E-Learning and Sustainability

This report has been produced by Graham Attwell from Pontydysgu for the University of Bremen as a contribution to the Lefo learning Folders project

Contact: Graham Attwell – graham10@mac.com

Content

1 Introduction – scoping the issues

1.1 The task

This paper has been commissioned by the University of Bremen as part of its contribution to The European Commission Socrates supported Lefo Learning folders project. The brief for the study was “working out an analysis of how to manage a virtual learning environment in different countries and by different types of organisations (universities, SMEs, primary schools, international associations) in a sustainable way”. This is a very wide-ranging assignment and one difficult to deliver within the confines of a short research paper. Put in its nutshell, I will attempt to address the central issue of how e-learning can become sustainable. In this introduction to the paper I will attempt to scope the different issues involved and provide an outline to my research approach.

1.2 About the sustainability of e-learning

Sustainability can be approached from a number of different viewpoints. It could be of ways to ensure new reforms and initiatives are sustainable, it could be about ways to change practice or it could – certainly in the context of e-learning, look at the sustainability of investment in infrastructure.

In this study I will focus on five aspects of sustainability. These have been selected because they are central to the sustainability of a culture and community of e-learning practice and to a pedagogy of e-learning for users or learners.

1. Sustainability of learning platforms and learning software.
2. Sustainability of institutional responses to the use of e-learning.
3. Sustainability of e-learning materials development.
4. Sustainability of pedagogic approaches.
5. Sustainability of teacher and trainers skills.

One of the major problems in addressing these issues is the speed of development and change. This is partly due to rapid technological development but is also due to the high level of innovation in practice and implementation of e-learning. This is much evidence to suggest that the results of research and innovation in e-learning are not being effectively or adequately disseminated with problematic consequences for change strategies. Equally evidence suggests few institutions have adequate policies and strategies for e-learning or for change management in this area. The rapid pace of change is also making policy formation and implementation difficult. In dealing with the different aspects of sustainability it is necessary to approach the issues from both the micro and institutional viewpoint and from a macro policy perspective. For policy to be effective it requires changes in practice. Equally effective practice has to be generalised to develop sustainable responses to the challenge of e-learning.

As will be apparent from this approach, I see the issue of sustainability as being much wider than being merely the cost and maintenance of procuring and developing learning infrastructures and materials. The sustainability of e-learning hinges on social processes and organisation and on the context and purpose of learning, as much as it does on hardware and software.

1.3 Problems and issues in e-learning

In order to approach the question of sustainability it is necessary first to consider the problems and issues facing policy makers, institutions, researchers, developers and practitioners in e-learning. This list is by no means comprehensive but is intended as a scoping exercise. These are the issues I will try to address in the paper.

Pedagogy and e-learning

Repeated studies have pointed to the issue of pedagogy as critical to e-learning. E-learning does not merely replace or replicate traditional classroom (or work based) learning but poses new challenges for how learning can be effectively facilitated and managed. There is an on-going debate as to what constitutes effective practice and how pedagogies approaches can cater for the needs of particular subjects, different learners and varying contexts or situations for learning.

The production of compelling e-learning materials

Despite the importance placed of multi media most e-learning materials remain essentially text based. As such they do not provide a compelling learning environment and are often dull and inappropriate for learners. The production of compelling learning materials is both a technical and pedagogic issue.

Access to hardware and networks

Despite the very considerable investment in hardware and networks for learning, infrastructure remains a major issue for many schools and education providers. Studies reveal large variations in the numbers of computers per student in different countries, different educational sectors and different subject areas. For many institutions, technical support is also a major issue.

Interoperability and redundancy

Whilst investment has been considerable in platforms and software, and often great effort expended in producing learning materials, the rapid rate of change has rendered much of the expense and effort redundant. This has focused attention on how to ensure interoperability between different learning systems and platforms and how to ensure migration of applications and learning materials between systems.

The cost of e-learning

There are different ways to cost the development and implementation of e-learning. Within enterprise Rate of Return on Investment studies have been common. Although there is some debate over how accurate these are and if they are even an appropriate measure for enterprise based learning) ROI studies are an inadequate way of measuring the costs and benefits of e-learning within public education bodies. Given the finite resources available to publicly funded education organisations, there is a major issue as to how much should be invested in e-learning.

Teacher and trainers skills

The attitude of teachers and trainers is often seen as a barrier to the implementation of e-learning. Teachers and trainers are seen as lacking the skills to apply e-learning and as being hostile to the use of ICT for learning. Other commentators have pointed to the centrality of teachers and trainers to implementing effective learning and pedagogies, especially since

blended learning concepts have emerged. There are major issues as to what the role of teachers and trainers should be in e-learning and as to how they should be supported in these new roles.

New models of teaching and learning

That e-learning offers great potential for extending access to learning is not generally challenged. But, as to how this potential can be best harvested within public education and training systems and within Small and Medium Enterprises is far more problematic. Evidence suggests the need for new institutional roles and models for the delivery of e-learning including partnerships and networks. These challenge traditional forms of educational and institutional organisation.

Managing change

Change management processes are always difficult. If e-learning is to fulfil its hoped for potential it will involve very widespread and on-going processes of change at every level of the education and training systems and at institutional level. The management of these change processes requires a policy and strategic approach to e-learning. Many institutions may at present lack the knowledge an expertise to develop such a strategic approach.

I cannot hope to deal fully with all of these issues within this paper. But what is interesting is that the issue of sustainability and the five aspects I listed above impinge on nearly every major issue facing the development of e-learning today. I would suggest that unless the issue of sustainability is addressed there is little hope of overcoming the issues listed above, at least not within the public education and training systems.

Writing in the Life Long Learning journal, Lline, in 1998, Matti Sinko said:

> "if we expect implementing ICT to bring about profound pedagogic change, then we are still struggling in the wide chasm between early adopters and an early majority, a chasm which is always the most difficult of the discontinuities on the innovation adoption curve to overcome."

Sustainability is the key to overcoming the discontinuities, which, if anything, have become more pronounced in the six years since Matti Sinko wrote his paper.

1.4 Underpinning precepts and ideas

There are a number of underpinning precepts and ideas which underpin this paper. It is wise in this introduction to make those preconceptions transparent.

The first is that e-learning has been predominantly driven by technology and that we should refocus on the needs of the leaner. Attwell et al (1993), in a report on the Leonardo da Vinci funded ICT projects in vocational education and training say the majority of developments follow the following technology driven development scenario:

Learning media –> Learning environment –> Categories of learning -> Learning objectives -> Learner.

They see the need to put the learners first in developing e-learning and propose to reverse the order of the schema:

Learner –> Learning objectives -> Categories of learning –> Learning environment -> Learning media.

I think this may be too simplistic and may even replicate a technology driven scenario. Technology developers have often been keen to stress the centrality of the leaner in imaging the learning process as direct interaction between learners and learning software and materials. I would place greater emphasis on the importance of pedagogy. Gavriel Salomon talks of “the tight rope between technocentrism and pedagogy, about the science of what can be done and the vision of what should be done”. I would see a dialectical relationship between the needs and actions of the learner in scaffolding ideas and making meanings and applying learning, and the actions of pedagogists in developing and applying learning opportunities, contexts and schemas.

This is not to imply that any one pedagogy is necessarily superior to another. As Dai Griffiths and Rocio Garcia (1993) says: “there are times when even the most enthusiastic constructivist recognises that reading specified texts, and rote learning, are appropriate, and when practice drills are necessary”.

But I am saying that e-learning should start from the position of pedagogy and the needs of the learners, not from the technology of the possible or the science of what can be done.

The second precept is that the public sector has a critical role to play in education and training and that education is a public right. This means I would oppose the idea that public authorities should only intervene in the situation of a market breakdown and even more importantly, would oppose the idea of a two-tier market between private and public education providers. This is important in that it means that public education authorities should attempt to develop e-learning provision, rather than concentrating only on traditional education delivery and systems, and allowing the private sector to develop high value added e-learning applications.

The final precept is that teachers and trainers have a central role to play in education both in facilitating learning and in developing e-learning materials, pedagogies and applications.

Research sources

There are four main sources of information and ideas which have been used in producing this report. The first is books and papers, although, given the speed of development, I have relied heavily on grey literature: recent internet publications and conference papers. The second is web sites, especially for information on Open Source and Open Content developments. The third is projects, especially projects conducted through the European Commission funded Leonardo da Vinci and Socrates programmes and through the 5th and 6th Frameworks for research. The final source is a series of interviews conducted with software developers, materials developers. e-learning researchers and experts and practitioners in the field.

Structure of the report

There are six sections in this report. Following this introduction, the second section will examine the pedagogy of e-learning. The third section will deal with software and platforms and look at the potential of open source software for education and training. The following section will address institutional issues in the sustainability of e-learning. The fifth section will look at sustainable content production. The next section will examine new roles for teachers and trainers. The penultimate section will discuss policy issues and models. The final section will provide a brief conclusion and will put forward a series of recommendations for practitioners, institutions, developers and policy makers.

2 Sustainability and the pedagogy of e-learning

The issue of the sustainability and pedagogy of e-learning is complex. There would appear to be general agreement by researchers that the introduction of ICT for learning requires the development of new pedagogic approaches and accordingly new skills of teachers and trainers. Yet even that is contentious. In Europe researchers and teachers have tended towards an emphasis on constructivism but it may be doubted how far this has been reflected in practice.

In reality, different ICT based technologies can support different pedagogic approaches. There is the world of difference between providing access to video based lectures on the web, the use of simulations as part of a course or lesson, using the web to provide access to lecture notes and further reading or supporting student led discussion groups. All of these can have a legitimate role in supporting learning, all have implications for sustainability.

2.1 A pedagogical continuum

Horst Dichanz and Annette Ernst (2001) have proposed a continuum to categorise learning. Whilst I may not agree with every category, the list does provide a useful heuristic tool for looking at different pedagogies in e-learning:

- Learning as a process for acquiring information;
- Learning as a process for acquiring information and processing experience;
- Learning as a process for acquiring information and processing experience that effects a long-term change in the consciousness of the learner;
- Learning as a process for acquiring information and processing experience in which the learner integrates new information and experience into his/her current knowledge base;
- Learning as a process for acquiring information and processing experience in which the learner perceives, selects and integrates new information and experience into his/her current knowledge base, thereby changing it;
- Learning as a process for acquiring information and processing experience, in which the learner selects and constructs knowledge that is useful and appropriate for him/herself and in turn uses this to drive and determine his/her own continuous learning process;
- Learning that becomes an individual process of interaction between the individual and his/her environment, in which the subjective reality of the learner is actively constructed.

All these processes of learning can be supported by ICT. But different learning processes will require different pedagogic approaches and in turn different applications of technology.

More importantly, most pedagogic applications of e-learning have tended towards those processes towards the top of the continuum. I would venture the most common use of e-learning is as a process for acquiring information. More advanced uses of technology as an integral part of a holistic learning system requires more sophisticated pedagogic approaches to technology, and fundamentally, the integration of ICT based learning within wider curriculum design and pedagogic applications.

2.2 Learning through making and action

John Seely Brown in a speech in 1999 entitled “Learning, working and playing in the digital age”, looked at the different ways young people were using Information and communication technologies of learning. He pointed to the growth of discovery or experiential learning. As kids work in the new digital media, he said, rather than abstract logic, they deploy bricolage. Bricolage relates to the concrete and has to do with the ability to find something – an object or a tool, a piece of code, a document - and to use it in a new way and in a new context. But to be a successful bricoleur of the virtual rather than the physical you have to be able to decide whether or not to trust or believe these things. Therefore the need for making judgements is greater than ever before.

Navigation is coupled to discovery and discovery coupled to bricolage but this requires judgement concerning of quality and trustworthiness of information and sources.

In his speech Seely Brown drew attention to the importance of action. He suggests new forms of learning are based on trying things and action, rather than on more abstract knowledge. “Learning becomes as much social as cognitive, as much concrete as abstract, and becomes intertwined with judgement and exploration”.

Such an approach to learning requires new pedagogies based on making and action

A case study undertaken as part of the European Commission, Minerva programme sponsored I-curriculum project is following the Seely Brown approach to ‘learning through making’ (Heinemann, 2004). In 2002, the Schulzentrum Obervieland, an integrated Hauptschule and Realschule in Bremen in Germany, developed a new programme for the use and integration of new media. As part of this programme the school has developed a partnership with the Bremen Open Channel.[1] The strategy is to use media as a flagship for the overall development of the school. Students are encouraged to produce video films on a wide range of issues as part of the curriculum and partly as a spare time out of school activity. The contents range from a documentary on the school canteen and personal biographies, to films on school sports trips. Developing expertise in ICT and the use of media by teachers is based on a grassroots approach through building teams for short cross subject projects, including at least one teacher already deemed an expert in the use of new media.

According to Heinemann this project has three different levels of impact. The first is in visual communications and the production of video. Students expressly address the issue that producing a film is more than just taking film footage. Different music, film techniques and cutting techniques affect the outcome and perception of the film. This is learnt both through practice and through learning theory and history about film – e.g. Citizen Kane, Metropolis and Battleship Potemkin. Not only do students look at the theory and making of films, but at assisted roles and skills including for example the process of producing copies. This leads them to examining the issue of the manipulation of media, in both theory and through the production of a short documentary followed by the use of different background music, camera angles and production techniques to make from the same material a film with different effects on the audience. The second level is in presentation. The effective presentation of materials depends on the subject, the medium and audience. The school is traditionally strong in organising group work and this approach has been strengthened by the focus on producing presentations. It is interesting that

1 In 1983, when private and cable TV were introduced in Germany, in order to provide free access to mass media, all German cities were required to develop Open Channels. The Open Channels were designed to allow free access to the media for all interested. There is some doubt as to the effectiveness of the strategy.

the adequacy of the use of the presentation, rather than more traditionally in Germany the understanding of the subject materials, forms part of the student assessment. The third level, integrated in the first two, is the change in the roles of teachers and students. Student work is based on producing things and the role of the teacher is to help and facilitate this production.

The Schulzentrum Obervieland has had very limited resources to develop this approach and access to infrastructure is a problem. But by embedding a pedagogic approach to ICT based learning within the curriculum as a whole, they have been able to develop a sustainable approach the work they are undertaking.

2.3 Creative, perceptive and innovative approaches to sustainable pedagogies

There is no, single, proscriptive theoretical solution or idea to the development of sustainable pedagogies. Whilst many researchers have focused on constructivism as offering rich pedagogic approaches to using ICT for learning, in reality, I think constructivism is only a way of describing in one category all the varieties of creative, perceptive and innovative approaches to facilitating the acquisition of new knowledge. To provide but one example, Bill Pelz (2004) puts forward three principles of effective online pedagogy.

1. Let the students do (most) of the work through:
    - Student led discussion
    - Finding and discussing web resources
    - Helping each other learn (peer assistance)
    - Grading their own homework assignments
    - Analysing case studies
2. Interactivity is at the heart and soul of effective asynchronous learning involving;
    - Collaborative research papers
    - Team projects
3. Strive for presence including:
    - Social presence
    - Cognitive presence
    - Teaching presence

I am not sure if this is a constructivist approach (and Pelz is careful not to label his pedagogy). But it is a good illustration of a pragmatic learner centred approach to innovative and effective teaching and learning.

2.4 Implications for sustainability

The major implication for sustainability is in the need for a new relationship between software and systems designers and teachers and trainers. The technologists' job in assisting 'constructivist' pedagogy is not to build 'constructivist systems' but to make it much easier for innovators to make effective use of technologies. Conversely, the task of pedagogues, teachers, trainers, researchers and learning designers, is to work with technologists in developing systems which can engage learners in creativity and reflection on action. This calls for iterative development processes at every level of design, testing and implementation.

3 Hardware, infrastructure and sustainability

No report into sustainability of e-learning can be complete without looking at the issue of hardware and infrastructure. E-learning requires access to digital devices – computers or handhelds – and many learning applications also require access to the internet. More recent technological developments require broadband connections.

3.1 What we know

Whilst there is little data available on the provision of hardware in vocational education and training or, as far as I am aware, in the university sector, there have been a series of European benchmarking studies on provision of ICT infrastructure in schools. The methodology of these studies may be open to some doubt, but they do reveal quite startling variations in the provision of computers in schools in different countries. Although, as is predictable, Scandinavia and the richer north European countries in general have more computers in schools, there are some interesting findings. Germany, in particular, is in the lower quartile in the number of computers per student and class in schools. This suggests access to hardware is not just an economic question but may also be dependent on cultural, curriculum and policy questions. It may also in part reflect different funding mechanisms.

UK schools

This is a rapidly changing field and sometimes it is difficult to access up to date data. In this respect the recent UK Department for Education and Science ICT in schools survey is interesting.

The survey shows that, on average, primary schools in England have 28 computers, allowing one machine for every 7.9 children. An average secondary has 159, with a pupil machine ratio of 6.5.

Schools are spending significant sums on ICT, over £11,000 in the average primary and £65,000 in a typical secondary. Nearly half England's primaries have an interactive whiteboard, while 82% of secondaries have bought into the technology. The average secondary has between four and five.

But these averages conceal some wide variations. The Guardian-supported Tools for Schools charity is the biggest educational computer recycling initiative in the UK. A survey by the charity found that:

- 67% of primaries do not meet the government target of one computer per eight pupils;
- 68% of secondaries do not meet the government target of one computer per five pupils;
- 51% of primaries still share one computer between more than 11 pupils;

the best ratio is a secondary school with one computer for every 1.5 pupils; the worst is at one primary which has just one computer for every 18.7 pupils.

The Guardian newspaper has reported that many schools close to the government's targets have only achieved that position with outside help.

In a recent article they provide the example of St Chad's Church of England school in Lichfield, Staffordshire. "'[The support] came from our parents,' says headteacher Tracey Coles. So far this year, St Chad's parents have funded £7,000 worth of ICT equipment.

Coles has spent £16,620 on ICT this year, £5,000 above the DfES average figure. And yet she is still tantalisingly outside the target pupil computer ratio - at 8.4 pupils per machine. The school now has six whiteboards, but only one was bought from school funds.

Coles is committed to the technology and, in the future, she would like to have a wireless network and a set of laptops. But the outlay is draining resources from other areas, and she worries about how long she can continue to make ICT a priority.

'We are running a deficit this year,' she says. 'Yet next year I have to replace 15 PCs we bought in 1999. It's a Catch-22.'

That ability to maintain the ICT momentum is a key issue for Naace, the national association of advisers for computers in education. 'We've lobbied strongly with the DfES for continued dedicated funding for ICT,' says Naace's general secretary, Steve Bacon. 'Schools are never going to get to the position where they can relax. If they sit back they will slip back.'" (Guardian, 18 November, 2003).

A digital divide?

There are also very considerable differences in access to the internet and to bandwidth. There is an emerging digital divide between industrial and rural areas, dependent partly on the degree of regulation and licensing conditions for telecom providers. The UK survey found practically all schools are connected to the internet, and the percentage using broadband increased from 11% in 2002 to 27% in 2003 for primary schools, from 68% to 86% for secondaries, and from 11% to 35% for special schools.

Obviously government policy is of great importance in this aspect. Access to infrastructure is costly in comparison with school budgets. It is both a macro policy decision as to what extent scarce resources should be diverted into hardware procurement and subsidising access to bandwidth. It may, depending the degree of funding autonomy, also be a policy decision for regional and local governments or for individual institutions. In this respect sustainability of e-learning may be closely linked to economic and resource decisions and be out of the hands of practitioners and even institutional managers. However, there are a number of strategies or initiatives that can be taken at a local level to prolong the lifespan of hardware investment or to secure additional resources

3.2 Strategies and initiative

Sharing resources

With the present cost of hardware, resources will seldom be sufficient for most public education and training providers. One answer lies in the sharing and more intensive use of scarce resources. Computers used in schools in the daytime can be used for community education in the evening. Design schools can allow use of high performance machines for project work by schools. Access points can be set up in local housing facilities. Greater co-ordination between library services and schools can allow access to scarce bandwidth. Universities can provide and maintain networks for schools and community education providers. Ideally, these initiatives need to be coordinated on a local basis.

Using older technology

Whilst most accounting systems depreciate hardware over a period of three years, there is nothing to say that machines may not have a much longer useful lifespan. I recently ran a

workshop in a computer training centre in a community centre on a large and poor housing complex on the outskirts of Dublin where not one of the computers was purchased after 1997. Although perhaps due to the excellence of the open source software used in the session, not one machine crashed during a whole days training. Modern computers are generally over-specified for the needs of most e-learning applications. Servers do not require a high performance machine. Many countries have schemes where older computers are recycled from industry and commerce to education.

Of course older machines tend to require more maintenance and anecdotal evidence suggests this can be a major problem for many schools. Students and parents seem to be frequently involved in this work. In this respect sustainability may lie in a greater community involvement and orientation. Local companies and computer professionals can contribute resources and expertise to designing, configuring and maintaining hardware and software networks.

Older computers may not run more modern and higher memory applications. It is doubtful how necessary these are for most subjects and learning contexts. Most open source applications are designed to run on lower specification machines and earlier operating systems. The Linux operating system will run on most computers.

A major issue for e-learning is bandwidth. High graphics applications and video conferencing features require more bandwidth. To some extent this is an issue effecting the design of platforms and Learning management systems, and the selection of particular applications at institutional level. However, recent advances in compression software do allow advanced communication even on dial up connections. The Cedefop you@etv platform for young researchers and youth workers in Europe has recently licensed a communication and whiteboard system which supports multi point audio conferencing even on 28mb connections.

Voice over IP (VOIP) applications which carry audio data through the web may offer schools and other educational institutions considerable cost savings in the future, savings which could be re-invested in hardware and infrastructure.

Mobile devices

One possible answer for access to hardware which is exciting some interest is the possible use of handheld devices, palmtop computers, PDAs and mobile telephones. Whilst many are skeptical due to the small screen size, other researchers have pointed to the intensive use of mobile telephones by young people for a wide range of applications. Furthermore, there is widespread interest in lesser-developed countries, where the cost of hardware is prohibitive to introducing e-learning.

In the report on the Deep Project (Leach J, 2004), an investigation of the use of information and communication technologies for teacher education in the global south, the project team put forward a tool kit and list the uses of particular technologies and list the advantages and disadvantages of each. The Deep project was undertaken by the UK Open University working in South Africa and Egypt where access to hardware is an obvious issue. The uses they see for handheld devices, additional to those of a laptop include:

Personal & professional development

- Readily accessible learning resources
- E–books enable personal learning, study, planning and information – material can be bookmarked, highlighted, annotated and text extracted.

Classroom Use:

- Use of the stylus input is resonant of a notepad and pen, extends the learners affordance of notetaking from the familiar paper/chalkboard, into the hand-held electronic notepad.

Professional and curriculum uses

- Mini–multimedia showcase (e.g. reading kinetic poetry; hearing Martin Luther King speech; listening to animated fables, watching videos of effective classroom practice (e.g. peer tutoring).
- Photography
- Voice recorder (language work and recording information and events)
- Support for field-work/school trips
- Facilitates collaborative work, both for groups of students and of teachers – device small, easy to pass around.
- Collaborative work encouraged by quick and simple facility of 'beaming' electronic notes and other communication

The advantages are

- mobility
- 'Anywhere–anytime' learning
- Flexibility – serves range of curriculum and pedagogic purposes
- 'Personal' computing – constant access and a sense of ownership, gives teachers liberty to 'play' & explore '…it is my companion.'
- Sense of 'personal ownership; encourages teachers taking care of device.
- Runs for several hours continuous use (often equating to several days/up to a weeks use).
- Remarkably robust in the challenging contexts of this study.
- Teachers feel safe and secure carrying these 'invisible' devices, compared to the conspicuous and attractive lap-tops

The disadvantages are:

- Requires regular (daily/weekly depending upon use) recharging.
- Prone to total data and partial application loss upon battery failure.
- Synching with main computer can be prone to failure.
- Small screen size requires re–design of educational content developed primarily for larger computers.
- Limited storage capacity (for multimedia), although use of memory cards may overcome this problem (ibid)

In the UK, Dudley Grid for Learning (DGfL), part of Dudley Council, is leading on a project to provide teachers and students with PDAs.

(http://www.dudley.gov.uk/news/fullrelease.asp?recid=919).

The Dudley Personal Data Assistant (PDA) project, which is currently in its pilot stage, will give teachers and pupils (Key Stage 2 and above) in every Dudley school access to their own (PDA). This will happen in approximately three years time.

The hand held devices have been developed specifically for the education community by PalmOne and will combine computing, internet and telephone facilities.

The project claims “PDA’s offer students an affordable tool with ready access to the Internet and on-line learning, enabling them to take and share notes, record assignment details, and access a range of powerful learner applications. They encourage collaborative learning by allowing students, working as a team, to undertake independent research, add personal contributions to a shared project, edit each others writing and develop final documents that are comprehensive and organised.”

With PDAs, as with other technology for learning, the key issue may be the pedagogic uses, rather than technological. If PDAs, or other hand held devices such as advanced mobile phones, can be used to provide a richer learning experience, they offer great potential in terms of sustainability and cost.

4 Software and platforms

Software and learning platforms are a key issue in attempting to develop sustainable strategies for the use of ICT in education. However, there are some difficulties in developing such strategies, because the very different learning applications used in different contexts and institutions. In addition to software designed specifically or learning, many courses will utilise work-based applications for instance CADCAM, spreadsheets, statistical applications. Almost all educational institutions use general office, financial and management applications. Many may also use specialist management information systems.

Sustainability in this respect takes on a number of different perspectives. The obvious issue is the cost of licensing software. A second issue is software support. A third is allowing learners access to modern applications, in terms of functionality, reliability and attractiveness. Form a work based learning perspective it is also important that learners are able to use software and applications they ill come across in the workplace. However, the fast speed of software development, the endless version releases and the expense of upgrades is a considerable barrier for many institutions.

In this section I will explore three issues. The first is Learning Management Systems (LMS). The second is the potential of Open Source Software for education and training. The third is new partnerships for developing software and architectures. There are other software issues such and the provision of data repositories and the importance of standards. These will be dealt with separately in the next section on materials development.

4.1 Learning Management Systems

In a paper written earlier this year I identified three different stages in the development and application of ICT for learning (Attwell, 2004). My aim in doing this was to examine the barriers and potentials for experimentation and innovation.

Innovation, like technology, is socially determined. The development of new pedagogies using ICT for learning leading to knowledge development requires social and cultural frameworks to succeed. An analysis of the different stages in the development of ICT for learning can provide a

theoretical underpinning for identifying where improvements to technology could be most usefully applied.

The first period in the use of ICT for learning was characterised by experimentation and innovation. Innovation often occurred because the technology was there but, critically, was driven by creators. These creators were often pedagogists by background, intrigued by the potential of the new technologies. Applications were usually 'free-standing' with little in the way of administration interfaces or even a 'learning environment'. Few, if any, developers claimed their application would replace traditional learning. Instead they frequently used games and activity based learning to supplement and build on more traditional forms of learning.

The second phase in the development of ICT for learning was a period of entrenchment, a phase from which we are only now emerging from. In this phase, with the widespread availability of Personal Computers and the development of the Internet and, (in particular) the world wide web, technology became ubiquitous. Technology development was for the administrators and managers and even the metaphor of teaching and learning applications was that of administration or control. Hasebrook, Herrmann and Rudolph (2003) say:

> "Web based training should … be used to introduce a modern controlling approach which comprises exact calculation of financial investments and gains, optimal planning of organisational processes and goal-oriented definitions of strategic and operational learning objectives".

The major development was the emergence and implementation of learning management systems (LMS). Learning Management Systems are integrated suites of modular and interoperable programmes, providing content creation tools, management functions and learning platforms. However the LMS were essentially concerned with content-push, with facilitating access to traditional learning materials. Baumgartner et al (2002) put forward the following features as the key constituents of an LMS:

- It is browser-accessible. The Learning Management System should be based on a standard-protocol (TCP/IP) and a standard web browser.
- The learner can interact via the browser with the teacher, the system and other learners. Also, the authoring options as the learning management features can be operated without any plug-ins/viewers/additional products.
- There are basic features for administration and the administration of users can be administrated. The system must offer an authentication feature. The system must offer rights managements for roles, groups, and permissions. The system must be multilingual.
- Communication must be supported electronically both within roles and between roles. There are basic features for at least authoring of tests and assessment. There are feature for course management, and content management.

The 'learning value' of the content was seen as being within the e-learning environment. Learning management Systems are designed for classroom based learning, albeit in a virtual environment, Sadly managers and administrators had failed to notice that much learning took place outside the classroom, still less did it take place in a 'virtual' learning environment.

In an earlier paper I said: "It may be giving too much credit to these systems to say they impose a pedagogy, rather they are simply shadows of a learning approach realised in software" (Attwell, 2004).

This is not to say that the 'Skinner-box' training approach has not had impact and influence, especially in larger enterprises and industries, for example in car manufacturing or in the aircraft industry. However, it has not been successfully translated or transferred to state or vocational or higher education systems. Firstly it is very expensive and secondly it only works within the limitations of the specific industrial applications for which it is developed. Even then, I would contend, it only works when embedded within the community of practice of the particular trade and industry.

A problem that many institutions have found is that of lock-in. Because of the lack of standards, applications developed on one platform are difficult to transfer or migrate to other systems. Equally modular applications will often not interoperate between systems.

A further issue for sustainability is the work in installing and maintaining Learning management Systems.

Alternatives to Learning Management Systems,

There are alternatives to Learning Management Systems, many of which are Open Source. In a recent blog entry, James Farmer wrote: "LMS' are most useful for an organization to monitor and track learning and for sequencing content. If that is an organization's primary view of learning, then sure, use an LMS. If, on the other hand, learning is primarily viewed as an informal dialogue, collaborative content creation, or a function of communities, then many effective tools exist. Some examples: Groove, Plone, Skype, SNA tools (like Multiply), Convea, aCollab, etc. IF you want to manage learning, use an LMS. IF you want to foster dialogue/community building, use a collaborative tool. Either option, thoughtfully implemented, can result in cost savings." [elearnspace]

Stephen Downes (2004a) further comments: "Virtually the sole purpose of these courses is to facilitate the effective design of courses on a visual and content based level. When it boils down to it the only way in which they facilitate effective asynchronous communication is by providing weak discussion boards and equally wanting internal messaging systems… Now, integrate these 'content' building / presentation devices with effective collaborative communication functionality and tools, add a touch of social networking and a pinch of interoperability and flexibility and you're talking."

I will look at some of these alternative options further in the section on Open Source Software. But lest it be thought that these ideas are reserved to the educational blogging community, it is worth looking at the development programme being undertaken by the Joint Information services Committee (JISC) of the UK universities.

Among the many initiatives being sponsored by JISC, is the e-Learning Framework (ELF), supported by JISC, DEST, Carnegie Mellon Learning Services Architecture Lab and others to build a common approach to Service Oriented Architectures for education. "The ELF", they say, "is the result of a shared conviction that exposing networked functions such as user and group data or learning content as simple services rather than as features locked up inside monolithic systems offers institutions more flexibility, more scope for pedagogic innovation and better return on present and future investment. The e-Learning Framework is a service-oriented factoring of the core services required to support e-Learning applications, portals and other user agents. Each service defined by the Framework is envisaged as being provided as a networked service within an organisation, typically using either Web Services or a REST[2]-style HTTP protocol."

[2] REST stands for REpresentational State Transfer. "**REST** is an architectural style for the building of network-based systems. The **REST** Goals are scalability of component interactions, generality of interfaces, independent deployment of components,

“The ultimate aim of the Framework is, for each identified service, to be able to reference an open specification or standard that can be used to implement the service, and also to be able to provide open-source implementation toolkits such as Java and C# code libraries to assist developers.”

“The intention is not to provide a blueprint for an open-source solution, but rather to facilitate the integration of commercial, home-grown, and open source components and applications within institutions and regional federations, by agreeing common service definitions, data models, and protocols.”

What does all this mean for sustainability? James Farmer, Stephen Downes and JISC share a similar approach. Instead of being locked in to large-scale applications, schools and universities can select different applications and programmes which meet their management and learning needs through component architectures. The critical point is the use of open standards, to allow data to be transmitted between the different applications. Institutions can extend or upgrade different components according to need and can scale systems to meet demand. Whilst the JISC Framework is far from complete, as Farmer points out there are already many applications available, which, if used intelligently, will meet most institutional needs. Such an approach provides flexibility, guards against redundancy and can save on resources and finance.

These applications are building on standards and open source approaches top software development. In the next section I will look at the potential of Open Source Software for developing sustainability in the use of ICT for education and training.

4.2 Open Source Software

There is growing interest in the potential of Open Source Software (OSS) for education and training. OSS software is differentiated from conventional proprietary software in that:

- the source code is available to the end-user. Normally only the executable application and its required components are available;
- the source code can be modified by the end-user. In effect, and given the required skills, the end-user can tailor the software to their needs and circumstances;
- the licensing conditions are intended to facilitate continued re-use and wide availability of the software, in both commercial and non-commercial contexts;
- the cost of acquisition to the end-user is often minimal, and always considerably less than would be the case for equivalent proprietary systems. This is especially true where bespoke versions of an application or system are required.

OSS has particular relevance to the education and training sectors for a number of reasons:

- Often specific versions of educational software will be required to reflect particular course content or pedagogical approaches.
- A loose ‘community’ of educational institutes already exists which supports the exchange of ideas and concepts. Thus, the basis of an OSS community is already in place.

intermediary components to reduce interaction latency, enforce security and encapsulate legacy systems” (http://www.prescod.net/rest/soap_rest_short.ppt)

- In many cases, larger institutes already have the human resources capacity in-house (through their departments of informatics or computer science) to perform the necessary software modifications, testing and deployment.
- Educational institutes are under increasing pressure to find the lowest-cost solutions for effective course provision.
- Learners can be involved in improving OSS software making it possible to take an approach which sees education as the process of supporting learners in joining a community of practice.
- More generally, the use of Information and Communications Technologies (ICT) in education provision is being recognised and explored.

However, despite much interest from the educational software community and from individual education institutes and providers, there is a lack of clear and unbiased advice and information over the advantages and disadvantages of OSS and how appropriate the adoption of OSS is for education and training and of policy advice and direction on the subject (JISC, 2003). Riina Vuorikari, in an Insight Special Report for the European Schoolnet (2004) points to the failure to fully exploit the potential of open source software, which, she says, seems to have been underestimated by national educational authorities and national school networks. “On the one hand, the lack of knowledge of open source development and free software hinders its deployment in school sector. On the other hand, the situation is complicated by the fact that the debate on the potential of open source is conducted by activists and lobbyists on both sides of the fence, where overstating advantages and disadvantages is common. This leaves little room for a considered appreciation of the issues involved.

Moreover, the concern on how national educational agencies and school networks can both make more active use of free and open source software and open content in school sector at the same time that governments continue to support and encourage educational publishers and content providers has not entered to the level of open and productive debate.”

The EC sponsored FLOSS study (which included only a short section on the use of OSS in education) found that overwhelmingly, the highest ranking reasons for using free software center on quality:

- Higher stability
- Better access protection
- Higher performance
- Better functionality

In a forthcoming paper David Griffith and Xavier Amatriain claim the advantages of Open Source and Free Software are better quality, more security, more stability, collective ownership and effort, and price.
Riina Vuorikari (2004) considers the advantages to be

- Ease of localisation of software for small language groups,
- Greater levels of accessibility,
- Fighting piracy,
- Spending public money wisely
- Creating new service and local job opportunities.

She also says the development of open content educational material and other web-based resources presents interesting opportunities for sharing and reusing content.

Ethical issues

However, more important, Dai Griffiths and Xavier Amatriain believe, are the ethical issues. “Firstly, the software infrastructure and tools have a significant impact on the organization of institutions and the processes which they support, and consequently they should be under the control of the communities which use them. Secondly, in universities we aspire to “teach to learn”. Proprietary software discourages this because it withholds information from users, and does not allow them to explore the potential of the software or to extend it. It may appear that this argument exaggerates the importance of accessing the source code, as it may be suggested that only professional software engineers will be able to really make use of it. There are, however, many levels of interaction with software, as is shown by those web authors using proprietary tools who end up editing HTML. Free software can ensure that appropriate tools are available at all levels so that users can take control of the environment which they use.”

What Open Source Software is available?

In the final section of his paper Griffiths and Amatriain look at what Open Source Software is available for use in schools and universities.

Probably the most widely used application in education, and beyond, they say, is Microsoft Office. “This proprietary package is used by staff, faculty and learners alike. A number of Free applications exist that substitute particular components in the package. For instance, Abiword is a solid replacement for Microsoft Word; Gnumeric can substitute Microsoft Excel quite well;. MagicPoint is a replacement for Microsoft Powerpoint; and TotalRekall is a reasonable substitute for Microsoft Access, though rather complicated to install in its Free version. There is, however, a Free package which substitutes for the whole of Microsoft Office (except for Access, included only in Microsoft’s Professional edition): OpenOffice. This is a complete suite that can be used to edit text documents, work with spreadsheets or prepare overhead projections. The package is very robust, stable, and comprehensive and many new features are planned to be added in the short term. The user interface is so similar to that in Microsoft Office that the learning curve for an MS Office user is almost non-existent. Furthermore, OpenOffice has been translated to a many languages, including some not available for Microsoft Office. OpenOffice is a cross-platform application that can be installed in both GNU/Linux and Microsoft Windows.”

“Another set of tools of general use, but also important in education, are the various internet services including web browsers and e-mail clients. There are many Free tools in this area but Mozilla is of particular interest. Netscape gave this Free version to the community and has now announced that the proprietary version is soon to be discontinued. The Mozilla package includes a web browser, an e-mail client and a basic webpage editor. The lighter Firebird version includes only the web browser. The Mozilla web browser and e-mail client is more secure and technologically advanced than Microsoft’s Internet Explorer or Outlook Express.

In scientific or technological education it is very common to use mathematical packages such as Matlab. Octave is a good Free substitute which is used in many research institutions, and lacks only some Matlab toolboxes which are not included in the regular version.

For graphics a number of applications can be recommended. The Gimp is a graphics and photograph editor which is very similar to Photoshop, and is even more advanced in some specific functionalities. For drawing diagrams and vector graphics Dia and Xfig can be used as substitutes of Microsoft Visio.

Many other Free tools can be used in education including some very advanced applications published as Free software by universities, or educational/recreational software for small children, such as TuxPaint.

Two examples of applications which are only available as Free Software are LaTeX and Emacs. The former is a complete environment for generating professional quality texts for publishing, and it includes tools for handling bibliographies or a large collection of publishing styles. LaTeX is even required by some international publishing companies when handing in manuscripts. Emacs is a very well-known tool, developed and maintained by Richard Stallman. It is a very advanced text editor that has tools for editing different formats such as LaTeX or html.

All these tools can be installed in both GNU/Linux and Microsoft Windows. Most have native Windows versions that can be installed just like regular Windows applications, while the others can be run using the Cygwin environment, which runs a GNU/Linux simulation under Microsoft Windows.

Finally, a number of Free Software e-learning environments have now been developed, and 48 are listed by the JOIN project."

Riina Vuorikari (2004) also points to the widespread availability of free and Open Source Software. The UNESCO Free Software Portal provides a listing of more than 300 entries of Free and Open Source Software (FOSS), of which around 30 are links to educational applications. European Schoolnet's Virtual School lists about 500 freeware and shareware (also open source) applications, evaluated by subject teachers and / or students.

National and regional initiatives

There are a number of initiatives by national and regional educational authorities in Europe to extend the use of Open Source Software. The Flemish Ministry of Education has evaluated 70 applications from the European Schoolnet Virtual School software library and has distributed them to all the schools in the Flemish speaking area of Belgium along with educational user scenarios to accompany the software. In France, the National Centre of Pedagogical Documentation (CNDP) has led a working group that evaluated 20 educational software packages with an emphasis on multiplatform usage and have developed educational guidelines on classroom use. The software was be made available for schools through the network of regional offices in February 2004.

France has invested 1390000€ in eight VLE-projects developed at a regional level in conjunction with local academies and school authorities (ibid).

As part of this development a consortium of schools, teacher training colleges and local authorities from the Rectorat de Bordeaux have developed a Virtual Learning Environment based on the ILIAS Open Source project managed by the University of Cologne.

The oss-watch study

In possibly the most extensive study of the use of Open Source Software in education in a European country (although limited to Further and Higher Education)[3], the UK OSSwatch (Tannenbaum D, 2003) found:

- 38% of HE and only 9% of FE respondents reported that their institutions have an IT strategy which explicitly considers OSS. Nearly none of the institutions has a strategy of not using OSS.
- FE institutions lag behind HE institutions in their number of staff with the skills to deploy OSS. While 88% of FE respondents reported that very few staff members had these skills, 59% of HE respondents reported that their staff had moderate or significant skills with OSS.
- HE institutions are much further advanced in the process of examining the potential of OSS solutions for their institutions. 73% of HE respondents reported that their organisation has either looked seriously into OSS and/or has already made some decisions on its deployment. By contrast, 61% of FE institutions said that very few members of their organisation were more than slightly aware of open source concepts, and only 15% had made decisions on deployment of OSS.
- Reasons for choosing OSS solutions in both HE and FE are principally financial, with 25% of HE respondents and 53% of FE respondents identifying cost as the most important reason for choosing OSS over proprietary analogues. Interoperability due to open standards is also a major attraction for HE institutions.
- The majority of institutions which develop software in-house (59%) have never considered the issue of licensing, and do not have an institutional licensing policy.

Open Source and underdeveloped countries

This paper is mainly aimed at a European audience and therefore is looking at sustainability in a European context. However, Open Source Software may be of even more importance in underdeveloped countries and also in the weaker east European economies. Many governments and school authorities in under-developed countries are actively developing policies and strategies to promote, develop and distribute Open Source applications. There are also many interesting case studies of its use. Guy Antony Halse & Alfredo Terzoli in a paper entitled ‘Open Source in South African Schools: Two Case Studies, say: “these case studies show that it is possible to provide modern, high-quality network services to schools using just the sorts of computers that ICT-disadvantaged schools in South Africa are likely to have, or are likely to be able to obtain. Obviously, as is shown by the difference between the services available at Nyaluza and Nombulelo, better computers allow us to provide more services and facilities. That said the configuration at Nombulelo clearly shows that one can provide the most basic of services using even very old computers.

The systems requirements of the computers set up using these open solutions is significantly lower than the requirements of modern commercial software providing comparable services. This is particularly important in helping us bridge the digital divide in countries where computers are a scarce and treasured commodity.

[3] Further education institutions in the UK include vocational schools and post 16 colleges which offer academic education.

The ideas presented in this paper are even more important in countries where large corporations (such as Microsoft in South Africa) haven't been forthcoming in their support of education. In these cases, the use of open source alternatives has the additional advantage that they are significantly cheaper than their commercial counterparts."

Problems with Open Source

Open Source Software would appear to be a key support for any strategic approach to sustainability. What are the problems and issues?

Firstly, in a number of countries and particularly in Germany, there remain issues over the legal status of Open Source Software. Forthcoming European legislation is likely to further cloud the issue. More work has to be undertaken to ensure the legality of the different Open Source Licenses.

A second worry is that insufficient support and documentation is available for OSS. It is certainly true to say that documentation for many Open Source products is poor. Then again, documentation of all software, commercial and open source, is open to improvement. And, as opposed to commercial applications, open source code is available for study. In terms of support, open source supporters would point to the growing number of companies that provide services for open source software.

Equally, the extended community of developers working on OSS projects provides security against companies ceasing development activity.

In many ways, it depends of selecting the correct products. If an institution has little in the way of technical skills and resources, it may be sensible to choose Open Source products which are relatively mature and for which there is a large user base and support. Alternatively, those with technical resources may choose to themselves contribute to more cutting edge developments.

One important issue is the interoperability of Open Source products. Although the source code is open, it is not always simple to share data between different products and service components. In this respect, there is the need for more integration or cross alliances between the open source and standards developers.

There is need for more work on strategies for migration to open source software. The experience of the EC sponsored e-Learning Action Plan SIGOSSEE and JOIN projects is that overall there is great interest in the use of OSS in education from all the educational sectors in Europe, but there is a serious lack of information and support. Open Days and seminars organised by the projects have been attended by up to 200 participants. The establishment of support services at European, national and regional and local levels would greatly help in promoting the use of OSS, and developing sustainable strategies of the development and implementation of e-learning.

4.3 Sustainibility – New partnerships for developing educational software

In my earlier paper (Attwell, 2004) I identified a third, and emergent, phase in the development of e-learning and ICT applications characterised, once more, by innovation. One of the main driving forces for change, I said, is widespread disappointment with the results of phase two development. "Central is the emergence of two technological developments, open source software and standards. Open Source Software (OSS) and standards – LMS, SCORM and particularly Learning Design - allow the accumulation of innovation and facilitate creativity activity and innovation within an administration and learning environment."

Enthusiastic amateurs, with strong intrinsic motivation and a deep interest in learning innovation, drove phase one of development. Phase two saw the domination of e-learning enterprises, both application developers and content producers. The importance of the OSS and standards developments is that they open the door to creators and innovators who no longer have to develop complex learning environments and comprehensive administration functionality. With limited knowledge of software and systems, teachers and learners themselves can produce content.

OSS has also contributed to a social recognition of the potential for sharing and co-development of learning applications. At the same time the emphasis on life long learning is driving awareness of the importance of different types of knowledge and of developing software to support wider forms and contexts of learning.

These changes do not, by themselves, guarantee a new period of innovation, still less the development of rich pedagogical applications and content. Nevertheless, they do promise a new freedom to experiment and innovate and may facilitate a refocusing on the needs of the learner and on pedagogic applications, rather than administration and control.

In order to realize the potential of this new period new relationships between software and application developers and the education community are required. Software engineers and developers rarely understand the pedagogic potentials and limitations of different applications. Pedagogic and education administrators and researchers usually have only a limited understanding of the limitations and problems of functionality and application design. Neither community shares a common language. The outcome is that applications often disappoint in terms of learning. Furthermore it is much easier to specify management functions and to gain shared understandings of how those functions should be configured than it is to specify learning in terms of functionality. Lowest common denominators come into play. All can visualize a whiteboard, bulletin board or chat room. Complex processes of communication and informal learning are far more difficult to describe in terms of functionality and therefore technological availability drives development processes.

It is too much to hope for the emergence of a new multi-skilled occupational profile encompassing both pedagogy and software development, although as e-learning becomes a more specialist field there are some signs that skills and knowledge are crossing occupational divides. More realistic and attainable is to strive for new development processes including, for example, co-design workshops and rapid application development allowing iterative processes of design and development.

The UK based National Guidance Research Forum

In this respect, the development of the UK based National Guidance Research Forum is of interest. The aim of the Forum is to bring together research and practice in guidance to increase effectiveness through the creation and support of an on-line community of practice for guidance. The principles behind the site, say the Forum developers, are inspiration, intelligence, innovation and inclusiveness and the site is targeted at a wide group of participants including practitioners, researchers, policy makers and students (NGRF, 2004).

A key feature of this development is the construction of a shared knowledge base, not from an a priori comprehensive blueprint, but by being grown more organically from the contextualised problems that policy makers, managers, practitioners, researchers and trainers face (Brown, 2003). This involves the formation of groups with relevant expertise that form a centre of expertise for particular topics and have several tasks. These include the identification of gaps, key areas or problems related to their expertise and provision of a mediated commentary on key

documents and research findings on-line. The process will represent a major contribution to research capacity building within the guidance community. The methodology involves a range of prospective users on an iterative basis in the project's progress. This not only enriches the research process, but also validates and ensures the relevance of outcomes.

The research has been organised across three work groups Findings from each part and stage of the case study research will be discussed, refined and transformed on a continuing basis, using a strategy for maximising research impact and user involvement that is informed by the Nonaka & Takeuchi (1995) model of knowledge transformation. This highlights the importance of four stages in the collective construction of new knowledge - socialisation; externalisation; combination; and internalisation. Since it is the combination of different types of knowledge that is often problematic, the emphasis is upon a process that integrates the research results with other findings in ways that are useful for policy, practice, training and research.

The structure of the Database comprises three main sections, as follows:

- **Future Trends** – consisting of labour market information focusing on labour market changes and skills needs.
- A **Research Database** – which links to the National Learning Resource, based at the Centre for Guidance Studies at the University of Derby.
- **Effective Guidance** – comprising six modules entitled:
- Equal Opportunities;
- Impact Analysis;
- Using Research in Practice;
- Improving Practice;
- Lifelong Learning;
- International Perspectives.

The site has taken a year to develop and is due to be launched in 2004. There are many lessons to be drawn from its development, which has included a team of over forty participants in developing contents and more than twelve in building the site.

One key point is the process of content development using face-to-face and virtual communication and an iterative process organised through a series of teams. Rather than just setting out to develop web-based content, the coordinators consciously designed a knowledge development process. ICT was used both as a learning tool in the development process and as a means for wider dissemination and discussion of the work.

The aim of the learning process was to involve and mobilize informal knowledge and experience, rather than just rely on the formal knowledge of the participants.

The system has been developed using the Open Source Plone programme. The role of the software developers has been to support the materials developers and the knowledge development process by designing and implementing tools and by customizing the Plone system to meet the needs of the project. The software architects have developed a close working relationship with the project team, with iterative feedback processes leading to rapid development and deployment of new features.

In the course of this work they have developed a number of products which have been published through the Open Source SourceForge site. The software developers have always been open

that products developed through the project would be used and deployed on other sites and this has been agreed by the project promoters.

Following the launch of the site in the UK, it is now intended to extend the process to five other countries in Europe, with support from the Leonardo da Vinci programme.

5 Sustainability and the development of e-learning materials

Perhaps the most pressing issue for the sustainability of e-learning is how to make e-learning content more engaging. The major problem with e-learning is that in general the content remains dull and unattractive. European and national government policy has been to stimulate production of learning materials by the publishing industry. In this section I argue that this policy is unrealistic and that instead the answer is at the same time technical in terms of making it easy to create, sore and share engaging content and social in terms of involving teachers and trainers in producing content. To this end, the realisation that teachers and trainers are more likely to create engaging content than proprietary content producers is a key step.

The European Commission noted in a recent document:

> "There is a general consensus that there is a lack of European educational multimedia content coming from institutional, professional and industrial sources in education, publishing and educational software. After an initial phase of enthusiasm, often described as "hype", there are growing doubts about the real demand for educational e-content, and about its relevance for improving learning"[4]

My studies would, in general, bear out this assessment. An initial examination of an extensive catalogue of e-learning materials available to SMEs in Italy reveals a narrow range of subject area provision (D'Angelis, 2003). Most materials are for technologies, mainly the use on the use of standard software packages and networking technologies. Next is learning materials for managers and for management activities such as marketing and ecommerce materials followed by e-learning materials for language learning. Beyond this the provision is very limited. Obviously these materials are largely targeted at technical, professional and management employees (or white collar workers).

5.1 Issues in developing learning materials

Cost of multi media learning materials

A major problem is the cost of producing high quality multi media learning materials. Whilst it may be quick and relatively easy to put lecture notes on the web, producing simulations can take many hours of effort in design and execution.

In the USA the development of materials has been promoted by vast investment by the Army and Navy. In a report for the US Department of Education (Dubois, 2002) the authors list a series of contracts awarded by the army and navy to private e-learning providers and to public education colleges and networks to provide e-learning. The five-year Army University Access Online project, launched in late 2000 with an initial contract to Price Waterhouse for $453

[4] European Commission Directorate-General for Education and Culture, Open invitation to tender No DG EAC 21/02 for the provision of services concerning the carrying out of studies in the context of the e-learning initiative.

million, aimed to ultimately reach one million soldiers across the United States and around the world.

Language and localisation

Whilst it is possible to launch such large-scale content initiatives in the United States, in Europe the question of language is a complication. E-learning was pioneered in Europe in the university sector. Most learning materials were provided in English. Whilst this may be acceptable in a higher education environment, most vocational learners require learning materials in their own language. Furthermore, whilst universities could draw on very broad discipline areas, and on common structures of disciplines between countries, the learning needs of vocational learners are often quite specific with limited national (or even international) markets.

The MESO (Multi Media European Software Observatory) study in 1998 drew attention to the problems of market led software and materials provision in different languages, especially those languages serving smaller population groups At that time they estimated only the English language market was sufficiently large to be viable in a wide range of subject areas.

There is also growing debate on the issue of globalisation and localisation in software and learning materials. The task of translating materials to different languages is not a straightforward technical issue of localisation but involves significant cultural transformations (Blandin, 2003). Bernard Blandin says that it is not enough to adapt content: the "form" of learning material has also to be localized.

> "Designing effective learning environments has to take into account social and cultural factors, but also learning software and learning material usability has to be considered as "situated" (Blandin, 2003b). Occasions and conditions for the use of learning material arise directly out of the context of learning activities which are implemented."

Blandin considers that the localization process as well as the design process for software and/or learning material cannot be isolated from the design or the adaptation of learning situations in which the software or the learning material is to be used.

Towards sustainability

e-Learning has not as yet developed sustainable models of content development. But there are a number of measures and movements which hold much promise in this direction and these will be explored further in this section. The first is the emergence of open standards which allow materials developed through one system or platform to be used on another and to be shared between institutions and users. The second, and linked, development is the development of smaller units of learning materials, known as learning objects. The third is development of content repositories allowing the storage and sharing of learning objects and content. The final trend is emergent open content model. Taken together, these trends and developments point the way towards sustainable content development. But, it should be cautioned that none of these developments is mature, and none is without controversy. In this section I will look at these trends and developments and analyse some of the issues being raised. I will also illustrate these trends through a number of short case studies.

5.2 Why we need standards

There is no well-elaborated system or form to categorize and explain computer based learning materials. This has made the learning content world somewhat chaotic, and many excellent materials are underused for that reason.

Other aspects of technology application suffer similarly from a lack of interoperability. Student records are stored in proprietary formats by different record systems, making it difficult or impossible to transfer them between different suppliers' systems, and hindering student movement between institutions. This is equally true for student lists, course descriptions and other administrative information.

The growth of the internet, followed by the use of intranets, groupware and learning environments, has highlighted this problem. People want to find content easily wherever it might be on the internet, and incorporate it into their courses; learners want to move between institutions taking their learning records with them; and teachers using e-learning systems want to have good information support from administrative systems.

To solve this situation interoperability standards are needed that address all of these areas. For learning content, not only technical standards like graphics interchange formats are needed, but also formats for the way in which the packaging, sequencing, and other management of the software is handled, so that it can be transferred between platforms and environments. Likewise standard ways of describing educational materials are needed so that they can be easily searched for and located.

Administrative systems need to agree on what information and how they save it so that it can be transferred to other suppliers' systems, and between systems wanting to use this information, like virtual learning environments. If agreement could be reached between those supplying systems and those buying and using systems on these matters, e-learning would be freed from the constraints of lack of information exchange. Getting this agreement is however easier said than done.

There are two key difficulties in designing these standards:

1. Users needs and suppliers needs are very different.
2. It is very difficult to define interchange standards that do not have some effect on functionality.

Nevertheless achieving interoperability standards for learning technology can have such a profound effect, that these problems must be tackled, challenged and overcome. A lack of open standards results in a fragmented market for education products, reducing choice and locking users into proprietary systems.

Until now, the market for electronic learning materials has been bounded by incompatible formats and supported platforms; standards for learning content mean that any compliant content will work with any compliant application, vastly increasing the range of materials available to educators and students. Rather than being forced into purchasing expensive total solutions, institutions will have the option to mix-and-match components that have the features they want, without having to worry about integration and data format issues.

Metadata

Before looking at the most commonly used standards I will first discuss briefly the issue of the metadata itself, on which the standards are built. Metadata is, simply put, data about data. Metadata allows one computer to obtain information from another about the structure, contents

and usage of a learning application or digital learning materials. Of course to enable this to happen some degree of consensus is necessary about what metadata should be described for an object. Obviously, this will be very different for different practices and communities. Therefore, different communities agree their own metadata schemas through a committee system – although there is a group of shred metadata known as the Dunlin Core, which is commonly exchanged between different community schema. The education community operates through the LMS (which nobody appears to know what its stands for) and who have produced the Learning Object Metadata schema (LOM). Two widely adopted standards have been developed based on the LOM – SRORM and Learning Design. These are described in some details below.

Whilst most developers and researchers in e-learning agree on the desirability of standards, agreement around metadata specifications has not been easy and is still extremely contentious. Whilst describing learning technology may be reasonably simple, describing learning, or the use of an object for learning, is not so simple. There have many critiques of the LOM for failing to address pedagogic purposes and concerns. Secondly, the learning community is very broad. The standards have emerged from the training community who may have very different conceptions of learning from universities or those involved in adult education. Thirdly, there are ongoing tensions between the interests of technical and application developers and those of teachers and trainers.

In the last two years a more fundamental debate has emerged as to whether or not metadata should be distributed (Downes, 2003). This argument recognizes a multiplicity of community interests in classifying and describing learning materials. These different communities may include content developers, education managers, librarians, teachers and trainers, evaluators and learners. Each will have their own different (and equally valid) way of describing learning materials. Importantly each community will intervene at different times in the lifecycle of a piece of learning material. Following this logic, it is impossible to prescribe a single set of metadata specifications for a learning object. Equally it is impossible to add all the metadata required at the point of creation of the learning materials. Critically, the creator of the learning materials cannot themselves add all the metadata needed for any one learning object. It would be quite ridiculous for the creator or developer to themselves add evaluative metadata about their own product. Neither are they able to know all the different ways their learning materials might be used in the future. Therefore, the argument runs, we need to support different metadata, with different communities and users adding their own metadata, based on their own community schema. Whilst the argument is strong it greatly complicates matters. In terms of practicalities, it is predicated on the ability of search engines, or of technologies for exchanging and sharing learning materials, to aggregate the different metadata available on any single learning object. That technology does not at present exist although proponents of distributed metadata, like Stephen Downes (ibid), point to the potential of RSS for this purpose.

MIT OCW has implemented a comprehensive metadata specification that was developed in collaboration with metadata specialists from MIT Libraries. This SCORM-compliant metadata specification was implemented using XML data structures (stored in SQL Server). A Web interface (implemented using C# and .NET) is provided for ease of creation and maintenance of metadata.

Metadata is captured at the course, section and resource level within MIT OCW. Where possible, metadata is defaulted by the system based on available information (various sources: course structure, workflow assignments, and configuration parameters, for example). A sophisticated inheritance engine further simplifies metadata capture by automatically inheriting appropriate metadata from courses to sections to resources within the sections.

The debates over metadata are key to future sustainability of e-learning but are far form resolved. The difficulty for materials developers, and for projects developing learning materials, is in making an informed choice of what metadata they should provide and support. Adherence to the SCORM and / or learning Design standards (described below) is probably commercially necessary for those in the Market driven sectors of education. But it may not be necessary or appropriate for many developers in the public education sector and may be a distraction form developing and implementing more innovative pedagogic of e-learning. Even gaining an informed appreciation of the issues and of current developments is a challenge at present. In this regard I would recommend tracking the excellent English language Centre for Educational Technology Interoperability Standards (CETIS) (www.cetis.ac.uk) web site and particularly the short briefing sheets they provide.

Learning objects

Standards are basically specifications of different sets of metadata. The best known standards for learning applications and content are SCORM and Learning design and these are described below. These will be described in the next section together with a short section on the QTI standard for testing and assessment. Generic to the standards is an understanding of the design and development of common objects for description. Central to this is the idea of learning objects. Learning objects are not a standard as such, but rather a common point of reference in the debate about the development of reusable 'chunks' of learning content. There is no common definition or understanding of learning objects, however, and there is an on-going and lively debate over the pedagogic desirability of such a conceptual approach to learning. Inevitably, the discourse and controversy over learning objects is intertwined with the debate over metadata and standards.

Learning objects have been seen as one of the main answers to the problem of sustainable content creation. Alison Littlejohn and S> Shum Buckingham (2003)[5] talk of "a vision of the future in which reusable resources (or learning objects as they are called) could comprise a new currency of exchange within a learning economy. Learning objects, produced by publishers, teachers, support staff and students themselves, would be stored in digital repositories where they could be easily accessed, recombined and reused within online courses. In an ideal world, these resources would be designed so that they could be adopted to fit different educational models, subject disciplines and levels of study." However, Littlejohn recognises that such as vision raises many complex issues. In her introduction to a special edition of the Journal of Interactive Media in Education entitled "Issues in Reusing Online Resources" they points to seven issues in the reuse and sharing of resources:

1. How can digital resources be used to support learning?
2. How can resources be reused within a range of educational models?
3. Why is standardization necessary?
4. Is there an optimum size for reusable resources?
5. Should resources retain contextual information?
6. How are educational institutions likely to change?

[5] Many of the ideas in this section are drwn from Littlejohn A. and Buckingham Shum S. (2003), (Eds.) Reusing Online learning resources (Special Issue) Journal of Intercative Media in Education 2003 (1) www-jime.open.ac.uk/2003/1/. Those inetrsted in this subject are recommended to access the full edition which is free for downloading.

7. Is global sharing of resources a possibility?

Many of these issues are dealt with elsewhere in this study. In this section I will focus on the issues concerning learning objects. The reason that learning objects have excited so much attention is that they promise to lower the cost of creating e-learning materials through allowing the reuse of materials in different programmes and different contexts.

The key benefits of object-based e-learning materials are seen as follows:

- Repurposing. Content in learning object format can be more readily reused for different purposes and can be easily updated by replacing only outdated learning objects content rather than having to rebuild a new course.
- Personalised learning. Customised learning can be produced to meet individual and specific needs.
- Performance support capabilities. Learners are able to locate specific information they need from learning objects in the context of their work.
- Distributed authoring. Subject matter experts can author new learning content directly.

Much of the work on standards has been to allow interoperability of learning objects and the approach has become mainstreamed in the last two years.

The debate over learning objects

However, there is much controversy over learning objects. There is even disagreement over the definition of a learning object. Wikipedia defines a learning object is a reusable unit of instruction for e-learning (Wikipedia,2004). Dai Griffiths points to a number of different definitions, dependent often on what framework the author is using (Griffith and Garcia, 2003). They cite Koper (2003) who defines a learning object as “any digital, reproducible and addressable resource used to perform learning activities or learning support activities, made available for others to use”. Koper goes on to clarify that when a learning object is aggregated to a learning activity, then the aggregate is no longer a learning object, but it is now a 'unit of learning'.

There are other approaches. Rehak and Mason, (2003) maintain that a common definition is something like, "A small chunk of learning which serves a learning objective". This view says that the Learning Object itself must have a learning objective -- not just be part of a learning opportunity. They later suggest that among the aspects of learning objects which need to be described are

- What it can be used for
- How learners will interact with it
- How it fits into the larger learning experience

Laurillard and MacAndrew (2003) develop a very different analysis in their Conversational Framework for Learning, in which the role of the academic is to provide “Digital document / resource with internal structure defined; a set of analytical tasks; the structure for the discussion around those tasks.” In this description Learning Objects do not seem to be distinguished from resources.

There has been fierce criticism of the idea of learning objects. Norm Friesen (2004) says: “The term ‘learning object’ suggests neither simplicity, compatibility nor any relative advantage over prevailing teaching practice”. Referring to SCORM he goes on to ask where is the learning in e-learning standards? Friesen is concerned that the modular approach to learning implicit in the

learning object model lacks coherence for the learner. He finishes his polemic by questioning the link between e-learning development and the US military:

> "Learning objects and e-learning standardisation bear the imprint of the ideology of the American military-industrial complex – of ways of thinking that are related either marginally or antithetically to the interests and values of education generally and public education in particular".

Lest it be thought these concerns are only expressed by marginal researchers, the Synergy Plus report for the US Department of Education also raises doubts (although perhaps in more muted terms!):

> "Although the examples of inter-institutional collaboration and resource sharing are increasing, these efforts raise questions about the reusability of content, uniformity of technical standards, and scalability beyond the initial set of collaborating institutions."

Learning objects and pedagogy

In Europe there have been more concerns expressed about the pedagogy. A basic assumption behind the idea of learning objects is that the smaller and more discrete the learning object the more reusable it is in new educational contexts (Liber and Olivier, 2003; Duncan, 2003). The granualarisation or modularisation of learning implicit in the learning object economy raises a number of issues. Firstly there is the question of how far it is useful to separate leaning resources in separate or more discrete parts (Nicol, 2003). Secondly treating learning objects as stand alone resources removes the contextual relationship of learning materials to their use, including the inter-relationship between different learning resources. Finally there is doubt as to whether teachers and trainers would be prepared to design learning materials in this way or indeed to use materials without an understanding of the contexts in which they were developed. As Paul Saffo quipped, " It's the context, stupid" (Saffo, 1994). The Learning Design standard aims to overcome some of these reservations by providing contextual pedagogic metadata to assist in the reassembly and sequencing of learning objects. Yet even this is predicted on a classroom model of learning and fails to recognise the informal and work based learning increasingly characteristic of vocational education and training.

Although it may at first seem trite, I would suggest that the obvious observation that objects cannot learn has more important implications. I suggest that the subject and object in the learning object theory are inverted. The learning materials are actually the subject of learning. The learning object is the end result of the students interaction (or bricolage) with the learning materials. This is important because, if students were provided with metadata tools for classifying their objects following the learning, it could be possible to develop a sustainable ecology of learning materials. New students could re-engage with the objects (now subjects) of previous learners' work. This also offers a way forward in using learning materials in work based learning where there are pedagogic traditions of practical and developmental project work.

Dai Griffiths and Garcia (2003) also question the abstraction involved in the concept of learning objects. They quote Koper (2003) who says that "In an ideal world of reusable learning objects, all objects could be used by a teacher for a course, irrespective of the pedagogy or 'learning design*"*. Griffiths and Garcia consider that if a learning object is constituted by its use, it can be argued that to this extent it partakes of the pedagogy within which it has been used. If, on the other hand, one were to remove the criteria for use from the definition of a learning object, one is left with something which looks very like a resource. Koper also seeks abstraction of context, although in this case he refers to learning resources rather than learning objects. A similar

question arises of whether a resource can be understood other than in the communicative context within which it was created and is used.

Griffiths and Garcia challenge the commonly held three level hierarchy of resources, learning objects and units of learning. He suggests we may not need learning objects at all, but should rather focus on resources and units of learning.

Clearly this debate is far from over. Whilst admirable from the point of reuse and sustainability, the seemingly technical questions over the definition and nature of learning objects cut to the core of the debate over the use of ICT and digital learning materials in education. It is interesting to see how deeply the issue of pedagogy impacts in this discussion. It may be that until we begin to have a better understanding of pedagogic approaches to e-learning, it will be impossible to progress far in resolving the issues over learning objects.

It is worth quoting from a recent polemic by Stephen Downers (2004).

"In the world of e-learning, meanwhile, the systems and protocols look more and more like jibberish each passing day as every possible requirement from every possible system - whether it makes sense or not - is piled into that tangle of 24-character variable names called Java (none of which will work at all unless you have exactly the right configuration ... But the last time I looked people weren't using learning objects in any great number, either in the classroom or (even more so) to support home learning. Gosh, make sure you can float before building a battleship." (OLDaily 12 July 2004)

Even if these issues can be resolved, and we can agree of metadata schemas and standards, a further hurdle to overcome is the development and implementation of technologies for storing and exchanging learning materials. This will be explored in the next section.

5.3 Learning repositories

If there is some agreement on specifying standards and open source architectures provide accessible and sustainable solutions for learning delivery, the next problem is how learning materials can be stored and accessed. This explains the current interest and rapid development and application of learning repositories.

Learning repositories are not a new idea; digital learning materials have always been stored in some form of library or archive, usually through some kind of direct link to the learning applications itself. (In this respect it is interesting to speculate how many VLEs are used primarily as a means of creating and storing materials, rather than for learning).

Increasingly developers and educationalists are looking for systems to avoid “'locking in' learning material/resources/objects within monolithic, custom, or proprietary architectures” (Morrison, 2004). In his state of the art review of learning repository development David Morrison says: “We want the material which is utilized by a learning tool, environment or application to be separate from the container(s) in which it can be presented. We want easy authoring, updating, archiving, retrieval and overall management of such material. We also want it to be finding and retrievable by software clients and even software agents/robots as well as humans. Why the latter?

Basically, we don't want to be trapped by the application interface provided by any one vendor and can therefore integrate the material, or at least links to it, within whatever software clients and containers we care to use.”

There are rapid technical advances being made in this area and in the following section I will review some of those developments. But, the development and implementation of learning repositories raises important cultural, social and policy issues. These will be examined in the following section.

Technical developments

One of the most interesting of the present developments if the UK universities Joint Information Services Committee's JORUM project. The project "aims to encourage sharing and re-use of existing materials, as well as the creation of new ones to fill gaps in the curriculum. Teachers will be able to locate resources using simple search facilities in the repository, download the resources for use locally, and deposit new or customised resources for sharing with colleagues." (JORUM, 2004)

"Creating resources for learning and teaching takes substantial time, effort and expertise. Sharing content can provide more time for teachers to engage in the real work of teaching i.e. supporting students and engaging in dialogue with them. The resources are seen as useful ways in which, for example, complex concepts can be discussed with students, as part of a blended learning approach, or descriptions of effective teaching activities can be shared with colleagues across the UK." (ibid)

"Providing facilities in JORUM to host virtual objects enables resource providers to make available descriptions of their content, within a system that is searchable both at the repository itself and via portals such as Connect (the Learning and Teaching Portal) and NLN Online. This gives resource providers added visibility for their materials." (ibid)

However, as David Morrison (2004) points out: "JORUM will be interacting in an environment in which institutional learning object repositories will also exist. It's unclear currently how JORUM will communicate with such local, regional, and national repositories; and indeed repositories already on the international stage such as MERLOT (ibid).

JORUM is by no means the only major repository project being developed. The cross-platform LionShare project aims to:

"facilitate legitimate file-sharing among institutions around the world through the use of authenticated Peer-to-Peer (P2P) networking. LionShare technology (which is currently under development) will provide tools for the exchange of academic, personal and work-related materials on an officially sanctioned and secure P2P network among participating groups and institutions around the world."

One of the bigger developments is Fedora.

"The Fedora project was funded by the Andrew W. Mellon Foundation to build an open-source digital object repository management system based on the Flexible Extensible Digital Object and Repository Architecture (Fedora). The new system demonstrates how distributed digital library architecture can be deployed using web-based technologies, including XML and Web services."

It would appear Foedora is being built on a service model and is intended to be:

"a general-purpose digital object repository system that can be used in whole or part to support a variety of use cases including: institutional repositories, digital libraries, content management, digital asset management, scholarly publishing, and digital preservation."

It should be remembered that these projects are using different standards specifications. But in most cases they do seem to be taking a pragmatic approach to the learning object debate in supporting a wide range of different objects. Flexibility is crucial to the success of learning repositories.

As David Morrison (2004) points out flexibility "means that learning objects from different sources/repositories may have a different 'look and feel' but the benefits of diversity and spread of development effort probably outweigh the insurmountable challenge of achieving global

consistency. Greater consistency is of course possible in a single repository or 'walled-garden' or development consortium model.”

He goes on to challenge “systems which effectively 'lock-in' learning objects, however they are defined, within any single learning object repository. If not we merely repeat what has happened with most learning management systems/virtual learning environments which claim standards compliance but in reality migration remains non-trivial in most cases. “

“What is required are tools and environments which don't assume that learning objects are necessarily contained within their repository system but which can either 'pull' objects from a variety of sources and repositories, or provide the means by which relevant objects can be found and accessed. What I'm proposing therefore is configurable tools and environments which can find, aggregate, display, and provide access to resources, tools, and services which are potentially distributed over a wide variety of repositories and sources; and which can respond to the user's current learning interests”.

The JISC Information Environment

JISC also recognizes these needs in its description of the JISC Information Environment (JCIE):

"… the Information Environment as it is proposed here aims to offer the user a more seamless and less complex journey to relevant information and learning resources … It is acknowledged that the Information Environment envisaged for the JISC is ambitious. This is primarily because this has evolved to embrace two key concepts which are by nature semantically and technically complex to advance through a process of investment these are:

- the view that digital resources are inherently distributed and will never be delivered by a single service provider
- the view that users do not all want to access information in the same way but will require a diverse range of views of resources in order to satisfy their needs. A web based portal or VLE for example may operate as a specific window upon a set of distributed resources."

A major problem is that if learning object repositories are to have an impact on e-learning the mechanisms by which they communicate with each other and with the end-users needs to be easy to implement. This has led to a discussion about the potential of distributed systems when the data is not actually held on a central repository. Instead the central system would contain information about the learning objects and provide access to distributed resources, which could even be held on a desktop. In this scenario it would not be critical for full metadata descriptions to be held by the central server. Indeed, it might be possible for the central repository to build up aggregated metadata descriptors based on different sources of information.

Distributed Learning Object Repository Network

Stephen Downes has developed a prototype distributed repository called DLORN (Distributed Learning Object Repository Network). DLORN is defined as:

- A system that allows content producers to distribute their learning resources
- A mechanism that enables the subject specific aggregation of learning resources from many sources
- A means to allow course authors to locate and use resources from many sources

DLORN is not concerned with the nature of the underlying systems used to produce the information about learning objects as long as that information is formatted in the relatively simple RSS format which can then be read by the multitude of 'readers' or web applications already out there.

Essentially DLORN uses RSS to allow the sharing of information about learning resources and where they can be obtained. Downes emphasised his system is only a prototype to demonstrate the potential of simple to implement technologies such as RSS. The new syndication standard Atom may offer more functionality.

Social, cultural and policy issues regarding content repositories

One of the major social issues is what role teachers and trainers play in creating and sharing learning materials. This involves major changes in culture. However this issue will be dealt with in some depth in the section on open content below. Here, I confine myself to raising a number of other issues, although I would emphasize from the outset I have few answers to the questions I am asking.

The first issue is how digital learning resource repositories relate to other institutional repositories including digital libraries?

The second issue is concerned with resource lifecycles (McLean, 2004). McLean says that as born digital materials proliferate we need to reconsider the established view of resource lifecycles. He points to the different status various resources might have static, dynamic, ephemeral or archived. Institutional repositories and information management strategies need to accommodate materials in the course of development, newly created materials and mature material. Resources will evolve in the course of development and use and will pass through a variety of repositories, controlled and managed by different individuals and agencies, throughout their lifecycle. McLean asks **a**t what point in the lifecycle is it necessary for resources to become persistent and questions what “persistent” means in relation to digital resources and in the context of distributed environments? For resources to become persistent, he says, they require globally unique actionable identifiers or metadata. At what point should these identifiers be allocated and by who?

A third set of issues relate to organisational and institutional management and policy. This includes the question of who is to be responsible for the management of repositories and digital archives and how different roles and tasks are to be distributed and coordinated. It also raises the issue of who owns, manages and controls access to teaching, learning and research resources?

There is a tension between the development of centralized resource depositories and the decentralized creation and use of resources. McClean questions whether decentralised systems can be used to manage digital resources at the organisational or institutional level? At a institutional level there is a major issue of how organisations can integrate owner centred curatorial repositories and user centred distributed repositories?

I will return to these issues when looking at open content. Before going on to this, the next section will examine standards.

5.4 Standards

As will have become apparent to readers of this paper, the issue of standards is central to the sustainability and re-use of digital learning materials. Standards are intended to allow the interchange and re-use of materials between different systems and platforms and to provide vital

information of the design and content of materials to potential users. This applies to both commercial and open content and to content intended to be delivered through proprietary platforms and through open source architectures.

So, at face value, standards are a 'good thing'. The reality is a little more complex. Given the close relationship to learning objects many of the criticisms of learning objects are also directed at standards. There are a number of further issues which are the subject of much debate.

One is the whole process of developing and agreeing standards and how that process should be managed. In particular what should the role be of educationalists, as against the interests and concerns of the major software developers?

A second issue, which I raised earlier in relation to learning objects, is how pedagogic approaches and uses can be represented in a technical standard.

A second issue is what should be included in the standards specifications. On the one hand to be useful and to ensure interoperability the standards need to provide comprehensive specifications. On the other hand the more detailed the specification, the more work it is to comply with the standards. Furthermore there is a danger that very detailed standards specification will constrain experimentation and innovation. Olivier and Liber (2003) have expressed the concern that:

"eLearning standards will constrain Internet supported learning by freezing a sub-set of existing practices, or whether specifications can be provided that can support the development of new, enhanced, but yet to be developed approaches to learning which the Internet makes possible"?

In the next two sections I provide a brief overview of the two major e-Learning standards, SCORM and Learning design and describe what they are and how they operate.

Shareable Content Object Reference Model (SCORM)

SCORM is an acronym for Shareable Content Object Reference Model. Shareable content objects (SCOs) are individual, electronic units of learning that may be combined to create a course of study (Bailey and Currier, 2003).

Reference models are collections of existing published technical specifications. A reference model may include some elements from the total set of all requirements within an existing specification. This smaller subset of elements is referred to as a profile of the specification. The SCORM is not in itself a specification or standard.

The SCORM has been developed by the Advanced Distributed Learning (ADL) initiative following a mandate given to the US Department of Defence in 1997 to develop a strategy for educational and training technology.

The SCORM combines and profiles a number of existing technical specifications into a reference model that describes the creation, deployment and behaviour of SCOs within Web-based learning management systems or virtual learning environments (ibid).

Four high level requirements have been developed by ADL to guide the development of the SCORM. According to ADL, SCOs should be durable, interoperable, accessible and reusable.

The main uses of SCORM are to:

- Provide web-based training for individual learners. The approach is self-paced and self directed. The SCORM was originally designed to support personalized instruction

within the US Department of Defence, and implies a pedagogical model closest to industrial and military training.

- Create individual, electronic units of learning that may be reused in different courses.
- Package instructional material and meta-data for import/export between different VLEs.
- Track and store records of the progress of a learner moving through a unit of learning.

SCORM uses the IMS Content Packaging Specification developed by the (IMS) Global Learning Consortium. The content packaging specification defines how training should be packaged digitally to facilitate sharing learning resources.

Issues and debate about SCORM

The SCORM debate tends to be polarised in two vehemently opposed camps with little middle ground at present (Rehak, 2002). This debate is an extension of the learning objects debate that can be traced to Wiley (2000). SCORM claims to be “pedagogically neutral”, a description which has since been associated with Wiley’s criticism of a learning object approach to learning product design:

“Software vendors and standards bodies describe their learning object related work as being “instructional theory neutral”. However many critics have challenged that assertion, claiming at best the standards are agnostic in ignoring the importance of pedagogy. Other critics belief that SCORM, far from being “pedagogically neutral” encourages a pedagogy that is behaviourist, didactic and instructive.

There has been a fierce debate over this. In a briefing by Dan Rehak, one of the principal architects of SCORM, he emphasised repeatedly that SCORM is not the right approach for higher and primary education. According to Rehak, "SCORM is essentially about a single-learner, self-paced and self-directed. It has a limited pedagogical model unsuited for some environments." This is mainly a consequence of the needs of the main initiators of SCORM: the US federal government in general, and the Department of Defence in particular. Their needs are mainly in the area of training for specific systems and situations by people who are not generally in full time education. This need is addressed very well by the spec, but "SCORM has nothing in it about collaboration. This makes it inappropriate for use in HE and K-12". (For more on this debate see CETIS - http://www.cetis.ac.uk/content/20021002000737).

What room is there, then, in SCORM for learning designs that adopt more constructive, problem or activity-based learning strategies?

In response, Oehlert offers alternative methods of thinking about SCORM. SCORM, as a set of specifications, is evolving “to ensure that it is as useful as possible to the ADL community”. It is also a “minimum set of standards, not the max. It describes a way in which content from one system can interoperate with another system. It says nothing about the ‘scope’ or ‘flexibility’ of content once over that minimum line” (Oehlert, 2002). Oehlert goes on to say that SCORM is a tool, much like HTML which, while governed by internal standards, has allowed “for an incredibly diverse array of Web sites.” He says “ADL/SCORM began life within the learning/training/performance support arenas but I do not see it as being learning specific.”

Despite the limitations many of the Learning management systems commonly available do support SCORM, and it would appear that designers have managed to overcome the perceived pedagogic limitations to create objects supporting different pedagogic approaches. But the doubt remains that the commercial incentive to support SCORM is holding back the development of more advanced applications of e-learning.

Frustration with the pedagogic limitations of SCORM lay behind the development of the Learning Design Standard which is examined in the next section.

The Learning Design Standard

The IMS Learning Design specification supports the use of a wide range of pedagogies in online learning (Learning Design, 2004). Rather than attempting to capture the specifics of many pedagogies, it does this by providing a generic and flexible language. This language is designed to enable many different pedagogies to be expressed. The approach has the advantage over alternatives in that only one set of learning design and runtime tools then need to be implemented in order to support the desired wide range of pedagogies. The language was originally developed at the Open University of the Netherlands (OUNL), after extensive examination and comparison of a wide range of pedagogical approaches and their associated learning activities, and several iterations of the developing language to obtain a good balance between generality and pedagogic expressiveness.

The IMS Learning Design workgroup's (LDWG) goal is to work towards establishing specifications for describing the elements and structure of any unit of learning, including:

- resources
- instructions for learning activities
- templates for structured interactions
- conceptual models (e.g., problem-based learning)
- learning goals, objectives and outcomes
- assessment tools and strategies

The specifications, which describe this framework, need to:

- describe and implement different kinds of learning approaches
- enable repeatable, effective, and efficient units of learning
- provide access to, and interchange of, units of learning between learning systems
- support multiple delivery models
- support reuse and re-purposing of units of learning or their component elements
- support the reuse or repurposing of the framework and components of a unit of learning
- leverage existing specifications and standards
- be culturally inclusive and accessible (internationalization)
- support multiple learners and multiple roles in a learning activity, reflecting learning experiences that are collaborative or group-based
- support reporting and performance analysis

The goal is to enable many kinds of educational designs to be created, using a consistent notation, which can be implemented uniformly in multiple courses or learning programs.

A new European Framework 6 project, UNFOLD, is focusing its efforts on IMS Learning Design, an open specification providing support for multiple users and flexible pedagogies. There is a

significant gap between the release of a new specification such as IMS Learning Design and the full realisation of its potential benefits in the teaching and learning practice. UNFOLD aims to:

- Reduce the time taken in realising the benefits of flexible open e-learning standards in Europe.
- Create an engine for the continuing development of European e-learning practice.
- Provide a model for the rapid realisation of the full benefits of any other e-learning specification.

Learning design is undergoing rapid development with the notable recent release by the UK JISC of a free open source design engine, CopperCore.

In a presentation at Limerick as part of the SIGOSSEE open source education project Dai Griffiths (2004) claimed Learning Design is of critical importance for the future of e-learning. He pointed out that it enables some of the same values as the open source movement - collaboration, building on the practice of others, adapting resources to local needs.

- He said that Learning design also addresses:
- How we exchange educational documents
- What did other people do with this document?
- What resources did people use to work in this area?
- Who used this resource in what context?
- What other ways could I use this resource?

In this way it is claimed that Learning Design values the participation of the teacher as playing a central role in learning.

5.5 Open Content

In terms of sustainability a major development is the growing movement for open content, the argument for open content parallels open source. There are three key parts to the argument. The first is that the present restrictive copyright system is morally and ethically wrong and that ideas cannot be treated as privately owned objects. The second is that innovation and the development of new ideas and content is naturally a collaborative activity and that the open content model builds on the natural way in which content creators work. The third argument is that present economic and social models for developing e-learning content are failing and that an open content model can overcome many of the existing problems in e-learning.

Ownership and content

The issue of sharing raises important social issues over ownership and content. Dai Griffiths (2004) addressed some of these at the open session of the June 2004 SOGOSSEE project meeting.

He argued that the Web has changed the technology for publishing and that the publishing industry and legal framework is responding by seeking to reinforce the existing structures. The way they are doing this is by promoting the metaphor of ideas as property as ‘Intellectual property’. This metaphor says:

- An idea is an object
- Copyright is property

- Reuse of an idea is theft

Dai Griffiths rejected this metaphor. He asked how do you know if someone “steals” your copyright materials? Copyright infringement is illegal, he said, but it is not theft pointing out here was art, music and literature before copyright. Copyright is a limited monopoly granted by the state. It is important, but it is not an inalienable right. Copyright is a body of inconsistent, ad-hoc arrangements to regulate markets.

Dai Griffiths argued that copyright should benefit the citizen, not the author or the publisher. He quoted the US House of Representatives report on the Berne Convention:

“The constitutional purpose of copyright is to facilitate the flow of ideas in the interest of learning.”... [T]he primary objective of our copyright laws is not to reward the author, but rather to secure for the public the benefits from the creations of authors”

(Implementation Act of 1988, cited in LR Patterson & SW Lindberg, *The Nature of Copyright* 1991).

The danger that Dai Griffith and others in the e-learning community have pointed to is that we have developed – or are in the course of developing – a good infrastructure for sharing but have no resources to share. This is the central issue being addressed by the open content movement. The key actions that are being promoted are to:

- Challenge the idea that an idea is personal property, which discourages the exchange of educational resources
- Fund and support free resources
- Support the Creative Commons license (see below)
- Set up repositories for free exchange of materials, which recognise contribution of Individuals.
- Work within the law

Issues in open content and shared repositories

Neal McLean (2004) has addressed a number of the key issues related to open content in his presentation on learning repositories. He asked why should practitioners apparently give away their resources? In this the key questions are what is the incentive to share materials and how can we encourage educational practitioners to manage their resources more effectively?

The development of open content or free resource repositories raises the issue of quality assurance, particularly in decentralised user controlled information management environments?

Mc Lean goes on to ask what does it mean to publish? He says “publication carries formal connotations across domain boundaries. If submitting resources to a repository equates to formal publication practitioners may be unwilling to relinquish ownership of their materials.” One answer may be peer to peer repositories which appear to offer a less formal alternative to publication.

McLean suggests practitioners may be more willing to share within communities of practice. However the concept of publication may have different meanings in relation to different types of educational materials and within different learning, education, training and research communities?

The question of alternative licences to the traditional copyright is a key issue for open content development. The major development in this area has been the increasing use of the Creative Commons Licence which is described in the next section.

The Creative Commons Licence

Creative Commons describes their major aim as to build “a layer of reasonable copyright.“

“Too often the debate over creative control tends to the extremes. At one pole is a vision of total control - a world in which every last use of a work is regulated and in which "all rights reserved" (and then some) is the norm. At the other end is a vision of anarchy - a world in which creators enjoy a wide range of freedom but are left vulnerable to exploitation. Balance, compromise, and moderation - once the driving forces of a copyright system that valued innovation and protection equally - have become endangered species.

Creative Commons is working to revive them. We use private rights to create public goods: creative works set free for certain uses. Like the free software and open-source movements, our ends are cooperative and community-minded, but our means are voluntary and libertarian. We work to offer creators a best-of-both-worlds way to protect their works while encouraging certain uses of them - to declare "some rights reserved."

Thus, a single goal unites Creative Commons' current and future projects: to build a layer of reasonable, flexible copyright in the face of increasingly restrictive default rules.”

(Creative Commons, 2004)

Creative Commons licenses are not designed for software, but rather for other kinds of creative works: websites, scholarship, music, film, photography, literature, courseware, etc. The aim “is not only to increase the sum of raw source material online, but also to make access to that material cheaper and easier.” Public Commons has developed metadata that can be used to associate creative works with their public domain or license status in a machine-readable.

Offering work under a Creative Commons license does not mean giving up copyright. It means offering some rights to any taker, and only on certain conditions. There are a total of eleven Creative Commons licenses based on different combinations of the following conditions (Public Commons, 2004):

“Attribution. You let others copy, distribute, display, and perform your copyrighted work - and derivative works based upon it - but only if they give you credit.

Noncommercial. You let others copy, distribute, display, and perform your work - and derivative works based upon it - but for noncommercial purposes only.

No Derivative Works. You let others copy, distribute, display, and perform only verbatim copies of your work, not derivative works based upon it.

Share Alike. You allow others to distribute derivative works only under a license identical to the license that governs your work.”

Case studies

The development of Materials Repositories and the interest in open content initiatives, linked to the availability of alternative Licences, has led to a growing number of major initiatives to develop open access resources in a shared environment. In this section I will highlight some of

these initiatives including case studies drawn from the US and Europe and targeted at the schools, university and vocational sectors.

LearningFolders

Amongst the European projects that aim to develop open access repositories of learning materials Miksike's LearningFolders Socrates funded initiative is interesting. The project aims to develop an open source movement in educational publishing and online support. The project is producing:

- free educational content in seven different languages for LeFo project target countries
- an eLearning software platform, which allows learners to work with these materials in a network-based learning environment and get additional services and support.
- a living learning community around LeFo.

The Miksike Learning Environment, targeted at both schools and life-long learning communities, provides access to more than 20000 worksheets in HTML format - called eWorksheets - and offers collaborative learning services. There are approximately 1000 voluntary contributors online (pupils, teachers, parents) and the site is used each day by more then 20000 learners (teachers/pupils).

A number of points stand out about LearningFolders. Firstly, it is a low technology application. Basically, teachers can upload their work sheets with a limited description. The project does not deploy metadata, neither is it standards compliant. Despite this it has gained a very large and growing community. This may be because it matches with teachers every day work and therefore imposes little new burden or unfamiliar tasks. The project has succeeded in building a critical mass of users and of materials. Therefore teachers access the web site as an everyday resource for their work and the incentive to add resources appears to be a moral obligation to contribute to a resource base which they use.

However, I would raise two caveats to the future development of this project. The first is that the lack of metadata makes refined searching problematic and it is likely this will emerge as an issue if the resource repository continues to grow at its present pace. Secondly by not specifying metadata requirement, the project has avoided many of the pitfalls referred to in the learning object debates. But the materials continued within the resource repository are not learning materials as such, but are teachers worksheets and do not support multimedia applications. As e-learning develops it may be that the project would wish to support more advanced multimedia an this would require a rethinking of the design of the repository.

EMERALD and EMITT

The Leonardo da Vinci programme sponsored EMERALD project, which ran from 1997- 2000, and the European Medical Imaging Technology Training (EMITT), which commenced in 2002 have both produced databases of learning materials which are now used throughout the world. The projects are providing training programme and materials for students studying Medical Physics, and using expensive and dangerous machinery. The two projects developed five different training packages. Each training package is designed to provide trainees with a four month structured training programme. Each package contains work tasks – around 50 in each of between half and three days duration each – with descriptions of equipment, measurements and associated issues for each task. Alongside the training packages is a database of images – around 500 for each package – including images taken inside the machines, images taken with

the machines and illustrations of faults etc. The images were initially distributed by CD ROM but are now also available on the web.

Like Miksite, the projects have focused on low technologies. They initially set out to develop high quality interactive materials but realised: “Multimedia was an enormous development effort for very limited benefit” (Roberts, 2003, cited in Attwell et all, 2003). Also similar to Miksite, the materials are essentially designed to support traditional course delivery. To use the materials as part of an e-learning programme would require further technology development and it will be interesting to follow future activities in this project.

MIT OpenCourseWare

The MIT initiative to develop Open Courseware has exited much attention especially in the higher educations sector in flying against the trend of major world known institutions seeking strategies for the commercial exploitation of their intellectual resources. MIT says the OpenCourseWare (MIT OCW) initiative flows from a “passionate belief in the MIT mission, based on the conviction that the open dissemination of knowledge and information can open new doors to the powerful benefits of education for humanity around the world” and “is true to MIT's values of excellence, innovation, and leadership” (MIT, 2004).

MIT OCW is a large-scale, web-based publication of the educational materials from the MIT faculty's courses. The initiative enables the open sharing of the MIT faculty's teaching materials with educators, enrolled students and self-learners around the world. MIT OCW provides users with open access to the syllabi, lecture notes, course calendars, problem sets and solutions, exams, reading lists, and a selection of video lectures, from 701 MIT courses representing 33 academic disciplines and all five of MIT's schools. The initiative aims to include materials from 2000 courses by the year 2008.

The MIT OCW evaluation team is studying how individuals' teaching and learning experiences change (if at all) through the use of the site, and aims to understand what broader effects OCW may have. “Early results have shown that:

- MIT OCW users overwhelmingly are finding that OCW has, or will have significant positive impact on both teaching and learning activities. Over 80% of all users report either positive impact or extremely positive impact, 18% report moderate or some positive impact and less than 2% reporting no positive impact.
- Educators plan to reuse MIT OCW materials in their teaching activities. Over 97% of users who identified themselves as educators expressed satisfaction with the quality of the course materials published in MIT OCW. Over 47% have reused MIT OCW materials (or plan to), and 41% may reuse materials in the future.”

(MIT, 2004)

MIT hopes that by sharing course materials, they “we will inspire other institutions to openly share their course materials, creating a worldwide web of knowledge that will benefit humanity.”

Rice University Connexions initiative

The Rive University Connexions initiative is also based on a strong philosophical basis. The project web site says:

“Knowledge should be free, open, and shared. Connexions is a rapidly growing collection of free scholarly materials and a powerful set of free software tools to help

- authors publish and collaborate

- instructors rapidly build and share custom courses
- learners explore the links among concepts, courses, and disciplines."

The promotion of shared knowledge is intended to allow users to select from the best ideas to create the most effective learning materials. "Connexions promotes communication between content creators and provides various means of collaboration. Collaboration helps knowledge grow more quickly, advancing the possibilities for new ideas from which we all benefit."

Connexions has aimed at developing reusable learning materials. Content is stored in XML to ensure interoperability using a meta data tool developed for the Open Source Plone platform. The project has adopted the Creative Commons License to ensure that materials can be reused and further developed. Authors are encouraged to write each module to stand on its own so that others can easily use it in different courses and contexts. Connexions also allows instructors to customise content by overlaying their own set of links and annotations.

Connexions describes itself as "internationally focused, interdisciplinary, and grassroots organized." They claim half a million people from 157 countries accessing over 1,800 modules and 40 courses developed by a worldwide community of authors in fields ranging from computer science to music and from mathematics to biodiversity. Modules and courses are also being translated into several languages, including Chinese, Thai, and Japanese.

One of the most interesting features of the Connexions initiative is the new roles foreseen for authors and contributors. Under the heading 'Ways of collaborating in Connexions' (2004) they put forward different roles for those who wish to contribute. It is interesting that the roles put forward are social, rather than the usual technological approach.

"There are several ways of using Connexions to collaborate with other authors.

Co authorship

Colleagues who participate in the creation of new content can each be listed as an author.

Additional maintainers

You can assign others to assist you in maintaining content in Connexions by granting them a maintainer role.

Workgroups

You and your collaborators can create a workgroup and look over each others' content as you work, making comments before publishing. This tool also works well with the above methods.

Suggest Changes

Even if you do not know the author of a specific piece of content, you can send a set of suggested edits.

Derive a Copy

If the author is not sympathetic to your suggestions, or if you want to take the content in a different direction, you can derive a copy and begin a new work based on the original. The

original author will still get attribution for his or her work. Note that your new content will not automatically be updated if he or she makes changes to the original."

Embedding materials development in the workplace

In an earlier paper I proposed an approach is to involve the learners in producing learning materials, especially within enterprises (Attwell, 2003). If learning is embedded as part of the work organisation it may be possible to start to generate learning materials within the enterprise or clusters or networks of enterprises. Within a wider vision of e-learning as a contribution to knowledge management or knowledge development, learning materials could be seen as the outcomes of learning; the knowledge created, at all its different stages and in all its different forms. The primary role of a computer based learning platform would not be for the delivery of the materials but in facilitating the transformation and communication of ideas as knowledge. The reusability of learning objects would be through recording and storing knowledge and in communicating and transforming the experience and practice of learners and participants in both an individual and group context. The computer or ICT based learning environment would be a process tool to support the creation and transformation of knowledge.

The overwhelming advantage of this approach is it allows learning materials to reflect and support the different contexts in which learning takes place in enterprises. It is worth considering whether this approach could be extended to the mainstream education sector.

6 Institutions and sustainibility

To a considerable extent, the sustainability of e-learning is dependent on institutional strategies. E-Learning has impacted differently on different sectors of education and training. It has had a pronounced impact on universities, although different individual universities have responded in very different ways to the challenge of new technologies for learning. In the public education sector and vocational schools the impact has been far less pronounced and is uneven. In small and medium enterprises e-learning has had little impact. Although it is not intended to deal with this analysis in any depth, I will briefly look at each of these sectors in turn to consider the direction and velocity of change and its likely implications for sustainability. At the end of this section I will look, again briefly, at emergent co-operative networks and at new patterns of education and training provision using ICT. I believe these new emergent networks offer a vision of sustainable development for e-learning.

6.1 Sustainability and e-learning in the universities

Four years ago studies in the strategic development of e-learning in universities focused on two different approaches. The first was to develop parallel programmes of e-learning to traditional classroom delivery. The second was to launch separate e-learning institutions with their own curriculum and subjects. Since then the debate has moved on and the recent period has seen the development of more differentiated strategies. These will be explored briefly in this section.

First though, it is worth noting that the big causality has been the e-universities. It seems only a short time ago that consultants were predicting the end of universities as we know them, to be replaced by on-line institutions with dispersed faculties. Despite sometimes very large expenditure these initiatives have often failed (with the exception of the 'traditional' Open Universities). One apocryphal case is the UK e-university.

The idea of an e-university to bring the best of British higher education to students around the world was proclaimed by David Blunkett, then education secretary, in a speech at Greenwich in February 2000, but it went through various permutations before being put into practice. At first,

universities - or consortia of higher education institutions - were invited to bid to host the proposed institution.

An enthusiastic supporter like Professor Tim O'Shea, now principal of Edinburgh University, predicted that the e-university could become the biggest in the world, with millions of students. It would need proper funding - of about £120m - but he assumed much of the money would come from the private sector.

The e-university strategy was to come up with an integrated service that would help universities develop online courses, to provide the technology to run and deliver e-learning to students around the world, and to market the courses abroad. To do this, it was decided it needed a "world-beating" platform, developed with Sun Microsystems. However they failed to convince other UK e-learning providers such as the Open University and London University to adopt the platform and Sun failed to deliver a fully functioning platform in time. £20m, a third of the total funds, was ploughed into developing the platform. However, the first three courses were not launched until September 2003.

In the event, the e-university, at had signed up only 900 students by the time the UK Higher Education Funding Council withdrew its support, and it never attracted any private money (Guardian, June 12, 2004).

There are a series of enquiries going on into why the venture failed. A consultancy report said:

"We have not seen evidence that customers recognise benefits from access to a one-stop service provider, and our discussions with UK universities have suggested that they regard the eU (e-university) as primarily a marketing vehicle." (ibid).

The debate over the demise of the e-university is continuing but it is possible to point to a number of lessons which are important for the sustainability of e-learning. Criticism has been made of the poor management of the project especially of the amount invested in the platform. To some extent, this misses the point. The real problem was the belief that the success of an e-learning initiative is technology dependent and failing to recognize the learning issues. As Robert Chapman (Guardian, June 16) points out:

“In theory, e-learning is flexible - you choose when and how you work and it supposedly fits round your life. The reality is that students opting for e-learning lead busy lives. Studying on their own, they need to be incredibly motivated and organised.

High drop-out rates and slow progress are putting students off this way of learning. Research shows that 76% of students rate classroom-based courses, with a mentor, as being effective. Only 12% think the same about web-based learning.”

A further error was the assumption that the private sector will make significant investment in e-universities. There is little reason to see why they should regard e-universities as a better source for their funding than traditional institutions (especially given the difficulties of undertaking research projects through the internet). Neither is their any reason to see why e-universities should be seen as generating higher incomes than traditional institutions. There have been no convincing total cost of ownership studies to support such a strategy.

Finally the UK e-University failed to form constructive networks and relations with existing UK universities. In reality they were in competition not only with the existing traditional universities bu8t also with the highly successful UK Open University.

Of course it is possible that it was just poor management and an unrealistic business plan which led to the UK e-University demise. But I suggest that the whole concept of separate e-Universities is flawed and that even in the US these bodies will struggle to thrive.

Similarly strategies based on offering dual and parallel provision (clicks and mortar boards?) of courses have also declined in popularity.

To an extent strategies for e-learning are dependent on a host of external, political and cultural factors especially funding and accreditation rules and regulations. This may explain why e-learning has been slow to develop in German universities. But, in general, universities in Europe are now focusing on three main strategies (or combinations of the three) – all seen as offering a more sustainable approach to e-learning and based on the integration of e-learning within the faculty, rather than as an external venture.

The first is the provision of selected courses and programmes through e-learning as an adjunct to traditional programmes. As an example e-learning programmes leading to a Masters Degree may offer part time provision as a progression route from Batchelor programmes. It also allows universities to market targeted programmes in other countries.

The second is the integration of e-learning within existing courses in a blended approach to learning.

The third is the development of e-learning programmes in partnership with enterprises and industrial organizations. This allows universities to exploit the knowledge and teaching expertise from within the faculty.

One very important development is the slow growth of partnerships and networks between universities, between universities and other educational institutions and on a regional and between subject area experts. Many of the Leonardo da Vinci programme ICT projects are based on networks developing learning programmes and materials for specific subject areas. It is interesting to note that learning platforms and technologies play only a minor role in most of these projects, the emphasis is on sharing of curriculum and subject area expertise. As such few of these projects have developed re-usable materials and many falter after initial project funding expires but they do point a way forward for sustainability based on sharing development and materials.

It is difficult to attribute the motivation for these new developments and to say to what extent the development of collaborative and networked approaches to e-learning are dependent on standards, open source, interoperability and content repositories or how much the desire for collaboration is driving these developments. In reality the relationship is probably dialectical, with both reinforcing each other in an iterative development cycle.

The last point to note in this section is the development of e-learning support units, going beyond traditional technical support, to assist faculty staff in developing e-learning materials, to provide support and development for platforms and architectures and to provide assistance and training in e-learning pedagogies and approaches. This differs from earlier phases when the role of such units was either purely technical or was to themselves deliver e-learning.

6.2 Sustainability and e-learning in schools

The impact of ICT on schools has been less marked than in universities. Despite optimistic policy pronouncements, the reality is a very uneven impact, although with major differences between individual schools and between schools in different countries. One major problem is the lack of institutional policies and strategies for the use of e-learning (Tannenbaum, 2003). This means that development is even more than usually dependent on ‘enthusiastic amateurs’ or self-driven innovators and often motivated by external funding opportunities. The lack of strategy means that promising innovation is often neither sustained nor mainstreamed.

ICT is being used in different ways in schools. Dependent on subject, it is being used to supplement traditional learning provision. The main means of delivery is blended learning, not because blended learning is the new 'in-thing', but because this is the obvious pedagogic approach, given the nature of the school curriculum! ICT is also being used to extend access to traditional provision in post compulsory education, notably through the development of outreach centres for those unable or unwilling to access traditional institutionally based courses.

In general the approach in schools is to integrate e-learning within the curriculum, although this is very dependent not only on access to computers, software and networks, but especially on the skills and confidence of the teachers.

E-learning and basic skills

e-Learning may be making a particularly large impact on basic skills provision, especially numeracy and literacy for adults. Firstly, it allows learning provision to be moved into the community, to reach learners who would not normally attend colleges and schools. In Pontypridd the local college has set up an outreach unit for basic skills in the main shopping street. Reading University has even opened an outreach unit at the main railway station, providing ICT based learning in office applications. Secondly there is some evidence to suggest learners are far happier to recognise learning needs in basic ICT literacy than in reading and writing. In both Pontypridd and in courses run by the VBAD in Belgium, adults are being taught reading and writing through the medium and pedagogy of basic computer literacy.

Distance Learning

There is limited evidence of VET institutions launching distance learning programmes. E-Learning may be extending their capacity to provide continuing professional development for companies, although many of the projects in this field have been far from successful.

An interesting example, although drawn from the higher education sector, of a successful distance learning project supported by European funding is courses in Welsh language provided by Lampeter College. Lampeter is based in the isolated, rural area of west Wales. Welsh is a minority language. The provision of e-learning courses in Welsh has enabled them to extend access to learners form all over the world (with somewhat surprisingly strong demand form Japan). An unexpected spin off from the Socrates funded project has been the development of an on-line Welsh dictionary. Whilst for course participants it would have been cheaper to send a traditional dictionary, the on-line product is being accessed daily by thousands of users.

Work based learning

E-learning may also be beginning to be used to facilitate more work based learning and to link VET school based learning to work practice. The Leonardo da Vinci monitoring study noted that over 60 per cent of Leonardo ICT projects claimed to be addressed towards work based learning (Attwell et al, 2003).

One example was a Czech based project in mechatronics, using virtual laboratories to link learning with the workplace. The case study said: "An important innovation within this project is that concepts and examples for real working and learning are developed and accessed virtually through remote processes. These concepts support the social aspects of learning, as learning is necessarily integrated in communication processes between different learning groups while working at the same machine".

It is possible that applications of this nature will be sustainable because of the integration of work and learning

VET institutions and Virtual Learning Environments

VET institutions have been slower than other organisations in investing in Virtual Learning Environments and organisation wide systems. This may be an advantage as Open Source and interoperable component based architectures make increasing market inroads. Those entering later into e-learning have less legacy systems to deal with. However there is some evidence (Synergy Plus) that smaller VET institutions are struggling to keep up with developments in e-learning and there is the danger of an internal digital divide between those institutions with resources and know-how and those without. This is a policy issue which needs to be addressed.

6.3 The use of ICT for learning in SMEs

Recent research (Attwell, 2003; Admiraal, forthcoming) that there is very limited use of ICT for learning in Small and Medium enterprises. Given the important role of SMEs in the economy and in provision of employment opportunities this is a matter of some concern.

In a small scale study undertaken by Cedefop (Attwell, 2003) the attitude of individual managers emerged as the single most decisive factor in influencing the development of ICT for learning in SMEs. Yet, surprisingly there seemed little support for individual SME managers or for SMEs in introducing e-learning.

Furthermore, there was little evidence, apart from isolated knowledge rich companies, to suggest that SMEs are able to provide an infrastructure to support learning. The Cedefop report said that providing access to advanced technologies for e-learning without a basic learning infrastructure will not work. In the sort term it seems unrealistic to expect that SMEs will themselves develop the necessary indigenous learning cultures and accompanying infrastructures. These responsibilities will have to be assumed by networks or regional or sectoral bodies who can bring a wider perspective on learning and greater expertise than is present in most SMEs. At present where networks or regional bodies are undertaking this role, expertise in education and training – or learning – tends to be separated from expertise in the provision of computer based infrastructures (and often is separate again from expertise in e-learning). This expertise must be brought together to unlock the potential of e-learning for SMEs.

Sustainibity: e-learning and knowledge management in SMEs

The report suggested e-learning could be best effective where it was integrated with ecommerce and with the use of digital media, computers and networks within work organisations and structures. Enterprises, even including smaller SMEs, are increasingly using computers and software systems as part of their business organisation for a range of different tasks and processes, including the procurement of materials, logistic organisation, sales and marketing and process control. If e-learning is integrated into these activities then it becomes part of the culture an organisation of the enterprise. Such a perspective breaks down the divide between what has tended to be seen as e-learning and what has been categorised as Knowledge Management or management development. Pedagogically it integrates the acquisition and practice of skills and knowledge with work processes, developing what some researchers have referred to as work process knowledge (Fischer, 1998). It means that there needs to be a re-examination of what is considered e-learning materials and may have quite profound implications for software platform providers. It is also dependent of the re-organisation of work processes. Many companies are taking steps in this direction, especially in the higher technology and higher value added industries. Partly this is because of the desire to implement new software systems, part is based on the need to reorganise and capitalise on intellectual and knowledge assets.

Developmental work tasks

Many of the ideas I have advanced here are strikingly similar to research on the learning organisation. Barry Nyhan (Nyhan et al, 2003) states

> "one of the keys to promoting learning organisations is to organise work in such a way that it is promotes human development. In other words it is about building workplace environments in which people are motivated to think for themselves so that through their everyday work experiences, they develop new competences and gain new understanding and insights. Thus, people are learning from their work - they are learning as they work."

He goes on to say:

> "This entails building organisations in which people have what can be termed *'developmental work tasks'*. These are challenging tasks that 'compel' people to stretch their potential and muster up new resources to manage demanding situations. In carrying out 'developmental work tasks' people are 'developing themselves' and are thus engaged in what can be termed *'developmental learning'."*

The challenge for developing e-learning in enterprises is the integration of ICT in such a way that it supports developmental work tasks, rather than merely electronically cataloguing and regulating routine roles and tasks.

The work initiated by Cedefop is being continued through a Leonardo da Vinci project, ICT and SMEs. The project, which runs to the end of 2005, is aiming to develop new policies and strategies for the use of ICT for learning in SMEs.

6.4 Sustainibility: networks and new forms of organisation

A major organisation development which impacts on the sustainability of e-learning is the development of networks and new forms of organisation, although it should be noted that e-learning is not the only driving force in this direction. These networks take a number of different forms.

1. Institutional Networks between education providers. These networks may allow institutions to share infrastructure and learning materials or may allow each institution to offer wider provision than would be possible on their own. They may operate on a local, regional or national basis.
2. Subject based networks between education providers. More limited in scope than the institutional networks, these consist of networks to provide e-learning in particular subjects. Although once more they cover different geographical entities there are signs of increasing stable transnational networks in some subject areas (e.g. Construct IT Europe).
3. Supply chain networks. These comprise of networks between supply chain organisations, large and small enterprises together with universities and vocational education and institutions to supply training to organisations within the supply chain (e.g. the UK based Motor Car supply Chain network).
4. Networks between industrial organisations (e.g. Chambers of Commerce and VET institutions. These networks may provide e-learning or a wide range of different subject areas based on regional geographical basis (e.g. Birmingham Learning Support for Small Businesses)

5. New network organisations to provide e-learning. Often state initiated these comprise of new network organisation providing contracts to VET providers for materials development and local support for e-learning provision (e.g. UK based Learn Direct)
6. City and regional networks of all education and training providers. These networks bring together all education and training in a particular city or region (e.g. Swansea Learning City).

In should be emphasised that these are only models. In many cases overlapping or multiple networks may exist. Secondly these networks may be formed for other purposes than the provision of e-learning. One driving force is the move towards lifelong learning. But there is evidence to suggest that new technologies and e-learning are a driving force in such networks both in providing opportunities of communication and shared or linked provision and in overcoming problems of limited resources. The development of new networks and new forms of organisational provision may be one of the major trends towards the development of sustainable e-learning over the next period.

7 Sustainable E-learning: teachers and trainers

Introduction

Throughout this report I have argued that teachers and trainers have a key role to play in developing sustainable e-learning. However, there is little doubt that at present many lack the knowledge and skills to undertake this new role.

In this section I briefly revue present measures for training teachers and trainers in the use of ICT for learning, before going on to outline a framework for continuing professional development. My argument is that learning about the use of ICT for education cannot be divorced from the overall concerns of the community of practice as a whole. The need to is give teachers and trainers the skills to shape e-learning as part of the everyday practice of a learning community embracing both teacher and learners.

The lack of skills and experience of teachers and trainers is seen as one of the major marries to the provision of e-learning (Barajas et al, 2002). The e-learning Leonardo monitoring report (Attwell et al, 2003) said that e-learning requires new roles and models for teachers and trainers. The traditional academic mission of transmitting a closed body of knowledge from the point of an undisputed expert is inadequate for ICT supported, open and flexible learning spaces. Teachers and trainers need to focus on co-operative knowledge construction, mentoring and preparation for individual, lifelong learning, in order to realise the potentials of e-learning (ibid). Put more simply, teachers have to move form being the ‘sage on the stage’ to being the ‘guide on the side’ (Pelz, 2004).

Training of teachers in e-learning

In many countries in Europe, teacher training is highly traditional with limited attention to ICT based methods (Attwell et al, 2003). There are a large number of measures to provide teachers and trainers with support and training in the use of ICt for learning but they lack coherence. These measures include the provision of short programmes of continuing training, project initiatives, on-line courses (often project funded) and in-school training. Universities are also increasingly providing training programmes for teachers in ICT. One problem is that there is limited value to these courses and programmes unless teachers and trainers have the opportunity to practice their new skills. All too often, opportunities for professional development are divorced from pedagogic and technical innovation.

In practice, many teachers and trainers basically have to teach themselves new skills, with limited support (ibid).

The Leonardo report suggested the organisation of regional seminars to disseminate national best practice related to e-learning. Although useful, on its own it could only provide a very partial answer to the problem. What is needed is new professional images for teachers and trainers linked to coherent programmes or frameworks for continuing professional development (Attwell, 2001).

There have been a number of European and nationally funded projects aiming to update the skills and knowledge of teachers and trainers for the use of ICTs. Approaches have varied according to the different cultures of professional development and learning.

These programmes, however well designed and implemented they may be, tend to focus too narrowly on the technologies themselves, and fall short of providing an integrated view of the technologies as part of the overall pedagogic process.

This can only be overcome if the new possibilities of ICT supported learning are seen as part of the changing role of teachers and trainers as a whole and if programmes for learning about ICTs are seen as part of an overall Framework for Professional Development. The need for such a Framework was the central conclusion of the EC Leonardo da Vinci EUROPROF project on the education of VET professionals (Attwell and Brown, 1998). We outline such a framework below. It is only through developing and implementing such a framework that teachers and trainers will be able to realise to the full the potential of ICT for enhancing learning.

Framework for professional development

The model developed is based on the development of new knowledge through the application of expertise. The model is designed to be robust at the level of pedagogy and design whilst providing the flexibility for its implementation in different cultural and social settings. The Continuing Professional Development (CPD) of professionals needs to be reflective, forward-looking and dynamic. It needs to equip professionals with the ability to support the development of skills, knowledge and understanding of others as well as of themselves, in a commitment to lifelong learning, as well as seeking to accommodate requirements for complexity and flexibility. Such a task is only achievable with a commitment to continuing professional development within a culture which acknowledges the importance of developing practice, expertise and a research capability in an inter-related way (Brown, 1997a), so as to be able to support the generation of new forms of knowledge (Engeström, 1995).

Communities of Practice

The Continuing Professional Development of professional communities of practice needs to incorporate current concerns, but also have the ability to look beyond these, and this is possible only if, as Ellström (1997) argues, practitioners develop a broad developmental and interactive view of occupational competence. This would complement a focus upon the significance of work-related knowledge and work process knowledge in the Continuing Professional Development of professional communities of practice. There is not the space in this key text to provide a full explanation of the model. Here we limit ourselves to a summary.

Developing practice

Initial competence as a professional is often associated with the ability to ‘survive’ and gradually assume a full position within particular ‘communities of practice’ (Lave, 1991). However, practitioners need to have a continuing commitment to explore, reflect upon and improve their

professional practice (Schön, 1983; 1987). This in turn means that practitioners have to develop the understanding, skills and knowledge necessary to evaluate and review their professional practice, recognising that such practice often takes place in complex and dynamic contexts.

Developing expertise

The initial key to going beyond competent practice lies in the ability to transfer skills, knowledge and understanding from one context to another (Eraut, 1994), so Continuing Professional Development has to be able to support this process, including through helping practitioners to perform effectively when they work with colleagues and in groups with different kinds of expertise (Engeström, 1995).

Developing a research capability

Teaching and nursing are recent examples of professions where there have been explicit attempts to move more towards making these research-based professions, where practice is not only informed by research, but new knowledge about practice is capable of being generated by the professionals themselves. This entails explicit recognition that practitioners have a key role to play in how new knowledge is generated and applied in practice (Engeström, 1995). Further this could be linked with an attempt to create wider communities of practice that embrace research as a guide to both policy and action (Brown, 1997a).

The ability to design and carry out authoritative research into aspects of professional practice individually or as part of a team is an integral part of practitioners developing a research capability. However, possession of research skills will also be valuable in helping professionals analyse, interpret, evaluate and, if appropriate, apply the research findings of others. .

The ability to communicate effectively

Personal change and development are central to the educational process, and professionals have to be receptive to challenges to their ideas and existing patterns of thought and action. Reflecting upon and responding to change will also involve complex social processes in which the ability to communicate effectively is essential.

Inter-relationships

Professional knowledge can itself regarded as a personal synthesis of received occupational knowledge and situational understandings, derived from experimental learning, which are capable of being further transformed through a process of critical reflection (Hammond and Collins, 1991). As expertise develops, and new contexts are utilised in the performance of practice, so the processes of research, review and reflection can lead to the creation of new forms of knowledge (Engeström, 1995). Continuing professional development can play a role in making these processes explicit such that others too can share in the developmental process. Hence Continuing Professional Development has at its core a number of inter-related commitments. The most obvious is a commitment to personal development. The others include:

- exploration of, reflection upon and improvement of professional practice;
- development of skills, knowledge and understanding (of critical reflection) necessary to evaluate and review professional practice;
- need to understand processes of change (as practice increasingly takes place in complex and dynamic contexts);
- ability to create new knowledge;

- development of theoretical knowledge to underpin and complement reflection upon practice;
- study of the interplay between theory and practice;
- need to be able to transfer skills, knowledge and understanding from one context to another;
- the generation of expertise through research;
- ability to handle complexity and inter-connectedness of issues (including through the formulation of mental models, schemas or networks);
- development of contextualised understandings;
- translation of understanding into action, as appropriate;
- further development of communication skills;
- attempt to create a wider community of practice that embraces research as a guide to both policy and action;
- ability to design and carry out authoritative research into aspects of professional practice;
- ability to analyse, interpret, evaluate and, if appropriate, apply the research findings of others.

Such a framework would equip teachers with the skills and knowledge, not just to use technology but to integrate technology with new pedagogic approaches and critically to update their own skills over time. This is the key to sustainability.

8 The evaluation of e-learning

For any policy seeking sustainability in e-learning, evaluation is critical. Put quite simply, we need to know what works and what does not. I have written much elsewhere of the issue of evaluating e-learning (see for example Attwell and Hughes, 2002). Whilst this work is ongoing, it is worth exploring a number of issues which have emerged in the course of initial transnational research. Importantly, we have found that most evaluation in e-learning focuses on the technology or on product evaluation. There is little evidence of a sustained approach to evaluating the learning experience. The following section does not answer this problem, but provides some pointer to on-going work and ideas in this important area.

The validity and usefulness of research

Not surprisingly, the validity and usefulness of the research into the evaluation of e-learning is often limited by the agencies that drive it. Firstly, most of the current evaluation at the business impact level has been driven by clients or buyers of e-learning (those who are funding the project) rather than by the designers, developers and front line deliverers and there is evidence in many cases that they are seeking to justify their investment.

Examining the explicit and implicit political and economic agenda of key agencies in the evaluation of e-learning is a major area of investigation. Is the purpose of evaluation about justification and valorisation or about improvement ? Do we really want answers and if so, what ‘currency’ would the answers have ? How would funding agencies react if evaluation reports were published claiming that e-learning was not effective, that e-learning projects had actually failed ?

Secondly, available evidence, thus far suggests that traditional classroom instruction yields a more favourable learner response than e-learning solutions. (Kirkpatrick 1975 : Level 1 Evaluation). This issue represents a perplexing problem for proponents of e-learning. (Scrivens M 1999). It also raises the question of whether evaluation of e-learning compared with traditional learning should be the real issue or is it evaluation of e-learning within itself ? (And similarly, between different e-learning platforms). Further research is needed to explore these two fundamentally different perspectives and generate reference materials which will look at the strengths and limitations of different models of e-learning evaluation.

Thirdly, e-learning has been shown to be as effective as traditional face-to-face learning over a parallel series of comparative studies with American university students over a range of science based subject disciplines undertaken at the University Ohio Centre for Evaluation Studies between between 1998 and 2000). While recipients of face-to-face learning have expressed more satisfaction with traditional learning solutions, the learning outcomes are not different for participants of e-learning programmes. Another key area for investigation should be whether these results are replicated in a European context, in vocational rather than in academic subjects.

Fourthly, many researchers have claimed that the same evaluation strategies and processes utilised in other types of evaluations can be applied to e-learning programmes. This may or may not be the case. However, a re-examination of widely used models and benchmarks is warranted and any inconsistencies and limitations in an e-learning evaluation environment identified particularly for their applicability and potential for adaption or refinement for the evaluation of e-learning in VET in Europe.

Fifthly, the Return on Investment (ROI) studies indicate a positive return for companies implementing e-learning programmes. (). Although most studies show a positive return based on cost reduction alone, (although often expressed in terms of revenue rather than capital expenditure) ROI studies need also to include analysis of benefits and ‘hidden’ costs for example, training the trainer staff costs, time away from the workplace costs. New research is needed which attempts a broader analysis and, in particular, will apply the ROI model to Vocational Education and Training providers in the public sector.

Sixthly, there is evidence of a growing practice of building evaluation into an e-learning process through the use of on-line tools that assess students’ perception and performance based on the belief that this can save time as well as money. This notion should be examined from the perspective of the pedagogical assumptions underpinning it and the robustness and usefulness of the data generated in this way.

Finally, most of the credible, holistic evaluation of e-learning has been based predominantly on an evaluative approach based on systems theory or using a positivist-rationalist approach. This is actually the case in most evaluations of VET programmes but the limitations of `systems theory evaluation’ (feedback and error detection) may be more significant in e-learning than in traditional learning. The relevance of this approach, particularly at policy level should be challenged and alternative theoretical bases explored.

A theoretical basis and framework for evaluation

What is lacking is a theoretical basis and a coherent research framework. There is little systematic research into broad based issues and concepts, or the generation of transferable models and processes of evaluating e-learning or into the design of tools for analysing, rather than collecting, data. Furthermore, there are few papers written which collate the results of the existing research and classify it in an accessible way. Nor is there substantial evidence of work

that extrapolates and tests generalisable principles arising from the case studies and surveys or which comments on the implications or application of these in the European VET arena.

Moreover, the gaps in knowledge impact on every level of the training and learning infrastructure. Policy makers and policy influencers need greater awareness of the implications of particular e-learning strategies and models to make informed decision on e-learning policy and funding. There need to be improved links between research and evaluation so that evaluation outcomes inform the research agenda and researchers can improve the validity of field observation. The skill base of e-learning evaluators need to be increased and they need tools and instruments which will increase their ability to make more analytic and interpretive evaluations of e-learning, using a greater range of methodologies. e-learning providers, and other education and training professionals need better evaluation products so that the design and delivery of e-learning programmes is improved.

9 Sustainibility: Mapping Policies

In a previous study I commented that whilst the technologies being employed are common across the European Community, the social contexts in which they are employed, and thus the policy settings, vary between and within different countries (Attwell, 1999). The different national and regional cultures of vocational education and training themselves provide very different frameworks for the development and application of ICT based learning tools. The MESO group report for DGXXII (Dondi, 1997) identifies considerable variation in the development of markets for multimedia based on linguistic factors, size and regulations of markets, levels of income and investment and social acceptance of technological innovation. The major contrast is between north and south Europe. In southern Europe, markets are relatively younger, there is a relatively negative attitude from potential users, private initiatives are not so strong in promoting the diffusion and use of new technologies and public policies in this field are relatively young.

However, while the report considers Europe to present a fragmented map in terms of technological penetration, strong signs of convergence are registered in the education sector, mainly due to the new public and public-private partnership initiatives created in order to foster the introduction of multimedia tools in schools, colleges, universities and in the public sector.

Even if there is fragmentation in technological penetration and uneven and culturally specific development in the utilisation of ICTs for vocational education and training, it is possible to attempt to a typology of policy orientation and the different measures being enacted in the field.

Policy Orientations and Implications

Dondi (1997) identified three major policy orientations in Europe.

The first is the innovation of the existing education and training systems. This is based on the assumption that, in the future, education and training institutions will retain their function as intermediaries between sources of knowledge and learners. To this end, governments are enacting measures to train trainers in the use of ICTs, investing in new technology for schools and establishing resource centres as well as launching pilot project programmes.

The second major orientation is based on the development of a new cultural industry for Europe, able to compete with the Japanese and Americans who dominate the multi-media market. Public investment aims to stimulate and support the production of innovative multi media products, encourage synergy among publishers and support the establishment of specialised software houses and video producers. Education may be seen as a potentially protected mass market for this new industry, though in the longer term learners may access knowledge directly without the medium of education and training providers intervening.

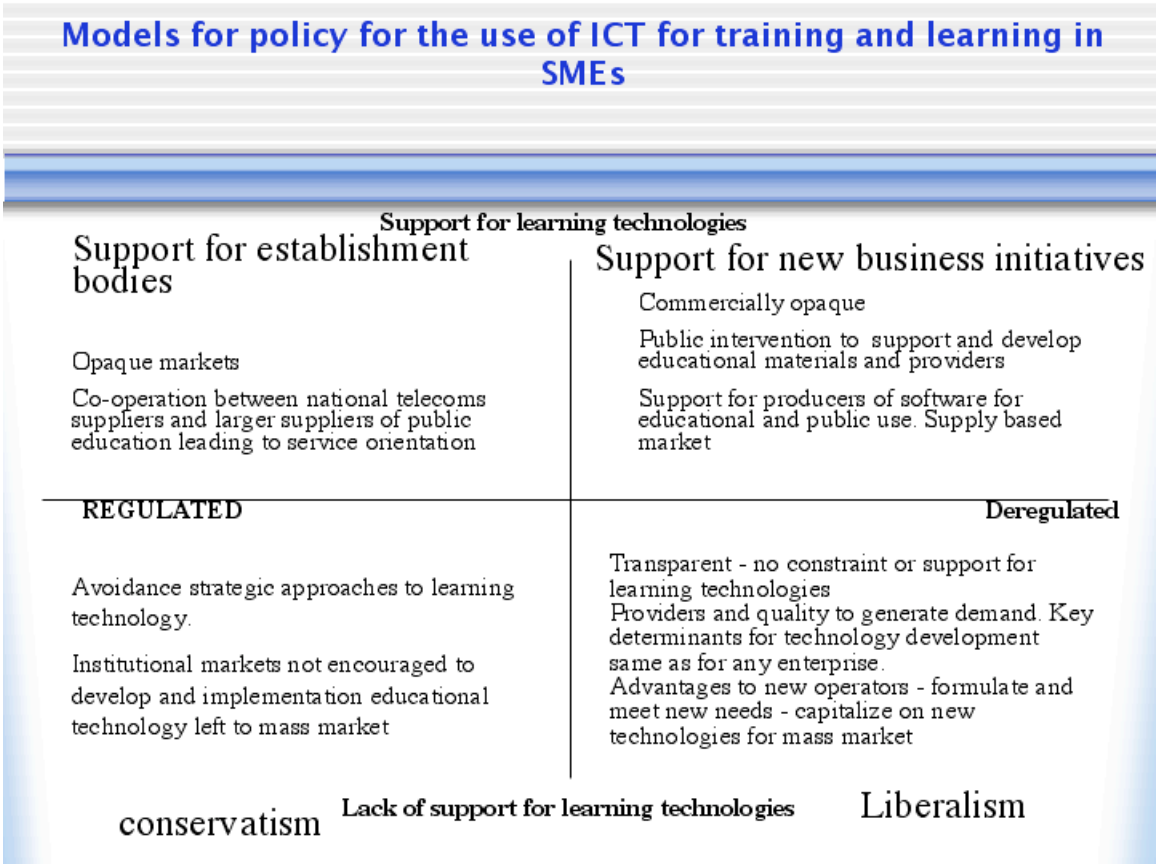
The third classification is the development of telecom based education services through satellite and broadband cable. Measures taken in this direction have included the regulation and licensing of hardware and infrastructure providers, the launching of pilot projects and studies and the provision of financial 'steers' to stimulate the development of distance learning provision.

Like any taxonomy, this are at best 'ideal case' scenarios and in reality elements of all these policy orientations can be seen to evolve simultaneously. In 1989 I commented that it may be, that these policies will have a different impact on different sections of education and training. For initial education and training vocational schools and colleges and other training organisations may well form partnerships with multi media producers to make best opportunities of the new technologies, particularly within pedagogically complex and certificated learning situations. In continuing training there will be more emphasis on commercially available distance learning provision and partnership between enterprises and producers for bespoke products. In other areas of learning, especially the fast growing 'leisure' learning sector, it is possible that the influence of education and training bodies will wane and non- mediated learning programmes will largely take their place.

In general I think my overall analysis was correct and still holds true today, although there is little evidence of the 'leisure' learning sector, which has indeed grown at a rapid rate, threatening traditional education and training provision.

Policy mapping tool

A further approach to analysing and assessing policy developments in Information and Communication Technologies for education is provided by Open Studio in France (1997). They have produced a policy mapping tool based on locating policy trends within a two axes graph. The vertical axis measures the degree of support for learning technologies whilst the horizontal axis plots the degree of regulation or deregulation of economic policy. This then leads to the identification of four policy areas: support for establishment bodies, support for new business initiatives, conservatism and liberalism.



Each of the four quadrants thus defined has different characteristics as policy trends. The top left quadrant, where support for technology policy within a regulated economic policy leads to support for establishment bodies, is characterised by opaque markets. The development of learning technology tends to rely on co-operation between national telecommunications suppliers and larger suppliers of public education leading to service oriented development.

The quadrant at the top right, where support for learning technology is combined with a deregulated economic policy, leads to markets which are also commercially opaque as public intervention supports the development of educational materials and provides support to producers of software and hardware for educational and public use. Whilst this trend may lead to the development of individual learning programmes these remain within the sphere of education in a supply-based market.

The third quadrant is formed through the lack of support for learning technology in the context of deregulated markets. The market is transparent, with the state neither constraining nor influencing the organisation of the learning technology market. Only the initiative of providers and the quality of commodities and services is likely to generate demand and enterprise requirements are key determinants for learning technology development. In this scenario advantages accrue to new operators who can formulate and meet new needs and to those able to capitalise on new technologies for a mass market.

The fourth quadrant, bounded by policies of lack of support for learning technology as well as a regulated economic policy, is characterised by avoidance of strategic approaches to learning technology development. As institutional markets are not encouraged to develop and implement educational technology, then the mass market offers access to education and training developments. This is the much-talked about `edutainment' scenario.

Once more, the scenarios painted above are ideal types. In reality, in any European country and in any one of the different markets associated with education and training technology, there will be features belonging to each of the different areas described above. This generates two issues. Firstly it illustrates the complexity of developing policies to manage innovation and support sustainibility, secondly it highlights the importance of the ongoing debates over the desirability of public intervention in education and training. Whilst most social and pedagogic researchers would join practitioners in an assumption that VET is an area of public policy development and subvention, for some time economists have been arguing whether in fact this should be so.

Without wishing to stray too far from the central theme of this paper, the argument of neo-liberal and liberal economists is that the state should not intervene unless there is clear evidence of market failures (e.g. the failure to provide adequate information about opportunities in education and training). The justification for intervention accepted by the educational economists is if there is evidence that a 'public good' is an outcome of publicly supported provision (e.g. continuing training which leads to enhancement of the employability of the workforce).

The provision of open and distance learning and educational technology has been defined as a `public good' which deserves public intervention on the basis of three main reasons. Firstly, it has intrinsic characteristics that result in externalities, that is, there are social benefits the value of which is not effectively considered by market forces. Secondly, there are imperfections in the educational technology market and thirdly the `good' is not accessible by disadvantaged sections of society who could benefit from it.

It is interesting to note that given the recent decline of neo liberalism, or rather its decline in terms of policy influence, there has been increasing attention on the problems of social exclusion from access to information and communication technologies.

In terms of sustainability, state intervention is critical. However, I would challenge the basis of state and European policies, which, I believe, have been overly biased in favour of supporting publishers in developing educational content. I would favour a policy move towards further support for teachers and trainers, working in partnership with open source providers, to develop learning materials.

There is little doubt that Open Source challenges traditional economic models. Policy is confused in this respect. Whilst national governments are yet to make any firm policy pronouncement, a number of regions have taken strong initiatives in favour of Open Source, and, in some cases sought to support the development of a sustainable and indigenous open source software industry. However, there is some way to go before such a policy becomes the norm.

10 Recipes for sustainability

It is not my intention to provide a traditional academic conclusion or summary to this paper. I have reviewed major trends in e-learning and attempted to draw out their implications in terms of the sustainability of e-learning. Throughout the paper I have stressed the interaction between the development and implementation of technology, the organization of education and educational institutions and the role of teachers and trainers. The desire for sustainability can only be fulfilled through understanding and addressing each of these areas simultaneously.

In this final stage of the paper I will put forward a recipe or checklist for sustainability. It is not intended to be followed slavishly. Different sectors and different institutions will have diverse starting points and objectives. Technologies are evolving fast and what appears to be an appropriate response at one moment may appear outdated and unnecessary at a later point. What I do suggest is that each of the issues I put forward needs to be considered and decisions

taken. It is impossible to prescribe a policy for sustainability. What is possible however, is for institutions to make informed judgments and to review those decisions over time.

As a final point I would register a plea to not forget the learning part of e-learning. It is only too easy to get carried away with the technology. E-Learning is nothing more than a tool. It promises much but has yet to deliver on that promise.

There are two lists provided here. One is aimed at institutions, the other at policy makers and planners at regional, national and international level.

10.1 Institutional strategies for sustainability

Open source

Develop and adopt strategies of implementing open source software. There are very good open source programmes available for most applications in education and training. Open source not only offers major cost savings but can provide higher quality and reliability.

Of course institutions cannot change to open source overnight. Firstly, when new software is required open source applications should be considered first. Secondly, institutions should develop strategies to migrate from proprietary to open source software.

Larger institutions may consider forming partnerships or contracting to the many open source companies providing support and consultancy services.

Establish data repositories or contribute to collective repositories

Compelling and attractive materials are the key to e-learning. In terms of sustainability those resources will mainly be generated by teachers and trainers. Materials repositories sallow the sharing and reuse of resources. Critically, repositories can be independent of learning programmes and applications preventing lock-in to any one technology or platform.

Larger institutions should consider establishing their own materials repository or a distributed repository across the institution. Smaller schools may consider the technology too advanced and demanding of resources and should consider partnerships and networks to contribute to a shared repository. In all cases it is important that as far as possible repositories are open and do not impose proprietary standards.

Look at what free resources are available

There are many free resources available on the web and collections and repositories of free learning resources are growing fast. The biggest barrier to using these free materials may be the lack of awareness of teachers that they exist and the lack of skills and knowledge ion how to search for free materials. Searching for and using free materials should be an integral part of any training for teachers and trainers in e-learning.

Encourage staff to share resources

Teachers and trainers have the skills to produce learning resources and materials. What is commonly lacking is a culture of sharing those materials. This requires an organisation culture change and a redefinition of occupational profiles. The creation of materials should become an accepted part of teachers and trainers every day work. This does not mean merely adding an extra burden of work; institutions should review their policies to include materials development as part of the everyday activities of their staff.

At the same time teachers and trainers should be encouraged to share materials through institutional and shared repositories.

Establish licence agreements

Sharing learning resources requires culture change and it is important that the effort and contribution of materials creators is recognised and their rights protected. Licensing is not an esoteric exercise or something to be left to legal departments or senor managers. Institutions should promote and encourage the use of licences with 'some rights reserved. Adopting and promoting the Creative Commons Licence is a positive step in tis directions although it is still based on US law.

Think carefully about alternatives to Virtual Learning Environments

Think as to whether you need a full-blown Virtual Learning Environment. Even the many excellent Open Source VLEs can be time consuming and difficult to install, configure and maintain. If learning materials are accessed through standards based open repositories there are many different ICT based options in how they are delivered and used in a pedagogic context. It may be possible to use different learning applications dependent of learner needs

Develop a framework for professional development

Staff development and training is central to successful and sustainable e-learning. However, all too often, such training is instrumentally focused on the technology of e-learning. As such it fails to allow teachers an appreciation of the role of pedagogy and does not develop the broader skills needed to implement ICT as part of the curriculum and pedagogy in the longer term. Institutions should develop framework for prfessional development in which the skills and knowledge to develop e-learning plays an integral part of everyday practice.

Develop and review strategies

Institutions, whatever size and sector, should develop and review strategies for implementing e-learning. Sustainability should be a key goal of those strategies and as a starting point I would suggest they consider the issues raised in this section of the paper! Strategies should start from the needs of the learners and the institutions' role in meeting those needs, and not form the availability of technology.

Institutions have to develop communications and feedback mechanisms to ensure that strategies are understood by every member of the organisation. Strategies should be evaluated and reviewed on a regular basis and updated in reflection of the fast changing context on which e-learning is developing.

Look at total resources – integrate services

Many different people on institutions have a role to play in e-learning and these roles are changing fast. Institutions should look at the total; services they deliver and at the roles of the people who deliver them. As an obvious example, librarians play a central role in cataloguing ands supplying resources. A sustainable strategy should consider how different services can be integrated or can interoperate at a technical, pedagogic and human level.

Consider metadata and standards issues

The provision and use of metadata and conformance to standards are key strategic issues for the sustainability of e-learning. Having said this it may not be appropriate or possible for every institution to move to fully standards compliant e-learning practices in the immediate future.

If institutions do decide to become standards compliant the Learning Design Standard may be seen as more appropriate for education than SCORM.

Take pedagogies seriously

Institutions must take pedagogy seriously. This seems obvious but all too often it is forgotten in the fervour of technological advance and implementation.

We are still in the course of a steep learning curve when it comes to using ICT for learning. Institutions should look carefully at what pools of innovation exist in e-learning practice and should seek to promote exemplary practice throughout the organisation.

e-Learning should be seen as part of the total pedagogic approach of the organisation, rather than as an add on or alternative to traditional teaching and learning practices.

Integrate ICT within the whole curriculum

Institutions should adopt a whole-curriculum approach to e-learning. Rather than see e-learning as a separate activity, appropriate only to individual target groups or courses, they should look at how e-learning can be used to enhance present learning provision.

This does not mean all courses should be delivered through e-learning. it means an understanding that there are many different e-learning applications which could be integrated in the organisations s part of a learning and teaching strategy, including for example, access to resources, the use of games or the provision of portfolios for students following traditional learning programmes

Use project funding wisely

Project funding is important in allowing opportunities for innovation and experimentation. Unfortunately, many projects falter or cease when project funding runs out. Institutions need to consider how project funding can be used as part of developing an overall institutional strategy for e-learning. this does not mean projects should not be undertaken if they do not match precisely with the institutional strategy. But, organisations do need to consider what the potential benefits, products and outcomes of a project might be and how they can be further developed. Institutions also need to think how project findings can be disseminated internally and the results mainstreamed within organisational practice.

Seek funding opportunities

Institutions should encourage staff to actively seek funding opportunities. Whilst sometimes grants may be available for hardware or infrastructure development, more important is the opportunity for experimenting and innovation. Project work and innovation should be seen as part of the mainstream life of the organisation and participation in this work should play a major part of the professional development plan.

Develop partnerships and networks

Institutions should actively seek to develop partnerships and networks for e-learning. These partnerships and networks may take many different forms, dependent on need and include the sharing of resources and resource development and the delivery of courses and programmes.

The effective use of collaboration and groupware environments can enhance the operation of such partnerships.

Institutions should also consider forming partnerships with software companies and materials developers which go beyond customer/supplier relationships to iteratively and actively co-develop e-learning applications.

Share practice throughout organisation

There are pools of experience, expertise and innovative practice in e-learning within most institutions. The issue is how best to exploit and use such resources. Institutions should review the resources and expertise available to them and develop strategies to disseminate and utilise innovative practice throughout the organisations.

Make sure sufficient support is available

The development of sustainable and innovative e-learning practice requires support. In particular, teachers need support in using ICT for teaching and learning and in developing e-learning materials.

Evaluate e-learning practice

We are still at a stage of experimentation in e-learning. It is important that institutions know what works and what does not. This means developing a rigorous evaluation strategy which not only focuses on the technology but on learning.

Formative evaluation should be an integral part of all plans and projects for e-learning with the results of the evaluation informing further development and the review of strategic plans and future directions.

11 References

Admiraal W., forthcoming, A survey of the use of ICT for learning in SMEs in Europe, www.sme-learning.org

Attwell and Brown, 1998, Cross Cutting Themes in the Education of VET Professionals, paper presented at the European Conference for Educational Research, Laihti

Attwell and Hughes (2004), (forthcoming), A tool for evaluating e-learning policy, www.evlauate-europe.org

Attwell and Hughes, 2000, Researching education and training: Notes on cultural approaches, in Figueira E.(ed)Vocational Education and training; culture, Vlaues and Meanings, INOFOR, Lisbon

Attwell and Hughes, 2002, A Framework for the Evaluation of E-Learning, paper presented at the European Conference on Educational research, Lisbon

Attwell, 2001, Developing policies for the training of teachers and trainers: Europe at the crossroads, paper presented at Journal of Vocational Education and Training conference, Telford 16.-18.7.2001

Attwell, 2004, How can ICT support learning leading to knowledge development?, http://www.know-2.org/index.cfm, accessed September 1, 2004

Attwell, Dirckinck-Homfeld L, Fabian P, Karpati A and Littig P, (2003) E-learning in Europe – Results and Recommendations, BIBB, Bonn

Aus- und Weiterbildung im Bekleidungsgewerbe, www.na-bibb.de/downloads/veroeffentlichungen/pilot7.pdf, accessed 25 July, 2004

Bailey B. and Currier S., (2003, What is ADL Scorm), cetis, http//:www.cetis.ac.uk

Batson, 2002, The Electronic Portfolio Boom: What's it All About? http://www.syllabus.com/article.asp?id=6984, accessed 25 July, 2002

Baumgartner, Peter; Hartmut Häfele, Kornelia Maier-Häfele (2002): Ergebnisse eines weltweiten Vergleichs von Lernmanagement-Systemen (LMS), http://www.elearning-expo.de/head_navi/fachwissen/downloads/Learntec2002Baumgartner.doc, accessed 25 July 2002

Bill Pelz (2004), (MY) THREE PRINCIPLES OF EFFECTIVE ONLINE PEDAGOGYin Journal of Asysnchronous Learning Newtorks, Volume 8, Issue 3 - June 2004, http://www.sloan-c.org/publications/jaln/v8n3/v8n3_pelz.asp, accessed 25 July 2004

Blandin, 2003, Localization of software and learning material for SMEs: *how is it possible?* http://www.theknownet.com/ict_smes_seminars/papers/Blandin.html, accessed 25 July 2004

BROWN, A (1997a) *Valuing the development of practice, expertise and research int continuing professional development of vocational education and training professionals,* paper presented at European Conference on Educational Research (ECER 97) Frankfurt, September 1997

Brussels, 28.5.2002 COM(2002) 263 final, europa.eu.int/information_society/eeurope/ehealth/conference/2003/doc/min_dec_22_may_03.pd, accessed 25 Jely, 2004

Cedefop, (2003), Perspectives for European e-learning businesses, markets, technologies and strategies, Hasebrook J, Herrmann W and Rudolph D, Luxmbourg, Office for Official Publications of the European Communities

Cedefop, (2003), The challenge of e-learning in small enterprises: Issues of policy and practice in Europe Attwell G, Luxembourg, Office for Official Publications of the European Communities

Cedefop, 2001, Curruclum Development Guidelines, New ICT curricula for the 21st century: designing tomorrow's education, Luxembourg

Connexions (2004), Ways of Collaborating in Connexions, http://cnx.rice.edu/help/reference/collaboration, accessed 25 July, 2004

Creative Commons (2004), http://www.creativecommons.rg, accessed 1 September 2004

D'Angelis, 2003, The use of ICT for learning in SMEs in Itlay in Cedefop, (2003), The challenge of e-learning in small enterprises: Issues of policy and practice in Europe, Attwell G, Luxembourg, Office for Official Publications of the European Communities

Deitmer and Wenzel, 2000, COATLearn - Neue Lernstrategien fuer die berufliche Aus- und Weiterbildung im Bekleidungsgewerbe, http://www.na-bibb.de/downloads/veroeffentlichungen/pilot7.pdf+COATLearn+-+Neue+Lernstrategien+fuer+die+berufliche&hl=en&ie=UTF-8, accessed 2 September, 2004

Dichanz,H , Ernst A (2002) eLearning – begriffliche, psychologische und didaktiktische Uberlengungen, in Scheffer, U and Hesse F.W. (eds) eLearning – Die Reolution des Lernens gewinnbringend einsetzen, Klett0Cotta, Stuttgart

Dondi (1997), Policy Delphi on Priority Needs for Research, Study and Experimentation in European Education & Training" realizzato da SCIENTER per la DG Educazione, Direzione Generale della Commissione Europea Educazione, Formazione e Gioventù

Downes S. (2004a), Do you really need an LMS, http://www.downes.ca/cgi-bin/website/research.cgi?item=1092664923, accessed 1 September 2004

Downes S. (2004b), Corn Hill Nursery, in OL Dialy, 12 July 2004, http://www.downes.ca/archive/04/07_12_news_OLDaily.htm, accessed September 1, 2004

Downes S. (2002), Design Principles for a Distributed Learning Object Repository Network, http://www.downes.ca/cgi-bin/website/view.cgi?dbs=Article&key=1034188482, accessed 1 September, 2004

Downes S. (2003), Resource Profiles. http://www.downes.ca/files/resource_profiles.htm, accessed 1 September, 2004

Downes S, 2004, From Classrooms to Learning Environments: A Midrange Projection of E-Learning Technologies, http://www.downes.ca/cgi-bin/website/view.cgi?dbs=Article&key=1086898598&format=full, accessed July 25, 2004

Dubois J (2002) Commissioned paper on the role of distance Learning in vocation education, Synergy Plus, http://www.itcnetwork.org/DuboisVocEdFeb2002.pdf, accessed 25 July 2004

ECDL, 2004, www.ecdl.com, accessed 25 July, 2004

ELLSTRÖM, P E (1997*) The many meanings of occupational competence and qualifications*, In Brown, A (ed.) Promoting *Vocational Education and Training: European Perspectives,* University of Tampere Press, Tampere

Emerald (2004), http://www.emerald2.net/emerald/index.htm

ENGESTRÖM, Y (1995) *Training for Change*, ILO, London

Epicc, 2004, European Portfolio Initiatives Co-ordination Committee, http://www.eun.org/eun.org2/eun/en/About_eschoolnet/content.cfm?ov=33518&lang=en, accessed 25 July, 2004

ERAUT, M. (1994) *Developing professional knowledge and competence,* Falmer, London,

European Commission Directorate-General for Education and Culture, 2002, Open invitation to tender No DG EAC 21/02 for the provision of services concerning the carrying out of studies in the context of the e-learning initiative

European Commission, *e*Europe 2005: An information society for all,

European Journal VOCATIONAL TRAINING, No 27 September - December 2002/III

Eurydice (2002), Key Competencies, Brussels, www.mszs.si/eurydice/pub/eurydice/survey_5_en.pd, accessed 25 July 2004

Farmer J. (2004), Do you*really* need an LMS, http://radio.weblogs.com/0120501/2004/08/16.html#a780, accessed 1 September 2004

Federal Ministry for Education and Research (2003) the German advanced IT Training system, Bonn, w ww.bmbf.de/pub/the_german_ advanced_it_training_system.pdf, accessed 25 July 2004

Fischer M (1998) Work process knowledge and its impact on vocational education and training. In Mulder, Martin (ed.). European vocational education and training research. Proceedings of the VETNET program at the ECER conference in Ljubljana, Slovenia, on 17-20 September 1998, pp. 175-184.

Friesen, N. (2004). Three Objections to Learning Objects. In McGreal, R. (Ed.). Online Education Using Learning Objects. London: Routledge/Falmer. http://phenom.educ.ualberta.ca/~nfriesen/, accessed July 25,2004

Griffiths D and Garcia R., (2003) Combining Re-usable Learning resources to Pedagogical Purposeful Units of Learning, in Littlejohn A. and Buckingham Shum S. (eds.) Reusing Online Resources (Special Issue), Journal of Interactive Media in Education, www-jime.open.ac.uk/2003/1/, accessed 26 August, 2004

Griffiths D (2004), Three metaphors inhibiting progress in Free / Open Source Educational Software (FOSS), presentation at SIGOSSEE seminar, University of Limerick, 2 June, 2004, www.ossite.org, accessed 26 July 2004

Griffiths D and Amatriain, X. (forthcoming), Free Software in Education: Is it a Viable Alternative? To be presented at IMAC Conference, Duisburg, September, 2004

Halse G. A. and Terzoli A (undated, Open Source in South African Schools: Two Case Studies, www.highwayafrica.ru.ac.za/archive/2002/papers.html, accessed September 1, 2004

HAMMOND, M and COLLINS, R (1991) *Self-directed learning: critical practice*, London, Kogan Page

Heinemann L., (forthcoming), I Curriculum: German Case Studies, http://prometheus.iacm,forth.gr/i-curriculum/outputs.html

ICT Skills Gap Workshop Discussion Paper, paper reporting on outcomes of workshop at the European eLearning Summit, Brussels 10 –11 May 2001

IMS, 2002, IMS Question & Test Interoperability :An Overview, http://www.imsglobal.org/question/qtiv1p2/imsqti_oviewv1p2.html, accessed July 25, 2004

International Information and Communication Technologies (ICT) Literacy Panel. (2002). *Digital transformation: A framework for ICT Literacy*. Princeton, NJ: Educational Testing Services (ETS). Retrieved April 11, 2003, from http://www.ets.org/research/ictliteracy/ictreport.pdf, accessed 25 July, 2004

JISC, (2004) The e-learning Framework Summary, http://www.jisc.ac.uk/index.cfm?name=elearning_framework, accessed 1 September, 2004

JORUM, 2004, http://www.jorum.ac.uk/general/background.html, accessed 1 september, 2004

Kirkpatrick D (1975); Techniques for Evaluating Training Programmes Alexandria VA ASTD

Kirkpatrick, D.L. (1994). *Evaluating Training Programs: The Four Levels.* San Francisco, CA: Berrett-Koehler

Koper, E.J.R. (2003). Combining re-usable learning resources and services to pedagogical purposeful units of learning. In A. Littlejohn (Ed.), Reusing Online Resources: A Sustainable Approach to eLearning (pp. 46-59). London: Kogan Page.

Laurillard and MacAndrew (2003), A converstaional Framework for Learning, in Littlejohn A. and Buckingham Shum S. (eds.) Reusing Online Resources (Special Issue), Journal of Interactive Media in Education, www-jime.open.ac.uk/2003/1/, accessed 26 August, 2004

Lave, J. (1991) Situated learning in communities of practice. In L. Resnick, J. Levine and S. Behrend (eds) Perspectives on socially shared cognition, Washington DC : American Psychological Association.

Leach J. (2004), Researching the issues, http://www.open.ac.uk/deep/about/about.html, accessed 1 September, 2004

Learning Design, 2004, http://www.imsglobal.org/learningdesign/ldv1p0/imsld_bestv1p0.html#1501762, accessed 1 September, 2004

Liber O and Olivier B. (2003), Learning Technology Interoperability Standards, in Littlejohn A. and Buckingham Shum S. (eds.) Reusing Online Resources (Special Issue), Journal of Interactive Media in Education, www-jime.open.ac.uk/2003/1/, accessed 26 August, 2004

Littlejohn A. and Buckingham Shum S. (eds.) (2003) Reusing Online Resources (Special Issue), Journal of Interactive Media in Education, www-jime.open.ac.uk/2003/1/, accessed 26 August, 2004

Lennartz, D. (1997). Neue Strukturmodelle für berufliches Aus- und Weiterbilden. In: Berufsbildung in Wissenschaft und Praxis 26, 6, p. 13-19

Mario Barajas, Friedrich Scheuermann, Teresa Aguado, Beatriz Alvarez, Katerina Kikis, Martín Owen, Virtual Learning: Implementation Practices in Traditional Learning Settings, http://www.jurpc.de/aufsatz/20020360.htm, accessed 25 July, 2004

Massey J and Alphametrics, (2002), The European e-learning Market Report, ,, Reading, Biz Media

MacLeod D (2004), E-university set to be dismantled, Guardian, Tuesday April 27, 2004, http://education.guardian.co.uk/higher/news/story/0,,1204497,00.html, accessed 1 September, 2004

McLean, 2004, Repository Management and Implementation, E-Learning Interoperability Seminar, August 17, 2004

MESO (1998), Final Report, http://www.meso.odl.org/newsboard/reports/content.html, accessed 25 July, 2004

Miksite (2004), http://www.miksike.com/

MIT (2004), http://ocw.mit.edu/index.html

Middleton C, 2004, E-learning and learner styles: Report for the Eval 3 project, accessed 26 July 2004

Morrison D. (2004), Learning material Repositories – Rafts or Battleships, http://www.bath.ac.uk/dacs/cdntl/pMachine/morriblog_more.php?id=292_0_4_0_M, accessed 1 September, 2004

Nevgri A (2002), Dropping the e and keeping on learning, Keynote speech, Leonardo da Vinci Confernce, Dipoli 8-10 Septemeber 2002, www.leonardodavinci.fi/elearning/summary/nevgi.pd, accessed July 25, 2004

NGRF, 2004, http://www.guidance-research.org, accessed 1 September 2004

Nyhan, B et al. Facing up to the learning organisation challenge. Vol. I. Thessaloniki, CEDEFOP, 2003

Oehlert, M. (2002) Discussion post for a thread in response to an article by Welsch, E. SCORM: Clarity or Calamity. Available from: http://instructionaltechnology.editthispage.com/discuss/msgReader$3094?y=2003&m=12&d=2

Ramsden P, (1988), Improving Learning: New Perspectives, London

Rehak and Mason, (2003) Keeping the Learning in Learning Objects, in Littlejohn A. and Buckingham Shum S. (eds.) Reusing Online Resources (Special Issue), Journal of Interactive Media in Education, www-jime.open.ac.uk/2003/1/, accessed 26 August, 2004

Rehak, Dan. 2002. SCORM is not for everyone. CETIS.

http://www.cetis.ac.uk/content/20021002000737/index_html, accesed 1 September, 2004

SCHÖN, D (1983) *The reflective practitioner*, Basic Books, New York.

SCHÖN, D (1987) *Educating the reflective practitioner*, Jossey Bass, London.

Scrivens M; Evaluation Core Courses; http://eval.cgu.edu

Seely Brown J,(1999) "Learning, Working & Playing in the Digital Age: Creating Learning Ecologies." Transcription of a talk by Brown at the 1999 Conference on Higher Education of the American Association for Higher Education. http://serendip.brynmawr.edu/sci_edu/seelybrown/, accessed 25 July, 2004

Sinko M, (1998) ICT in Finnish higher education: impact on lifelong learning, LLine

Smith, Donna M., and David A. Kolb. 1986. *The User's Guide for the Learning-Style Inventory: A Manual for Teachers and Trainers*. McBer & Company. Boston, MA.

Tannenbaum D, 2003, OSS Watch Scoping Study, JISC, http://www.oss-watch.ac.uk/studies/scoping/, accessed 25 July 2004

UK ICT Skills Survey (NOP, 2001

Ulicsak and Owen, 2003, An Overview of current ICT teaching, Unpublished report by the Socrates I-Curriculum project

UNESCO, World Declaration on Education for Asll: Meeting Basic Learning needs, http://www.unesco.org/education/efa/ed_for_all/background/jomtien_declaration.shtml, accessed 25 Jely 2004

University of Calgary, What is e-learning, www.ucalgray.ca/cted/elearn, accessed July 25, 2004

Vuorikari R. (2004), Insight Special Report: Why Europe Needs Free and Open Source Software and Content in Schools,, http://www.eun.org/insight-pdf/special_reports/Why_Europe_needs_foss_Insight_2004.pdf, accessed 1 September 2004

Wang, Po-Ching. 1996. *Gardner's Multiple Intelligences.* Penn State Educational Systems Design Home Page: Penn State University. http://www.ed.psu.edu/dept/ae-insys-wfed/INSYS/ESD/Key/Keyschoo/key1.htm, accessed 25 July 2004

Wiley D. (ed.) 2000. *The Instructional Use of Learning Objects.* Bloomington, in: AECT. http://reusability.org/read, accessed 1 September 2004