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# The evolving landscape of learning technology

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*This paper provides an overview of the current and emerging issues in learning technology research, concentrating on structural issues such as infrastructure, policy and organizational context. It updates the vision of technology outlined by Squires' (1999) concept of peripatetic electronic teachers (PETs) where Information and Communication Technologies (ICT) provide an enabling medium to allow teachers to act as freelance agents in a virtual world and reflects to what extent this vision has been realized. The paper begins with a survey of some of the key areas of ICT development and provides a contextualizing framework for the area in terms of external agendas and policy drivers. It then focuses upon learning technology developments which have occurred in the last five years in the UK and offers a number of alternative taxonomies to describe this. The paper concludes with a discussion of the issues which arise from this work.*

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## **Foreword**

This article is dedicated to David Squires and aims, along with the other articles in this issue, to celebrate David's research work and his substantial contribution to learning technology research. On a personal note, I knew David for a relatively short period of time but he had a significant influence on my own career; in particular he acted as a valuable sounding-board at a stage when I was making major career-changing decisions. He had a relaxed and easy-going approach, was always willing to work collaboratively with others and had a genuine enthusiasm for learning technology research. His support and friendship were much appreciated and he is very much missed.

## **Introduction**

In his paper 'Peripatetic electronic teachers in higher education', Squires explored the idea of Information and Communication Technologies (ICT) providing a medium to enable higher education teachers to act as virtual freelance agents (Squires, 1999). In this futuristic

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vision, peripatetic electronic teachers (PETs) existed as multiple telepresences (pedagogical, professional, managerial and commercial) in PET-worlds: global networked environments which supported advanced multimedia features. Squires opens by stating that most people agree that the role of teachers will change with the advent of ICT. The article explores the possibility that ICT could break exclusive links between educators and a single institution. Squires states:

Just as future learners may be seen as clients contracting to receive educational provision from a range of providers, educators may be seen as independent workers offering their services to learners on demand. These educators will not be confined to the classroom, rather they will be electronic workers providing a virtual presence in public spaces, the workplace and the home. A new type of peripatetic electronic teacher (PET) will emerge.

This article provides an overview of learning technologies and considers the extent to which this vision has been achieved.

A review of pedagogic developments in this area has already been undertaken (Thorpe, 2002), charting the shift from focusing on individuals to the social context of learning. Thorpe concentrated on the effects of changes in practice which have arisen as the use of ICT has become more widespread. She maps the changes to relevant pedagogical theories, in particular drawing on the notion of communities of practice (Lave and Wenger, 1990) and the shift from independent to collaborative learning. This article is complementary to Thorpe's review, concentrating on the following aspects:

- the impact of national and international policy agendas and drivers;
- an outline and categorization of key funded technological and related development programmes (focusing particularly on those in the UK);
- an overview of some of the resultant issues;
- a synthesis of key emergent themes.

## **Background**

Over the past decade a considerable wealth of digital resources and Information and Communication Technology (ICT) tools have been developed to support learning and teaching. These have been funded from a variety of sources such as the National Science Foundation (NSF) and the Sloane Foundation in the States, and the Joint Information Systems Committee (JISC) and the New Opportunities Fund (NOF) in the UK. These research and development programmes have allowed academics to experiment with the use of new technologies and integrate digital resources with more traditional teaching methods. This has raised a host of pedagogical and technical issues, such as:

- How effective are these new approaches?
- What are the underpinning technical, managerial and infrastructural requirements?
- What protocols and standards are needed to ensure interoperability?
- How do we deal with issues such as copyright and the rise in plagiarism?

This article aims to provide an overview of these activities and some of the emergent

themes and focuses primarily on higher education; Guile and Hayton have published a review of the impact of ICT in further education, summarizing key implications (Guile and Hayton, 1999).

A considerable body of research has been carried out on the development and use of learning technologies. The literature on the area has been expanding exponentially in the last five years, including the emergence of a range of specialized journals (such as *ALT-J*, *Education, Technology and Society*, the *Journal of Interactive Multimedia Education*, the *Asynchronous Learning Network Journal*, and more recently *Educational, Information and Communication*) and a series of notable summaries for the area (Bates, 1995; Hiltz, 1995; Mason, 1998; Collis and Moonen, 2001; Laurillard, 2001). In parallel specialized conferences have arisen (such as ALT-C, ASCILITE, EdMedia, ICALT, ICCE, Ideas in Cyberspace Education, and the Networked Learning conference, to name but a few). Finally there are a number of useful introductory guides to the area (Forsyth, 1996; Barnett, Brunne *et al.*, 1997; Seale and Rius-Riu, 2001).

There is a growing trend towards taking stock of what has been achieved. Squires *et al.* have collated a representative sample of articles published in *ALT-J* over the last decade (Squires, Conole *et al.*, 2000). Lockwood and Gooley have co-edited a collection of essays on successful developments in online and Web-based learning (Lockwood and Gooley, 2001). In addition several books have focused on networked learning, including two excellent overviews of its foundations and theoretical perspectives (McConnell, 2000; Steeples and Jones, 2002). There have been several recent reviews of the area. Williams reviewed the literature on learning online, concentrating on the problems involved in transferring courses online (Williams, Lock, Crisp and Longstaffe, 1995; Williams, 2000; Williams, 2002), whilst Bonk provides a survey of the use of ICT in teaching in the states (Bonk, 2001). An analysis and mapping of ICT developments to underpinning learning theories have been carried out independently by Ravenscroft and Thorpe (Ravenscroft, 2002; Thorpe, 2002).

Since no article could adequately cover the breadth and scope of this area, this article instead aims to provide a snapshot of recent and ongoing activities and provide some coherent categorization of these. It will begin by focusing on the context in which this work arises.

### **The wider context – drivers and initiatives**

National strategies and policies 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 is being considered as part of a wider, more generic learning and teaching debate.

As might be expected, the technical research aspects become dated very quickly. In contrast the organizational and pedagogical issues remain pertinent and a number of common themes emerge. One of the most influential policy reports, addressing many of these issues, was the Dearing report (NCIHE, 1997). This was the culmination of the systematic review of higher education, and included at least fifteen recommendations

which make explicit reference to ICT. These have significantly influenced the focus and direction of many ICT projects in the last five years, as was evident from a recent in-depth analysis of the teaching and learning projects of the JISC-funded JTAP programme (Conole, 2002). Similar effects have arisen from the FE sector (Kennedy, 1998); other notable reports include the Fryer report (NAGCELL, 1997), the Booth report (Booth, 1998), and associated papers on lifelong learning (DfEE, 1998).

The Dearing report has had a significant influence over the focus and direction of many of the funding programmes and initiatives. Several strategic factors have been of particular importance in the last five years. The first is that the Higher Education Funding Council for England (HEFCE) now requires all higher education institutions to have 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 (McNaught and Kennedy, 2000). Secondly, 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 (Littlejohn and Cameron, 1999). Furthermore, the scaling-up of ICT use has had a profound influence on the infrastructure of institutions, raising debates about staff and student training needs, the integration of strategies and future planning (the JISC has funded a range of projects which have addressed these issues and also explored the associated sociocultural issues, in particular see [www.jisc.ac.uk/mle](http://www.jisc.ac.uk/mle)). This has now begun to mature as most institutions move towards developing institution-wide managed learning environments.

The above indicates that ICT is moving from being associated with peripheral innovations and developments to affecting all aspects of learning and teaching, although currently this is probably more true at the strategic than at the operational level. It is clear that the 'ICT-debate' can no longer be addressed in isolation, but must be considered across all institutional and national strategies and policies. The latter point has profound implications on funding mechanisms and national initiatives.

Initiatives over the past decade reflect these trends. There has been an increased focus on ICT in HEFCE and JISC calls, but also in research-focused programmes through the EPSRC and ESRC. In addition, the National Grid for Learning (NGfL) and the University for Industry (Ufi) have sought to increase the base-level of ICT skills within the community and 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 their integration (HEFCE 1997). Within JISC calls, there has been a greater focus on 'joined-up' technologies and the provision of a solid technical infrastructure with a critical mass of materials through the development of an Information Environment (IE) of resources, tools and initiatives focusing on the development of managed learning environments.

Technological developments are not the only influence on higher education; the sector has also been changed by developments such as the government's widening participation agenda and the consequential expansion of student numbers, the collaborative

opportunities and potential threats of increasing globalization, the impact of increased monitoring and quality assurance processes, the increased drive towards professionalization and accreditation, the changing nature and expectations of the student population and the rise of the 'Nintendo generation' of computer-literate students (Morice, 2000).

## **Overview of current ICT developments**

This section provides a broad overview of areas of current interest in the UK. It is a synthesis of a number of recent research studies, reviews and evaluations (Bull, Conole *et al.*, 2002; Conole and Bull, 2002; Conole, Smith and Franklin, 2002).

### **Learning technology taxonomies**

Learning technology is an inherently multidisciplinary field involving researchers from a wide range of backgrounds (educational research, cognitive psychology, instructional design, computer science, and so on) as well as teaching subject-experts who engage with it as 'end users' or 'consumers'. This multi-disciplinarity is a common feature of emergent research areas, but makes the task of providing an overview of the key research activities difficult. This diversity also makes the task of creating a definitive taxonomy for learning technologies difficult. This section highlights some of the alternative classification systems that have been developed.

Beetham has suggested that ICT can be classified in three main ways: as a tool, as a resource, or as a medium for communication (Beetham, 2001). These can range from simple office tools through specialized databases and applications, to subject-specific tools (chemical molecule drawing packages or CAD software for engineers). Tools can be used to produce a range of digital resources ranging from simple documents through animated presentations to complex modelling tools. Finally ICT can be used as a communication mechanism (asynchronous and synchronous). Examples of the former include email and discussion boards where the interaction does not occur in real time. In contrast, examples of synchronous communication includes live chat groups and video conferencing. ICT tools can be combined in a variety of ways to meet specific purposes and functions, or for use within a specific context.

Alternatively, ICT can be classified by research and development activities (Conole 2002), using the following categories:

- the development and use of digital resources, tools and software;
- the development of supporting infrastructure, underpinning standards and protocols;
- research into related pedagogical and sociocultural issues (the use and uptake of ICT);
- the development of learning environments to support learning, teaching, research and administration.

Finally a taxonomy can be used which illustrates the breadth of the area spanning the development and use of specific technologies (such as video conferencing), underpinning technologies such as networking and infrastructural issues, holistic and integrative environments such as virtual learning environments (VLEs) and managed learning environments (MLEs), as well as associated 'softer' issues such as impact on organizational change and associated staff development needs (Conole, 2002). Classification then includes:

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- 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;
  - synthesis of key findings and production of good practice guidelines, support tools and toolkits, and templates;
  - methodological issues about the use and impact of evaluation;
  - critiques on the broader socio-cultural issues;
  - evaluation of the use of communication technologies;
  - evaluation of the use of virtual learning environments;
  - multimedia and adaptive interactive environments.

In terms of simplicity the remainder of this section will outline some key developments under the following broad categories which cut across each of the taxonomies described above. Some of the features described in the above lists have been omitted as they have already been covered by Thorpe (2002).

This paper focuses on:

- learning environments – focusing on VLEs and MLEs;
- digital libraries, gateways and portals;
- resources and tools for learning;
- underpinning architecture and standards development;
- associated research and impact (changing practice and professional identities; accessibility, IPR, copyright and plagiarism; organizational change; and strategic and policy issues).

### **Learning environments**

The development of robust technical infrastructures for institutions has become a major area of activity in the last five years. These learning environments include enclosed virtual learning environments (VLEs) as well as more encompassing managed learning environments (MLEs) which attempt to join up VLEs with institutional administrative systems.

VLEs are systems that integrate communication tools (email, discussion boards, and so on) with learning resources and assessment tools. There is a host of activities that VLEs are purported to support, such as, 'encouraging active learning', 'shifting from didactic to facilitative teaching' or 'building online communities' (Britain and Liber, 1999; Armitage, Brown *et al.*, 2001). The reality is more complex, involving the context within which these systems are used and how well they are adapted to specific student needs. Making a discussion board available on a course will not automatically create a motivated virtual

community of collaborating students with a benevolent smiling ‘tutor on the side’. Therefore although VLEs can be used to significant effect for the delivery of materials, for supporting learning and as a management tool, this is not an inherent property of the technologies themselves.

VLEs have three main applications: (i) to support learning and teaching, (ii) as an administrative tool, and (iii) for storing information. VLEs can be used to support learning and teaching; through discussion boards to encourage debate, by extending face-to-face contact, through pre- and post- workshop topics, peer support groups, live chats around topical issues, or access to subject experts. Administratively, communication functions include the use of ‘virtual notice boards’, pre- and post-meeting agendas, minutes and papers, the setting up of tailored email groups and mailing lists and the use of discussion boards for debates on meetings or issues. Management functionality includes the setting up of staff and student details, collaborative document writing, monitoring/tracking the use of resources, and as a staff development tool to explore the potential of the online environment and ways of sharing expertise. Information management includes the development of shared virtual filing cabinets, mechanisms for storing materials, shared repositories of course information (syllabi, timetables, diaries), and so on. Knowledge management applications include staff expertise databases, course templates, shared resources, questionbanks, FAQs, bookmarks and reference repositories. One of the key properties of VLEs is the fact that they have the potential to provide a holistic all-encompassing platform for supporting both teaching and learning and the associated administration and management.

Recent interest has shifted to thinking about how these functions can be ‘joined up’ with other university management systems, such as student records and personnel data. A managed learning environment (MLE) will include administrative information about courses, resources, support and guidance, collaborative information, assessment and feedback – essentially linking up to back-end office systems and databases. JISC is currently undertaking a large programme of work on the development of managed learning environments (JISC, 2000). One of the key advantages of an MLE is the ability to have common authentication between VLEs and other systems such as email and also enable transfer of results from VLEs or online assessment systems to the MIS.

#### **Digital libraries, gateways and portals**

The second major area of development is specialized information gateways. These are increasingly important because of the need to tailor information for specific audiences (Currier, Brown *et al.*, 2002). A number of niche information gateways have developed. In the UK the main gateway for higher education is the Resource Discovery Network ([www.rdn.ac.uk](http://www.rdn.ac.uk)); similar gateways exist in Europe and elsewhere (Renardus, 2001). The term ‘gateway’ is used to describe a range of Internet sites that in some way provide access to other, predominantly Internet-accessible, resources. Gateways are intended to facilitate resource discovery by their target audience, to help their users find what they need via the Internet. ‘Information gateway’ is a generic term that refers to a whole range of Web-based resource guides pointing to Internet information resources, whereas ‘subject gateways’ are subject-based instances of these (Renardus, 2001). Resource description and subject classifications are the most important characteristics of such guides. In addition, it is becoming more common for publishers to make journals, books, data archives and

collections available online. Considerable thought is being given to how users can access and use these resources in a coherent way; a good example of this is a recent definition of a portal architecture by Powell. In his paper, he defines a subject portal as something that “brokers” end-user access to a range of services, relevant to a particular subject area, over a number of application protocols (LDAP, Whois++, Z39.50, ILL, FTP) [and] . . . provides “discover”, “locate”, “request” and embedded “use” . . . functionality’ (Powell, 2000). Powell goes on to describe the architecture for a portal. He defines six types of ‘player’; the end-user, presenters, coordinators, mediators, communicators and providers, and describes the roles and relationship between them. At the ‘bottom’ of the architecture are the information providers, such as subject gateways, data archives, service providers and collections. Clearly, these systems represent a rich variety of structures, supporting a range of applications.

It is also evident that the boundaries between VLEs for learning and portals for research are blurring and that many of these systems are starting to provide additional functionality beyond their original scope. For example, the social science research gateway, SOSIG, primarily focuses on the development of a quality-assured set of resources of relevance to the social science research community. However it also includes a facility to develop personal profiles, ‘My SOSIG’, and to network with ‘likeminds’ using its grapevine facility. SOSIG is also linked closely to a set of online tutorials which provide an introduction to the Internet (Virtual Training Suite, available online at <http://www.vts.rdn.ac.uk>). Similarly VLEs are often now used as gateways or portals to specific types of resources of relevance to a particular learning programme. These developments suggest that evolution is in process, namely that an information source, once established, starts to adapt according to user needs.

### **Resources and tools for learning**

There has been significant investment in the development of resources and tools for learning in the last five years. JISC and the New Opportunities Fund (NOF) have funded a number of large-scale programmes to enable the development of resources for learning and teaching. Some examples are described here. The development of computer-aided learning materials to support learning and teaching is nothing new, but perhaps began to accelerate with the emergence of easy-to-use authoring tools (such as *Authorware* and *ToolBook*) that did not require extensive programme skills. And during the late 1980s and early 1990s the Teaching and Learning Technology Programme (TLTP) produced a range of courseware resources, using these kinds of tools. A more recent example of a resource of this type is the highly successful Virtual Training Suite which is a set of over 50 tutorials which provide a clear subject-specific introduction to the Internet. Subject areas span FE and HE and include subjects as diverse as ‘Internet for chemists’ and ‘Internet for hairdressers’. The guides sit alongside the relevant subject gateway within the Resource Discovery Network (Place, Conole *et al.*, 2000a; Place, Conole *et al.*, 2000b).

A second area of significant activity has been the development of models, simulations and virtual worlds to support subject disciplines. For example the Virtual Economy is a model of the UK economy which very closely mirrors the real model used by the Chancellor of the Exchequer. Students can change a range of variables and study the impact at micro- and macro-economic levels. The model is linked to a variety of resources and teaching guides and is part of the larger Biz/ed business gateway and portal. Other projects have

attempted to simulate practical teaching such as the development of Virtual Laboratories and Virtual Fieldtrips, see for example <http://www.ch.ic.ac.uk/vchemlab/> and <http://www.geog.le.ac.uk/vfcl>.

In terms of assessment there have been two main areas of focus: the development of assessment tools for authoring, the creation of subject-specific question banks and the delivery of tests. An example of the former is the CASTLE toolkit which is an online authoring tool that allows course tutors and managers quickly to create interactive quizzes for use on the web (<http://www.le.ac.uk/castle/>). The creation of question banks has been of particular interest in the science and engineering subject domains. An FDTL-funded project e<sup>3</sup>an is developing a network of expertise in assessment issues within electrical and electronic engineering. A major focus of this project is the development of a test bank of peer-reviewed questions for diagnostic, formative and summative assessment (White, Dickens *et al.*, 2002). The Technologies for Online Interoperable Assessment (TOIA) project is developing administrative procedures and Question and Test Interoperability (QTI)-based systems and databases to facilitate and promote the uptake of online assessment across the sector (TOIA, 2002).

Video conferencing has developed significantly in the last decade and most higher education institutions now have one or more central video conferencing systems in place. These are most commonly used for administrative and research meetings, but 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 these developments. The MANs initiative and Talisman project encourage the use of the ATM video conference suites available at all Scottish HEIs, see [www.umi.ac.uk](http://www.umi.ac.uk) for further details. An important example of the use of video conferencing for staff development is a seminar series where institutions across Scotland link into monthly video conference discussions and lectures (SES DL, 2002). However desktop video conferencing systems are not yet so commonplace, perhaps because they are still perceived as being unreliable.

The rapid growth of multimedia and visualization technologies has led to the exploration of the increased use of images and different visual representations of data (Conole, Evans *et al.*, forthcoming). There are a number of trends emerging in terms of the use of images. 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. Furthermore, 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.

### **Underpinning architecture and standards developments**

There has been considerable work on the development of networking technologies, specifications and associated standards. Much of this is being orchestrated internationally through the IEEE ([www.ieee.org](http://www.ieee.org)). 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. In some areas standards are relatively mature, whilst others are still being contested. One of the most important aspects of this work with respect to learning technologies and education is the development of a standard for Learning Object Metadata (LOM). The standard aims to specify the syntax

and semantics of Learning Object Metadata (LTSC, 2001). Learning objects are defined as any entity, digital or non-digital, which can be used, reused or referenced during technology-supported learning (Littlejohn, forthcoming). Examples of technology-supported learning include computer-based training systems, interactive learning environments, intelligent computer-aided instruction systems, distance-learning systems, and collaborative learning environments. Examples of learning objects include multimedia content, instructional content, learning objectives, instructional software and software tools, and persons, organizations or events referenced during technology-supported learning. The Learning Object Metadata standards focus on the minimal set of attributes needed to allow these learning objects to be managed, located and evaluated. However work in this area is still been contested; in particular, claims such as 'where applicable, Learning Object Metadata may also include pedagogical attributes such as teaching or interaction style, grade level, mastery level, and prerequisites' (Littlejohn, forthcoming) is highly contentious.

## Discussion

As outlined above, ICT research covers a broad spectrum of activities ranging from a focus on particular technologies or their application to associated organizational, cultural or infrastructural issues. It is evident, however, that there are a number of cross-themes involved in differing degrees: the software and hardware requirements, human resource and skills issues, and associated cultural and organizational aspects. The software research tends to focus on the development and application of new forms of software to support learning and teaching. Hardware research is primarily concerned with the development of a robust technical infrastructure to support this; but also investigation of the nature and potential role of peripheral devices and their use. A large area of research in this area is interested in the investigation of the human resource implications of increased use of ICT and in particular associated staff and student needs and skills and the type of training, support and development they will need to achieve maximum benefit out of the technologies. Research is also exploring the associated attitudes and perceptions of different key stakeholders and the resultant issues of organizational change. Other organizational issues include evaluation of the impact on infrastructure and the integration within existing practices. This links closely to institutional strategic and policy debates and the impact on and effects of relevant strategy and policy and the influence of national level agendas and drivers.

A consistent issue across many ICT-developments is sustainability, including who should maintain and 'own' resources once produced. In recent years funders have begun to address the problem 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. The Teaching and Learning Technology Programme (TLTP), for example, provided a comprehensive project management handbook, and the Joint Information Systems Committee (JISC) through its 5/99 and 7/99 programmes, has in place a variety of valuable support mechanisms. In addition, the sector now has a developed network of expertise and 'project professionals' in the management of these kinds of programmes (Beetham, Jones *et al.*, 2001). There has also 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](http://www.ilrt.bris.ac.uk)), UKOLN ([www.ukoln.ac.uk](http://www.ukoln.ac.uk)), and the Learning Technology Research Institute ([www.unl.ac.uk/ltri](http://www.unl.ac.uk/ltri)).

How far do the above go towards enabling the vision of Squires' peripatetic electronic teacher (PET)? Certainly there is now a fairly robust technical infrastructure in place and a rapidly growing number of ways of getting at resources along with learning object metadata to enable teachers to pick and choose courses. There are also tools for assessment and a variety of mechanisms for supporting communication and collaboration online. Despite this, the take-up of ICT in teaching is still fairly low. This can be attributed to a number of factors. It is evident, for example, that staff and students often still lack the necessary ICT skills, as recent reports on literacy skills and user behaviour highlight (Harris, MacKenzie *et al.*, 2002; Rowlings, 2002). Other barriers to large-scale uptake include resistance to change, lack of time for experimentation and implementation, dedicated resources and already adequate mechanisms for ensuring sustainability (Conole, 2001; Bull, 2002).

## Conclusion

This paper has provided an overview of learning technology research over the last five years, focusing on the UK. It has described the issues associated with the increased use of learning technologies and its impact within institutions at both strategic and operational levels.

Throughout these technology-focused programmes a common aim has been to explore and report on the range of technologies and their uses in learning and teaching. Perceived benefits include the potential ICT has in terms of offering access to resources, enhancing skills, improving curricula, raising standards, providing mechanisms for sharing practice, accessing a range of online materials and advice, linking up isolated learners, accessing authentic learning (for example use of native speakers in language learning), accessing a wide range of quality materials, creating opportunities to tailor materials to specific interests and abilities of the individual and overall enabling the potential to make learning more attractive. However, research has also uncovered related issues, such as the need to develop robust underlying infrastructures to support these activities, staff and student training needs, associated cultural and organizational issues, integration with other learning and teaching processes, associated accessibility and legal issues, and the need for transparency over human and technical costs. There is also concern about over-hyping the potential of technology and the fact that fictional vignettes which aim to give example scenarios of the potential opportunities are often technology-centred and date quickly.

The paper set out to consider to what extent the infrastructure and context required for Squires' vision of a peripatetic electronic teacher has been achieved. It is clear that learning technologies are now no longer marginal activities within institutions. They are a significant part of strategic thinking, as senior managers recognize that a robust technical infrastructure is mission-critical and essential for future success. Furthermore technology

tools and resources are increasingly part of the working practice of teachers and students; email is now probably the main communication vehicle, and students and researchers alike increasingly expect resources and papers to be available online through digital libraries and other content repositories. However, there is also a recognition of the limitations of technologies and the value of many traditional practices. Increasingly users look to integrate real with virtual practices using each to its particular strengths. So in one sense we are a long way from Squires' visionary peripatetic electronic teacher (and may never actually achieve it) but in another sense we could argue that we have moved beyond this, with technologies becoming simply a part of the fabric of higher education, an essential tool, used as and when appropriate. The next few years will see ever increasing changes as applications such as mobile and wireless network impact and it is likely that a similar pattern will arise – with innovations giving way to more embedded uses alongside existing practices.

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