Learning Technology: The Myths and Facts

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Abstract

This paper considers some of the major issues in the field of learning technology. It seeks to identify areas in which technology has greatest potential to contribute to the learning process, and also those areas in which the application of technology is inappropriate or detrimental.

Issues described include the support of different kinds of learner, learning environments, reusability and accessibility. Questions raised include the changing role of learning in the information age, the extent to which learning materials may be re-used and how misunderstandings between the various contributors to learning technology projects may be overcome.

The paper concludes with a description of a hypothetical example of an effective application of learning technology.

What is Learning Technology?

Learning Technology, Educational Technology, Instructional Technology, e-Learning, Computer Assisted Learning (CAL), Computer Based Training (CBT)….. One or more of these closely related terms seems to occur in almost every discussion on education and learning these days. But what do they mean? And how might they shape the educational landscape of tomorrow?

A widely accepted definition of Instructional Technology is that provided by the Association for Educational Communications and Technology Definitions and Terminology Committee. “Instructional Technology is the theory and practice of design, development, utilization, management, and evaluation of processes and resources for learning.” (Seels & Richey, 1994).

This paper employs a slightly simpler definition of learning technology as any application of technology, particularly computer and information technology, which contributes to the learning process.

Learning technology per se is not new. The first maths teacher to bring an abacus into his classroom was using technology to aid learning. Projectors, tape recorders and televisions have featured in schools for decades. Even the use of computers is in education is not new. Riley (2002) describes how simulations and modelling programs “were in the mainstream of 1980s computer-assisted learning”. This author can remember a modem connected teletype unit in his maths class of the mid-70’s.

However, rapid advancements in the power and capability of desktop computers along with the proliferation of the Internet have led to intense interest in the potential of the computer as a learning tool.

This paper seeks to provide an overview of learning technology and to explode some of the myths about surrounding the field. It identifies areas where technology is most able to add value to the learning experience and also raises a number of questions which need to be addressed if the potential of the discipline is to be fully realised.

What Learning Technology Can - and Cannot - Do

Learning Technology has the potential to bring improved learning opportunities to a larger audience than has ever previously been possible.

It is able to support a more active learning experience through a high degree of learner involvement, thus promoting a deeper understanding. Dale’s "Cone of Experience" (adapted from Wiman & Meirhenry, 1960) suggests that people remember 10% of what they read, 20% of what they hear, 30% of what they see, 50% of what they hear and see, 70% of what they say and write, and 90% of what they say and perform at a task. Confucius makes the same point even more succinctly: "Tell me and I'll forget. Show me and I'll remember. Involve me and I'll understand". My own experience as a student on a master’s course in multimedia revealed that I learned least in formal lectures, a little more in organized tutorials, and most of all during the completion of assignments. Active learning is an effective approach for developing deployable skills.

Learning Technology places the learner in control of their own education. It is better able to meet the individual’s learning requirements by providing a (potentially) unique experience to every learner, tailored to their individual circumstances and characteristics.

It is able to support communicative and collaborative activity irrespective of the physical distance that may separate participants. Communicative activity reinforces and extends knowledge promotes a broadening of understanding through the sharing of ideas. Even where an individual comes into conflict with the group consensus, that conflict forces the individual either to justify their opposition or else to modify their belief.

Schacter (1999) analyzed five large scale studies of educational technology (including a meta-analysis of over 500 individual studies) covering a range of ages and levels. Schacter concludes that "students

with access to computer assisted instruction, or integrated learning systems technology, or simulations and software that teaches higher order thinking, or collaborative networked technologies, or design and programming technologies, show positive gains in achievement on researcher constructed tests, standardized tests, and national tests".

Fletcher (2003) argues that technology-based instruction is effective because it allows greater individualization and Interactivity than traditional classroom instruction. Fletcher concludes from the evidence that "technology-based instruction will reduce the costs by about a third and either increase achievement by about a third or decrease time to reach instructional objectives by a third". Learning Technology does not obviate the need for work on the part of the learner. It is not yet possible to download knowledge and experience directly into the brain. To understand something we must engage with it, a process which requires effort.

Learning Technology does not obviate the need for work on the part of the educator. Delivering content electronically does not automatically transform it into an effective aid to learning. In fact what might have been a very good aid to learning in its original form may lose its merits through inappropriate “electronification”. The most effective use of learning technology requires considerable planning and effort on the part of the educator to best exploit the strengths of the target media.

Learning in the Information Age

The final decade of the twentieth century saw exponential increases both in computing power and the number of people able to access computers and the Internet. Numerous commentators have described the proliferation of information and communication technologies (and in particular the growth of the Internet) as bringing about a transition as marked as that of the industrial revolution. We are said to be moving from the industrial age to the *information age*, in which radically different rules will apply in every aspect of society, education being no exception. (N.B. a *Google* search on the phrase "information age" retrieved some 725,000 results.)

Society’s transition to the information age is likely to impact on learning and education in two ways. Firstly, rapidly improving technology will enable higher quality learning to be made available to an ever-growing audience through increasingly sophisticated modes of presentation. Secondly, the very nature of the information age may require a different kind of preparation (i.e. learning) from its membership than was the case in the industrial age.

In the industrial age the majority of human roles could be described as algorithmic. Most circumstances determined the pre-defined procedure to be followed upon their occurrence. People left school or college, learned the rules of a given trade of profession, and expected to remain within that trade for life. Large corporations, with deep hierarchies were the norm, in which instructions from above were expected to be unquestioningly carried out. It could be argued that an approach like Skinner’s behaviorism which sought to develop specific responses to given stimuli was most suited to industrial age learning.

It is likely that members of the information society will need to learn continually throughout their lives in order to keep up with the rapid and relentless change that is characteristic of the age. Because it is unlikely we shall be able to enjoy perpetual studenthood, learning will need to be presented in increasingly flexible ways (e.g. distance learning, open learning, part-time and mixed mode study…).

It is likely traditional corporate structures will be forced to change in order to survive in the new economy. Small (2000) describes the limitations, in the information age, of the traditional managed team operating as part of a rigid hierarchy. Instead he proposes the concept of temporary, virtual teams, brought together by an initiator, someone able to "identify a win-win situation where cooperation can produce benefits" and "produce enough evidence that profits will result from [the] proposed cooperation". Such teams aren't "held together by rules, but by benefits of mutual advantage.”

Structural changes together with the increasing mechanization of algorithmic tasks imply the need for more creative, innovative and interpretive skills. Such abilities are more likely to emerge from a constructivist approach to learning in which individuals construct their own individual mental models of

the world in order to make sense of their experiences. Learning is the process of adding to or refining this mental model.

All Kinds of Learner

The continued and increasing state of social and economic flux of the information age means the need for lifelong learning will become a reality for most people in the twenty-first century.

Rather than being something that tales place between infancy and early adulthood, learning will become a cradle-to-grave activity. Rather than catering only for those with a certain predisposition, effective post-compulsory learning will need to be made available to the majority.

Rather than being an activity that takes place mainly in a classroom with rows of students seated at desks paying close attention to a teacher standing before a blackboard at the front, learning will take a variety of forms.

Of course there will still be institutional learning that takes place mainly in classrooms on campus. But distance learning seems set to become a major growth area of the early twenty-first century, offering learners the chance to study where and when they choose, scheduling their learning around work and family commitments. A third category of learner may also be identified, the *attached* learner. Attached learners fall somewhere between the extremes represented by their institutional and distance colleagues. Attached learners spend some of their learning time on campus while the rest is spent at a distance. They may be part-time students, or those out on work placements.

For distance learners learning technology can provide access to tutorial and peer support as well as relief from the inevitable isolation. The lone learner is brought into contact with colleagues and mentors from around the globe. Technology also provides an extremely efficient mechanism for delivering learning materials on demand. Such materials may be traditional study texts or fully interactive multimedia learning experiences. Simulations offer the distance learner almost the same degree of involvement as their institution-based counterparts by way of virtual laboratories and rich, interactive models. The World Wide Web provides access to a huge amount of content. Quality assured digital libraries and portals may serve as a roadmap to the more valuable resources.

On-campus learners may also benefit from learning technology, albeit in different ways to those at a distance. Simulations and models extend conventional laboratory facilities in supporting active learning by enabling ideas introduced in the classroom to be put into practice. *Learning environments* (see below) can provide access to pre- and post-lecture materials and serve as a gateway to a wide range of digital resources. They may also provide a shared workspace for group assignments as well as extending the learner's immediate peer group by linking them with others from around the world.

Learning Environments

Known by terms including Virtual Learning Environments (VLEs), Online Learning Environments (OLEs) and Managed Learning Environments (MLEs) these facilities offer technology mediated support for the learning process in a number of areas. Additionally, MLEs offer access to institutional administration systems allowing learners to view grades, update personal details, pay fees etc. online.

Learning Environments may offer any, or all, of the following features:

- A repository of learning materials, e.g. lecture handouts, PDF files, PowerPoint presentations etc., i.e. the environment serves as an efficient distribution mechanism.
- A portal to additional (i.e. external) quality assured resources.
- A communication facility which may be synchronous/asynchronous, tutor-student, student-tutor and/or student-student. This facility could include inter-institutional communities and/or guest lectures/seminars.
- Archiving of real-time events for the benefit of those unable to participate at the time.

- A shell for interactive/multimedia course materials. In this case the environment would provide each learner with access to the right materials at the right time, possibly determined by personal preference and/or prior performance.
- Online assessment - both formative (for guidance only) and summative (assessed as part of final grade).
- A collaborative working environment, e.g. a communication facility plus shared file space for group assignments.
- Links to administration systems, i.e. the environment is an MLE.

Many institutions make use of “off the shelf” products, the current market leaders being WebCT and Blackboard. Others develop their own environments to suit their specific needs. Considerations in selecting a learning environment include:

- How easy is it to use - for academics, tutors, administrators - and learners?
- To what degree can it be customized / accessed at HTML or server level?
- What does it cost? And how is it licensed - institutionally, per user, per seat (i.e. per user per course)?
- Does it conform to *accessibility* (see below) guidelines?
- Does it conform to emerging *interoperability* (see below) standards?
- Can it be used off-line (e.g. for distance learners with poor Internet connectivity), or is there an alternative such as e-mailed discussions?
- What is the minimum platform/connection required to run it?
- Will it interface with the institution’s administrative systems?
- Does it support single sign-on authentication?, i.e. once logged in will students be able to access other resources without having to repeatedly log in?
- Can closed access discussion areas be created for group work?
- Does it use the pull (e.g. bulletin board) or push (e.g. mailing list) model or both for supporting communications? Ideally a combination of the two will be supported with learners receiving regular e-mails informing them of new additions to the VLE; additionally there will be a web-based, searchable archive of messages available.

Accessibility

Learning technology may make the opportunity of learning available to a wider audience than ever before and as such has the power to promote a fairer and more equal society. The issue of accessibility is concerned with ensuring that the opportunities offered by the technology truly are available to as large and diverse a group as possible. In particular it is concerned with ensuring that learners with disabilities, including those who may be accessing materials through assistive technologies such as screen readers, are not unduly disadvantaged.

Accessibility concerns are not solely altruistic. The number of people worldwide with some form of disability represents a massive potential audience that few educational providers (or indeed commercial operations) can afford to exclude. Additionally much educational provision is, or will soon, be subject to accessibility legislation.

In the USA Section 508 of the 1998 Rehabilitation Act requires that Federal agencies' electronic and information technology (including Web) content is accessible to people with disabilities. In the UK the Special Educational Needs and Disability Act (SENDA) will make it illegal to discriminate against disabled students by treating them less favourably than others. Institutions must make reasonable adjustments to provision where students with disabilities would otherwise be at a substantial disadvantage. SENDA came into effect on 1 September 2002.

Learning technology practitioners should endeavour to make their outputs accessible to as wide an audience as possible and must make themselves aware of any legal requirements governing their work. Further guidance may be found from the World Wide Web Consortium (W3C) Web Accessibility Initiative (WAI - see http://www.w3.org/WAI/). Authoring software producers such as Macromedia (Dreamweaver, Flash etc.) may also publish guidelines on developing accessible applications with their software (e.g. see http://www.macromedia.com/macromedia/accessibility/).

e-Learning or Blended Learning

The oft-used term e-learning implies the concept of learning which is delivered electronically. The author dislikes the term, preferring to see the computer as just one possible medium through which learning may be presented.

Radio, cinema, television, video etc. were all exciting new media, once. They all remain widely used. But they have not replaced media which pre-existed them. The oldest mass medium, i.e. the printed word, continues to flourish.

Just as older means of communication continue to thrive alongside the latest computer technology in the information age, so too do more traditional forms of learning medium such as the printed word and audio and video cassette. The latest forms of learning technology should supplement rather than replace these earlier media in a blended approach to learning.

A successful learning experience relies on each of the available modes of delivery being employed to its strengths.

There are numerous examples of so-called learning technology that do little more than transfer the contents of the printed page to the computer screen in the belief that presenting the information this way will magically promote enhanced learning. In fact delivering significant amounts of printed text on screen rather than paper is likely to be detrimental to the recipient's comprehension and comfort.

Nielsen (1998) states "people read about 25% slower from computer screens than from printed paper". Reading from screen is certainly less comfortable than reading printed text. The UK Health and Safety Executive (1998) found that "long spells of VDU work can lead to tired eyes and discomfort". In fact UK law requires employers to plan the work of those using VDUs so there are breaks or changes of activity (HSE, 1998). Paper can also be more portable and robust, e.g. one cannot use a computer in the bath, whilst dropping a book doesn't usually do it any significant damage.

Reusability

A holy grail of the learning technology field is the concept of reusability as witnessed by the intense interest and activity in reusable learning objects.

The concept of reusable learning objects is a simple one. Learning material is packaged into discrete chunks for the purposes of being used in a variety of contexts.

Definitions of what constitutes a learning object vary. The IEEE Learning Technology Standards Committee (2002) defines a learning object as " any entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning." This is not very useful since absolutely anything can be referenced during technology supported learning.

Other, more precise definitions exist, e.g. learning content management system vendor Knowledge Planet states "A learning object has four components: an objective, content, a means of assessment, and metadata." (Knowledge Planet product literature).

The rationale for the learning object approach is similar to that for the use of object oriented programming in computing. Rather than continually develop software to represent common entities such as people, orders, accounts etc., the software industry produces one (or a small number of) very good representation(s) of these entities. When a programmer needs to code people in his software he simply plugs in a pre-written, quality-assured person object, which he may refine as required.

Rather than every mathematics teacher develop their own way of introducing students to differential calculus, they are simply able to call upon one or more very good learning objects, which do the job. The mathematics teachers may then devote their efforts to supporting students understanding of those objects.

Some examples:

- A single object introducing differentiation is offered on courses in engineering, science and economics.
- The learning object on introductory differentiation is multi-purposed into print, Web and CD-ROM versions.
- A degree level management course is created as a series of reusable learning objects. A subset of these learning objects forms the basis of a short, vocational course.

The best learning objects would be made available, at a cost, to the entire educational community. Widespread adoption of the learning object paradigm would see a separation between the traditionally integrated functions of content preparation and learner support.

Reusability in education is not new and has not until recently been seen as controversial. A textbook is a reusable learning object. A textbook on basic calculus might be used in courses on mathematics, physics, engineering etc. with different groups of students in numerous schools and colleges throughout the world. It may be translated into different languages to further extend its reusability. Learning objects take the reusability concept a step further, extending it to the entire content component of the learning experience.

Downes (2000) makes a compelling case for the economic benefits of the learning object approach, claiming “there will be sharing, because no institution producing its own materials on its own could compete with institutions sharing learning materials.”

One criticism of this approach comes from the recognition that knowledge does not exist as discrete chunks, but is inextricably related to other knowledge as well as to the context in which it is applied, i.e. the learning object approach is too reductionistic to meet the learning needs of the real world.

The term *digital divide* has been coined to describe the division between those that have access to technology and those that do not. In March 2003 an estimated 649 million people, some 10% of the world's population, had Internet access (Global Reach). It is sobering to reflect that 90% do not have such, thus the technology that promises to make learning opportunities more widely available than ever before is effectively excluding the vast majority.

This difference in the levels of access to technology is driving the goal of multi-purposing learning objects across a range of delivery media, e.g. it should be possible to present printed, low-bandwidth and high-bandwidth versions of a particular object. The problem in meeting this ideal is that material is written to the strengths of a target medium, e.g. a novel and a screenplay of the same story are quite different. Thus in trying to author an object for a number of formats there is a risk of compromising the strengths of each and delivering a mediocre product.

Despite these criticisms reusable learning objects will most likely play a major role in the future of learning presentation. The focus at this stage should be on identifying those scenarios in which the approach has most to offer.

Interoperability

Closely related to the concept of reusability is that of interoperability. Essentially this means ensuring that where reusable learning materials are created they are truly reusable, by different institutions and across different delivery platforms.

To this end a number of bodies are working towards the development of standards. These bodies include the IEEE Learning Technology Standards Committee (LTSC), Advanced Distributed Learning (ADL) Initiative (developers of SCORM - the Sharable Content Object Reference Model) and the Instructional Management System (IMS) Global Learning Consortium. Specifications are emerging to describe things like learning object metadata, content packaging and question and test interoperability. The UK Centre for Educational Technology Interoperability Standards has described the adoption of standards as being “key to the realisation of Life Long Learning and a global education marketplace.” (CETIS 2002).

Although much work is being done in this area few standards have been officially ratified. The learning technology practitioner would be advised to become acquainted with the current state of affairs and to ensure that any deliverables are broadly compatible with existing recommendations whilst watching closely for further developments.

The Understanding Mismatch

One of the greatest difficulties in implementing learning technology projects is the need for mutual understanding between a diverse range of skill sets.

This difficulty exists to a lesser degree in traditional education where those with the greatest subject knowledge aren't always the most able to impart it to others. In the UK this is more of a problem in higher education, where academic staff are selected solely for expertise in their field and are not required to possess any qualifications in education.

The problem is intensified in technology mediated learning as not only subject specialists and educationalists need to be involved the process but also a whole range of technical experts (systems administrators, web/multimedia designers/developers, support staff…).

The successful development of a learning technology project from conception to delivery requires that each of these specialists is able to work together, each having an appreciation of the role played by the others. Without this mutual understanding the dangers are that the subject experts will simply regurgitate what they know without regard to how the learner will engage with it; the educationalist will produce unrealistic expectations of the technology, or worse, have little understanding of the technology's potential; and the technologists will create excellent demonstrations of their specific skills and knowledge that stand as works of art but do little to enhance the learner's understanding.

In an attempt to address the problem of understanding mismatch two relatively new professions have emerged from the learning technology industry, namely the instructional designer and learning technologist (or educational technologist).

The instructional designer is able to work with subject experts to create a learning experience appropriate to the target learner. It is a role that should be found throughout traditional educational establishments, particularly those of higher education. Indeed in the UK more and more higher education institutions are introducing learning and teaching units with a view to helping academics improve the quality of learning presented to their students.

The learning technologist is likely to be technically skilled as well as being able to communicate with other technical experts and will have a good awareness of the potentials of technology in promoting learning. Most importantly he/she will be able to communicate with subject experts and/or educationalists to advise where and how technology might enhance the learning experience that is being developed. The learning technologist may demonstrate a range of examples to inspire ideas, and will then work to refine those ideas into a realisable form.

These roles are intended to serve as an interface between subject specialist and technical expert. They will ensure that the right amount and level of subject knowledge is presented to the learner in the appropriate form for the most effective learning to take place.

As the discipline of learning technology matures it is likely a number of project lifecycle methodologies that enshrine best practice will emerge. However, it is the author's opinion that the field is currently too young to be so rigidly constrained and that further experimentation and innovation are required if its full potential is to be realised.

Effective Learning Technology

How may learning technology be most effectively deployed? And what might be the characteristics of the resulting learning experience?

Technology has the potential to facilitate communication across physical boundaries. It also has the potential to involve the learner, particularly the distance learner, to a high degree as well as being able to present a highly personalized learning experience.

We might expect an effective technologically mediated learning experience to offer the opportunity for communication and collaboration with similarly minded individuals from around the world. These individuals would comprise both peers and mentors and would ideally form communities in which different members could take the lead at different stages of the learning process. The communication facility could take any form from the simple e-mail list and/or discussion board through to intelligent avatars inhabiting three-dimensional virtual worlds.

The experience would employ different media to achieve different ends. In many cases, depending on the nature of the course, there would be a significant reading component. This reading need not be delivered as bundles of paper. Instead it could be distributed as PDF files for the learner to print locally. It is likely these files will be fully indexed and searchable to enable the learner to quickly retrieve relevant content. There may also be some form of computerized organizer, note taker and annotation tool, which some learners might find beneficial.

Where the computer is used to present learning there is likely to be a high degree of learner involvement. Rich simulations and models will allow the learner to experiment in a variety of novel situations, learning from the experience of active participation and the resulting feedback. There will not be a pre-determined pathway through the computer-presented component. Instead it will adapt itself to the characteristics, needs and earlier performance of the individual learner.

Audio and video elements will also be offered where these media are most appropriate for presenting the learning material. Where a course of study is comprised of different media (print, computer, audio, video) each component will be of sufficient size to provide a study session of satisfying length and substance, i.e. learners will not be required to switch from screen to paper and back every few minutes. Multi-media courses may also provide a printed “summary” of key concepts for revision purposes. This summary could be in skeletal form to be expanded upon by the learner as they progress.

Conclusions

Learning technology is currently attracting intense interest due to the rapid increases in technological capability and in the size of the audience able to access it, and also due to the increasing demands upon the education system as the need for lifelong learning becomes reality.

Technology can provide quality learning to a mass audience, and by offering greater learner involvement and a more personalized learning experience can deliver the kind of learning most suited to the information age. But if technology’s potential is to be fully realised its strengths and weaknesses need to be understood by learning providers. The computer is just one of a range of media that should be used to present learning in a blended approach.

Reusability, and in particular the topic of reusable learning objects, is the subject of much activity. The concept is attractive from an economic standpoint, but does not represent an educational panacea. Major criticisms of the approach are that it is too reductionistic and of compromising the quality of purpose-made content.

Further work is needed to identify the boundaries within which reusability might be most effectively applied, e.g. are there differences in the applicability of the approach between arts and science subjects, introductory and advanced topics, or academic and vocational contexts? Work is also needed on the development of models for the efficient authoring, representation, storage, distribution, presentation and production of learning objects.

A major difficulty in learning technology project implementation is due to the diversity in the skill sets that need to be involved and the potential for misunderstanding that might occur between them. The problem of understanding mismatch may be alleviated once learning technology implementation

methodologies become established. However there should be no rush to move to rigid methodologies at the expense of widespread experimentation and innovation in this evolving field.

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