prosaic enterprise than the standards enthusiasts would have us believe – and is in fact a relatively lo-tech problem. If quality and efficiency in higher education are indeed the foremost priorities then the solution lies in the redesign of the curriculum and the restructuring of employment contracts as part of organisational change (Casey & Wilson, 2006c).

Real world users operating in complex systems like universities tend to take existing resources and tools and use them in unexpected ways in order to meet the exigencies of real and immediate problems. For example, one novel use of learning objects that flies in the face of existing learning object 'doctrine' concerning size and decontextualisation is to have very large objects (e.g. a whole semester course) with fairly detailed and good metadata at the top level of the structure. This cuts down drastically on the cost of the metadata/cataloguing creation and all the content of the object 'inherits' the same semantic relation. In addition if the content of the objects is made searchable, individual teachers can explore the objects to great depth. Add attention metadata and we might begin to see a realistic mix of traditional information management techniques and Web 2.0 approaches that on the one hand support the longer-term needs of the institution and on the other empower teachers to make more sense of the 'data-deluge' they face in their working lives.

Interoperability standards may well change education for the better – but it is likely to be in ways that their supporters have not envisaged. This would be consistent with history of other technological innovations such as the bicycle, computer and the Internet.

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