A REVIEW OF THE TECHNOLOGIES APPLICATION PROGRAMME – PERSPECTIVES ON TEACHING AND LEARNING

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Abstract

This paper reports on a review of the UK Joint Information Systems Committee (JISC) funded Technologies Applications Programme (JTAP) and in particular focuses on outcomes of relevance for learning and teaching. The review concentrated on 26 of the 117 projects which the programme funded that were deemed to be of particular relevance to learning and teaching. The projects included investigations into the development of virtual laboratories and associated resources, exploration of innovative applications of cutting edge technologies, new forms of Virtual Learning Environments, development of authoring tools to support learning, teaching and assessment, as well as projects which investigated a host of associated issues such as staff development needs and infrastructural and standards issues. Some of the projects produced tangible 'products' which are still in use within the community, one or two have even been commercialised. However the intangible effects of the programme are equally important. There are three key benefits. Firstly the projects helped to raise the profile of learning and teaching within institutions. Secondly, there is now a body of expertise in the development and integration of technologies to support learning and teaching. Thirdly, projects have often acted as catalyst for enabling institutions to secure external funding for related research and development activities, or matched funding within the institutions in terms of embedding the project work and alignment with institutional strategic priorities.

Keywords

Joint Information Systems Committee, Technology Applications Programme

Background

Within the Higher Education (HE) sector there is a widespread belief that e-learning is an essential requirement for the long-term success of HE and its associated organisations and professional bodies. However, the exact nature of e-learning and how much individual organisations should become involved in this is unclear. Programmes like the HEFCE-funded Teaching and Learning Technology Programme (TLTP) and the JISC-funded e-lib and Joint Technology Application Programme (JTAP) are, in part, an attempt to explore these issues, as well as providing a mechanism for developing innovative technical applications and building a critical mass of resources and tools to support learning and teaching. However, whilst the programmes themselves produce a range of direct and indirect products and benefits, there has been no attempt to take an overview of these types of programmes, specifically in terms of the macro benefits and issues for learning and teaching. The TechLearn service of the JISC-funded Technologies Centre, commissioned this report into a review of the JISC JTAP projects and in particular

their relevance for learning and teaching. It reports on the review of the projects and in particular an analysis of any results arising from these projects which are of relevance to learning and teaching.

Over the last decade the use of Information and Communications Technologies (ICT) to support learning and teaching has increased dramatically. The JISC JTAP programme provides a valuable snapshot of experimentations and innovations in the use of ICT to support learning and associated issues. The JISC JTAP programme ran from 1995 to 2000. The overall aim of the programme was to "identify, investigate and promote the timely use of key technologies that underpin applications of relevance to the needs of the higher education community and in particular those identified by the JISC strategy". This covers all areas of HE work including teaching, research and administration. A total of £8 million was allocated to 117 projects. Further details of the full range and scope of the projects is available from the project web site (JTAP, 2000). The range of projects covers a wide variety of different technologies (video conferencing through networking and infrastructural issues and Virtual Learning Environments) as well as associated 'softer' issues such as impact on organisational change and associated staff development needs. The projects in the JISC JTAP programme explore and report on the following areas:

- Experimentation and reporting on novel uses of ICT
- Review of technologies
- Evaluation of the use of ICT in teaching and learning
- Development of resources and tools
- Exploration of associated issues

Scope of the programme

A series of briefing papers outline the scope of the programme which can be divided into five main themes: virtual reality (VR), video conferencing, standards for networking, visualisation and multimedia, and environments for learning.

The briefing paper on VR discusses common misconceptions. It includes reference to Lombard and Ditton's definition of presence, in terms of the feeling of 'being there' or 'visiting a place'. They identified six aspects of presence: social richness, realism, transportation, immersion, social actor within medium and medium as social actor (Lombard & Ditton, 1997). In terms of virtual laboratories, Stimson has defined seven categories: hypermedia databases, simulations, tutorial simulations, virtual reality labs, discursive learning labs, remote laboratory without manipulation and remote laboratory with manipulation (Stimson & Tompsett, 1997). Surprisingly, six years on from the beginning of the JTAP programme, there is still little significant use of Virtual Reality systems. This is primarily because of the very high cost of developing Virtual Reality systems for education in what is seen as a limited market, together with the reluctance of institutions to invest in the equipment when the software is not available. It may also in part be due to a number of technical barriers for implementing these systems, which are still primarily based on proprietary software. However, the expected revolution of learning as a result of a significant rise in the use of Virtual Reality and the transfer of gaming technology to learning have not yet taken place. Additionally, this may be a consequence of a lack of understanding of what forms of learning these technologies can best support. However recent related research on children's use of technology in the home, reveals that children are utilising the skills they develop through playing with computer games to other forms of computer learning and importantly that this transfer is leading to more authentic, engaging and interactive learning (Sutherland, Facer, Furlong, & Furlong, 2000). More research and development is needed to explore the different properties of Virtual Reality systems and to develop pedagogical models for effective ways in which they can support authentic learning.

The briefing paper on video conferencing outlines the perceived potential for learning and teaching and also the key pedagogical and technical challenges. It includes references to practical and case study-based guidelines on the use of videoconferencing. Most institutions now have one or more central videoconferencing systems in place. These are most commonly used for administrative and research meetings, but as with one case study described in the JTAP programme they are also used in institutions with multiple sites or where programmes are delivered across more than one institution. Scotland has been at the forefront of much of these developments and an important example of the use of

videoconferencing for staff development is the SESDL videoconferencing seminar series, where institutions across Scotland link into monthly videoconference seminars and lectures (SESDL, 2002).

The next briefing paper articulates the need for and importance of standards. It defines the notion of an educational object as anything ranging from text, lecture notes, a video clip through to Virtual Reality simulations. The standards that underpin the use of networks to deliver educational content include: transport protocols, text, images, sound and moving images, 3-D environments, metadata, and rights management. The paper reports that in some areas standards are relatively mature, others are still being contested. Much of the development of specifications and standards is being orchestrated internationally through the IEEE (www.ieee.org). More locally two key contact points are the Centre for Educational Technology Interoperability Standards (CETIS) centre (www.cetis.ac.uk) and the recently established JISC QA Focus post (http://www.ukoln.ac.uk/qa-focus/).

The briefing paper on Visualisation and multimedia explores the increase in the use of images and different visual representations of data which are possible because of the rapid growth of multimedia and visualisation technologies. The briefing paper suggests that there are a number of trends emerging. Firstly, traditional disciplines are using the technologies to create remote classrooms and laboratories. Secondly, library and archive services are finding new ways of storing, indexing and making material available. The report suggests that the ability to create, collect, store and retrieve images and multimedia objects of all types will be central to the successful exploitation of ICT in the future. Since then there has been significant work in the development of visual databases and associated standards through a range of JISC initiatives.

The final paper considers the emergence of research and development activities on Virtual and Managed Learning Environments and in particular asks; what kinds of V/MLEs should we build? What technologies will be needed? It also outlines associated issues such as interoperability and cultural and organisational factors. Much of this work has now been moved on through the subsequent JISC MLE-focused programmes and the more up to date MLE web site (http://www.jisc.ac.uk/mle/).

The wider context: drivers and initiatives

This section outlines the wider context within which these projects were taking place and in particular outlines some of the key drivers and initiatives which were referenced by the projects and which had an influenced on the focus of the JISC JTAP programmes. National strategy and policy for the Higher Education sector and, in particular, the role of Information and Communication Technology (ICT) to support learning and research, sit within a context of rapid technological change (Conole, 2001). This provides immense opportunities, whilst at the same time making firm commitment to specific systems or developments very difficult. Over the past decade, there is evidence that this area is maturing; it is becoming integrated into the core business of institutions, and in particular is being considered as part of a wider, more generic learning and teaching debate. The Higher Education Funding Councils now require all HEIs to have in place a clear and demonstrable learning and teaching strategy as a condition of funding, closely related to this are institutional Information Strategies and more recently Human Resource Strategies. Taken together, these strategies are an attempt to ensure the use of ICT is appropriately embedded into the institution.

The above indicates that ICT is moving from being associated with peripheral innovations and developments to underpinning and affecting all aspects of learning and teaching within institutions. However, it is also clear that the "ICT-debate" should not be addressed in isolation, but needs to be considered across all institutional strategy and policy and also within the wider context, including relevant national strategic thinking and developments. The latter has a profound effect and influence on funding mechanisms and national initiatives and to what extent ICT features within the various funding themes. National drivers over the past decade, reflect some of the thinking above. There is evidence of an increased prominence of the importance of ICT in Funding Council and JISC calls for projects, but also in more research focused programmes through the EPSRC and ESRC. For example, the National Grid for Learning (NGfL) and the University for Industry (UfI) are major initiatives to increase the base-level ICT skills within the community and to provide a solid technological infrastructure for education from primary through to tertiary level. The shift towards embedding ICT is well illustrated by the Teaching and Learning Technology Programme (TLTP), where the last phase of funding for the programme clearly

shifted from development of materials to integration (HEFCE, 1997). Specifically, in terms of JISC calls, there has been a greater focus on developing 'joined-up' technologies and providing a solid technical infrastructure with a critical mass of materials through the development of a Distributed National Electronic Resource (DNER) and the MLE initiatives.

In addition to the opportunities and challenges that new technologies offer Higher Education, the sector is also susceptible to a number of other key factors, such as the impact of the Government's widening participation agenda (including lifelong learning) and the consequential expansion of student numbers, the collaborative opportunities and potential threats through increasingly globalisation, the impact of increased monitoring and quality assurance processes and the related increased drive towards professionalisation and accreditation of HE, the changing nature and expectations of the student population and the rise of the 'nintendo generation' of computer literate students (Morice, 2000).
The most widely cited and perhaps influential report at the time the JTAP programme was running was the Dearing report, which was the culmination of the systematic review of Higher Education (NCIHE, 1997). The report included at least 15 recommendations which make explicit reference to ICT (referred to in the report as Communications and Information Technologies). Many of the projects quote Dearing and more specifically key recommendations from the report which focus on ICT. It is clear that these recommendations have had a significant influence on the focus and direction of the projects. Related reports and findings of relevance referenced by the projects include the parallel review of the FE sector (Kennedy, 1998), the Fryer report (NAGCELL, 1997), the Booth report (Booth, 1998), as well as associated government papers such as ''the learning age' green paper on lifelong learning (DfEE, 1998)

Project review

This section gives a summary of the findings from each project and an outline of the key emergent issues which are of relevance for learning and teaching. Table 1 lists the projects which are covered in the report. The projects will be of interest to three main stakeholders (academics, managers and support staff) and can be grouped into the following broad themes: Environments and tools for learning (ETL), Technologies – (eg Videoconferencing, smart cards, mobile computing), Virtual Reality (VR) and Visualisation and multimedia (VM).

Project title	Theme	Lead Institution	Reference
A guide on online teaching: existing tools and project		Oxford University	(Lee, Groves, Stephens, & Armitage, 1999)
Computer Assistance for Managing Collaborative Educational Processes	ETL	South Bank University	(Siviter, 1999)
COSE - Creation of Study Environment	ETL	Staffordshire University	(Styles, 1999)
Development of a High Level Authoring Shell for Online Interactive Tutorials and Assessment	ETL	University of Leicester	(CASTLE, 2002)
Networked Delivery of Undergraduate Tests	ETL	University of Bristol	http://www.tal.bris.ac.uk/
Toolkit for the Management of Learning	ETL	University of Wales, Bangor	http://toomol.bangor.ac.uk/
Virtual learning environments in the online delivery of staff development	ETL	Heriott Watt	http://www.icbl.hw.ac.uk/jtap-573/
Virtual Seminars for Teaching Literature	ETL	University of Oxford	http://info.ox.ac.uk/jtap/
WWW Corpora: World Wide Web Access to Linguistic Corpora	ETL	University of Essex	(Arnold, 1999)
Multimedia Conferencing for Distance Learning of Language	ETL	University of Exeter	(Stringer, 1998)
A smartcard accessible, web-based secure database for undergraduate clinical teaching	Technologies	University of Cambridge	http://www.cbcu.cam.ac.uk/cbcu/index.asp
Mobile Computing in a Fieldwork Environment	Technologies	University of Kent	http://www.cs.ukc.ac.uk/projects/mobicomp/Fieldwork/index.html
Multimedia Conferencing for	Technologies	University of Exeter	http://www.exeter.ac.uk/pallas/relate/

Distance Learning of Language			
Student portable computing	Technologies	Birmingham University	(Cabot, 1999)
Video conferencing and teaching and learning	Technologies	De Montfort University	(Lander & Burns, 1999)
A 3D Virtual Chemistry Laboratory	VR	Imperial College	http://www.ch.ic.ac.uk/vchemlab/
A Networked, Virtual Laboratory for Experimental Psychology	VR	University of Wales, Cardiff	http://cti-psy.york.ac.uk/vplabprototype2/search.htm
A visual MUD system on the WWW: Computer supported co-operative learning for part-time students on theoretical social science or humanities modules	VR	University of Huddersfield	http://comentor.hud.ac.uk/
Developing a Virtual Campus	VR	University of Lancaster	No web link
Networked Virtual Reality Resource Centres for Art & Design (NVRCADs)	VR	University of Coventry	http://nvrcad.coventry.ac.uk/
The VENUE Project: Virtual Environments for Urban Environments	VR	University College London	http://www.casa.ucl.ac.uk/newvenue/newvenue.htm
The Virtual Field Course	VR	University of Leicester	http://www.geog.le.ac.uk/vfc/
Virtual Laboratory Developers ToolKit (VLDTK)	VR	University of Edinburgh	http://www.hcrc.ed.ac.uk/Site/VLDTK.html
Virtual Medical Laboratory	VR	University College London	http://james.ilo.ucl.ac.uk/
Creating Art with layer Manufacture (CALM)	VM	University of Coventry	(Smith, 1998)
Effective, sustainable use of network-accessible data sets	VM	Manchester Metropolitan University	(http://lenny.mcc.ac.uk/kindsdb6/)
MultiVerse – Delivering Simulation-based Educational Resources on the Internet	VM	Heriot-Watt University	(McAndrew, 1999)

Table 1 JTAP projects included in the learning and teaching review

General observations and emergent themes

As outlined above the projects reviewed focused on particular technologies, applications of the technologies or associated organisational, cultural or infrastructural issues. However, it is evident that across the projects the following types of factors are being considered to different degrees:

- Software – in terms of development and application of new forms of software to support learning and teaching.
- Hardware - particularly investigation of peripheral devices and their use.
- Human resources – associated staff issues and needs.
- Staff and student skills – training and development requires and mechanism of delivery for both students and staff.
- Attitudes and perceptions – of different key stakeholders and issues of organisational change.
- Organisational issues – impact on infrastructure and the integration within existing practices.
- Strategy and policy – impact on and effects of relevant strategy and policy and the influence of national level agendas and drivers.

As might be expected the technical aspects of the reports have dated very quickly. In contrast the softer issues remain pertinent and a number of common themes emerge. The analysis also reviewed the projects against national and local drivers and changes. Many of the reports make explicit reference to the Dearing report and specifically the key ICT recommendations from the report. It is interesting to note five years after Dearing which of these recommendations are now in place. For example, the Institute for Learning and Teaching (ILT) has now been established. In terms of strategy there are three of significance in the

last five years. The first is the establishment of institutional Information Strategies (NB these are not the same as Information Technology Strategies). JISC was instrumental through its Information Strategy programme. Secondly, HEFCE now require that all institutions have in place learning and teaching strategies. Thirdly institutions have been required to develop human resource strategies. One of the most prominent features of the impact of ICT on teaching and learning is the way in which ICT has acted as a catalyst for opening the debate on learning and teaching issues more generally. Thirdly, the scale up in use of ICT across institutions has had a profound influence across the infrastructure, raising debates about institutional infrastructure, staff and student training needs, the integration of key strategies and future planning. This has now begun to mature as most institutions are now moving toward thinking of the development of institution-wide Managed Learning Environments.

A consistent issue across the projects is the issue of sustainability of project outputs after the programme has finished and where resources produced should be located. Some projects clearly suffered from inexperienced project teams and poor project management which is reflected in the ultimate success and final outputs of the projects. This has been a consistent issue with funding programmes of this nature and has been heavily criticised in previous summative evaluations (HEFCE, 1996). However this situation has changed in recent years due to the impact of two complementary factors. Firstly, funders have addressed the problems by improving central programme support through the provision of generic workshops, guidance and support, via the creation of networks across common projects and through the introduction of named funding support liaison staff. TLTP for example provided a comprehensive project management handbook and JISC through its 5/99 and 7/99 programmes has in place a variety of valuable support mechanisms. Secondly, the sector now has a developed network of expertise and 'project professionals' in the management of these kinds of programmes. In addition there has been a growth in research and development centres, where a number of initiatives of this kind co-locate and are then provided with a local support and infrastructure. Importantly these kinds of centres provide a degree of stability to projects and associated staff and enable the provision of staff development and sustainability beyond an individual project's lifespan. Examples of centres of this kind include the Institute for Learning and Research Technology (www.ilrt.bris.ac.uk), UKOLN (www.ukoln.ac.uk), and the Learning Technology Research Institute (LTRI) (www.unl.ac.uk/ltri).

Part of the role of programmes like JTAP is to explore and report on the range of technologies and their uses in learning and teaching. The issue of redundancy of information for example in terms of detailing particular technologies, raises a number of questions:

- what level of detail of technologies specifics should be reported on?
- how can redundancy due to pace of change be avoided, so that there are generic distilled knowledge which stands the test of time?

Most of the projects adopt a balanced view of both the perceived benefits and potential issues surrounding the exploitation and use of ICT for learning and teaching. Perceived benefits across the projects include the potential ICT has in terms of offering access to resources, enhancing skills, improving curriculum, raising standards, providing mechanisms for sharing practice; access to a range of online materials and advice; opportunities to link up isolated learners; access to authentic learning, for example use of native speakers in language learning; access to wide range of quality materials; opportunities to tailor materials to specific interests and abilities of the individual and overall a potential to make learning more attractive. To counter this many of the reports highlight associated issues, such as the need to develop robust underlying infrastructures to support these activities, staff and student training needs, associated cultural and organisation issues, integration with other learning and teaching processes, associated accessibility and legal issues, transparent human and technical costs. Some reports also warned against the over hyping of the potentials those technologies can afford and the fact that fictional vignettes which aim to give example scenarios of the potential opportunities are often too technology centred and date quickly. One report cites the following three rules for using technology in teaching:

1. Technology should not be used to replace teachers or teaching, it should be used as a supplement.
2. Technology should only be used where a noticeable gain in teaching quality is evident.
3. Technology should be applied in appropriate stages. Don't need to use every bit of technology.

There is an issue about what the purpose (current and future) of programmes like JTAP should be. In terms of the final reports for example, are they by nature time restricted? Is their function to provide a current snap shot of the use of technologies? Should the projects be attempting to draw out generic issues and make recommendations for the future? A number of success factors for effective use of ICT in learning and teaching emerge across the projects and these include the importance of adequate: support (academic, admin, technical) and training, appropriate and flexible equipment provision and space, managed delivery, a supportive and robust infrastructure of support.

The projects describe a large number of different uses for technology and illustrate the importance of ICT for new modes of collaboration and communication rather than just access to resources.
There are a number of indirect benefits arising from the JTAP projects, beyond the individual products and achievements. Firstly, the projects have often helped to raise the profile and level of debate about learning and teaching within institutions. Secondly, the experience of being involved with the programme has been a valuable form of staff development and helped generate a breadth of expertise across the sector (much of which has subsequently been utlilised in follow-on programmes). Thirdly, the success had often resulted in additional funding for related projects, from EPSRC, ESRC and the EU. A further breakdown and analysis of this is available in the JTAP summative report (ESYS, 2000).

Key learning points

This section will outline the key learning points which have arisen from each of the projects. Table 2 provides a summary overview which includes major findings which have arisen from each of the projects, issues, products, potential future work. The section then goes on to suggest ways in which the outcomes of the projects could be reworked or combined. The section will also suggest ways in which the work can be built on by JISC, the LTSNs, individual institutions and others to add value to the output of the programme. It will also suggest ways in which the JTAP programme links in to current (and potential) future initiatives in learning technologies and more generally in learning and teaching. Table 3 maps key outcomes and learning points for each of the projects, grouped under the following categories: Guidelines, Mapping, Tools, Implementation of pedagogies, Exploration of issues, Architectures and Case studies.

Project title	T	Key outcomes and learning points
A guide on online teaching: existing tools and projects	1	Guidelines for effective use of technologies Mapping of tools and their uses, benefits and limitations
Computer Assistance for Managing Collaborative Educational Processes	1	Mapping of communication, collaboration and coordination
COSE - Creation of Study Environment	1	COSE learning environment Explicit application of a pedagogical approach in the implementation of an environment Exploration of the issues around the development and use of learning environments
Development of a High Level Authoring Shell for Online Interactive Tutorials and Assessment	1	CASTLE – an authoring tool for creation of online assessments Exploration of the CAA issues Value of cheap or free systems to enable practitioners to trial
Networked Delivery of Undergraduate Tests	1	Database of multiple choice questions for Maths, Engineering and Chemistry Exploration of the development of generic resources for use across different subject domains Development of a taxonomy and architecture for Questionbanks Lessons learnt from the issues around the creation of distributed resources created across a community of peers
Toolkit for the Management of Learning	1	Development of a toolkit for managing aspects of the learning process Exploration of different functionalities and components of a managed learning environment Articulation of key theories – from learning and organisational theory within the specifications and architecture of the system developed Precursor to much of the current MLE work
Virtual learning environments in the online delivery of staff development	1	Comparison of VLEs and analysis of the different pedagogical approaches adopted Review of staff development on the effective use of technologies to support learning

	T	
		Guidance on key aspects of good online learning
Virtual Seminars for Teaching Literature	1	Case study in the use of virtual seminars in a subject specific domain
WWW Corpora: World Wide Web Access to Linguistic Corpora	1	Adaptation of research resource for learning and teaching Development of a web-based linguistic corpora
Multimedia Conferencing for Distance Learning of Language	1	Exploration of the use of synchronous learning tools to teach languages Identification of subject specific requirements in the use of technologies
A smartcard accessible, web-based secure database for undergraduate clinical teaching	2	Report on the use of smartcards and associated issues
Mobile Computing in a Fieldwork Environment	2	Exploration of the use of mobile technologies in the field Development of prototype systems Case study report on the use of the prototypes in the field
Student portable computing	2	Report on portable computing
Video conferencing and teaching and learning	2	Report on the issues associated with using video conferencing for learning and teaching
A 3D Virtual Chemistry Laboratory	3	Development of virtual tools to manipulate data and resources for use in laboratories Development of a 3D Virtual Chemistry lab
A Networked, Virtual Laboratory for Experimental Psychology	3	Investigation of the feasibility and benefits of virtual laboratories Development of a Psychology Virtual database of resource
A visual MUD system on the WWW: Computer supported co-operative learning for part-time students on theoretical social science or humanities modules	3	Experimentation with MUDs to support co-operative learning Development of the co-mentor system
Developing a Virtual Campus	3	Report on some of the issues of 3D presentation techniques
Networked Virtual Reality Resource Centres for Art & Design (NVRCADs)	3	Exploration of the use of 3D in Art and Design
The VENUE Project: Virtual Environments for Urban Environments	3	Demonstration of how GIS technology can be used in urban planning
The Virtual Field Course	3	A support resource for field courses
Virtual Laboratory Developers ToolKit (VLDTK)	3	A generic toolkit for creating virtual labs
Virtual Medical Laboratory	3	Experimentation with the use of devices for remote manipulation
Creating Art with layer Manufacture (CALM)	4	Transfer of technology and use across subject domains Workshops and artefacts created by the participants using the tolls
Effective, sustainable use of network-accessible data sets	4	A set of tools to discover, browse and visualise spatial data
MultiVerse – Delivering Simulation-based Educational Resources on the Internet	4	A authoring toolkit for developing simulations

Notes: **T** = **Themes:** *1. Environments and tools for learning, 2. Technologies, 3. Virtual reality, 4. Visualisation and multimedia*

Table 2 Key learning points arising from the JTAP projects

Key outcomes and learning points	Project title
Guidelines	
Guidelines for effective use of technologies	A guide on online teaching: existing tools and projects
Guidance on key aspects of good online learning	Virtual learning environments in the online delivery of staff development
Review of staff development on the effective use of technologies to support learning	Virtual learning environments in the online delivery of staff development
Case study in the use of virtual seminars in a subject specific domain	Virtual Seminars for Teaching Literature
Identification of subject specific requirements in the use of technologies	Multimedia Conferencing for Distance Learning of Language
Report on the issues associated with using video conferencing for learning and teaching	Video conferencing and teaching and learning
Mappings	

Mapping of tools and their uses, benefits and limitations	A guide on online teaching: existing tools and projects
Mapping of communication, collaboration and coordination	Computer Assistance for Managing Collaborative Educational Processes
Tools	
COSE learning environment	COSE - Creation of Study Environment
CASTLE – an authoring tool for creation of online assessments	Development of a High Level Authoring Shell for Online Interactive Tutorials and Assessment
Database of multiple choice questions for Maths, Engineering and Chemistry	Networked Delivery of Undergraduate Tests
Development of a toolkit for managing aspects of the learning process	Toolkit for the Management of Learning
Development of a web-based linguistic corpora	WWW Corpora: World Wide Web Access to Linguistic Corpora
Development of prototype systems	Mobile Computing in a Fieldwork Environment
Development of virtual tools to manipulate data and resources for use in laboratories	A 3D Virtual Chemistry Laboratory
Development of a 3D Virtual Chemistry lab	A 3D Virtual Chemistry Laboratory
Development of a Psychology Virtual database of resource	A Networked, Virtual Laboratory for Experimental Psychology
Development of the co-mentor system	A visual MUD system on the WWW: Computer supported co-operative learning for part-time students on theoretical social science or humanities modules
A support resource for field courses	The Virtual Field Course
A generic toolkit for creating virtual labs	Virtual Laboratory Developers ToolKit (VLDTK)
Experimentation with the use of devices for remote manipulation	Virtual Medical Laboratory
A set of tools to discover, browse and visualise spatial data	Effective, sustainable use of network-accessible data sets
A authoring toolkit for developing simulations	MultiVerse – Delivering Simulation-based Educational Resources on the Internet
Implementation of pedagogy	
Explicit application of a pedagogical approach in the implementation of an environment	COSE - Creation of Study Environment
Articulation of key theories – from learning and organisational theory within the specifications and architecture of the system developed	Toolkit for the Management of Learning
Exploration of issues	
Exploration of the issues around the development and use of learning environments	COSE - Creation of Study Environment
Exploration of the CAA issues	Development of a High Level Authoring Shell for Online Interactive Tutorials and Assessment
Exploration of the development of generic resources for use across different subject domains	Networked Delivery of Undergraduate Tests
Lessons learnt from the issues around the creation of distributed resources created across a community of peers	Networked Delivery of Undergraduate Tests
Exploration of different functionalities and components of a managed learning environment	Toolkit for the Management of Learning
Comparison of VLEs and analysis of the different pedagogical approaches adopted	Virtual learning environments in the online delivery of staff development
Exploration of the use of synchronous learning tools to teach languages	Multimedia Conferencing for Distance Learning of Language
Exploration of the use of mobile technologies in the field	Mobile Computing in a Fieldwork Environment
Report on portable computing	Student portable computing
Investigation of the feasibility and benefits of virtual laboratories	A Networked, Virtual Laboratory for Experimental Psychology
Experimentation with MUDs to support co-operative learning	A visual MUD system on the WWW: Computer supported co-operative learning for part-time students on theoretical social science or humanities modules
Exploration of the use of 3D in Art and Design	Networked Virtual Reality Resource Centres for Art & Design (NVRCADs)

Experimentation with the use of devices for remote manipulation	Virtual Medical Laboratory
Transfer of technology and use across subject domains	Creating Art with layer Manufacture (CALM)
Architecture	
Development of a taxonomy and architecture for Questionbanks	Networked Delivery of Undergraduate Tests
Precursor to much of the current MLE work	Toolkit for the Management of Learning
Case Study	
Case study in the use of virtual seminars in a subject specific domain	Virtual Seminars for Teaching Literature
Adaptation of research resource for learning and teaching	WWW Corpora: World Wide Web Access to Linguistic Corpora
Report on the use of smartcards and associated issues	A smartcard accessible, web-based secure database for undergraduate clinical teaching
Case study report on the use of the prototypes in the field	Mobile Computing in a Fieldwork Environment
Report on some of the issues of 3D presentation techniques	Developing a Virtual Campus
Demonstration of how GIS technology can be used in urban planning	The VENUE Project: Virtual Environments for Urban Environments
Workshops and artefacts created by the participants using the tolls	Creating Art with layer Manufacture (CALM)

Table 3

Conclusion

The conference presentation will highlight some of the key projects and their outcomes and list the series of learning points and recommendations for future research and development in this area. Across the projects there are a number of key aspects which emerge:

- The importance and relevance of good staff development, guidance and support for effective implementation of technologies to support learning.
- The importance of cultural differences across subject domains.
- Successful examples of the transfer of technology use across domains, often accompanied by a change in use of the technology.
- The potential for technologies to display data and represent concepts in a multitude of different ways.
- The emergence of a range of different forms and types of technologies There is little explicit educational underpinning for the majority of the projects reviewed.
- Where the pedagogical approach is made explicit there is evidence of excellent and innovative applications.

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