

## **ONLINE LEARNING: towards enabling choice**

**John D Ferguson, George R S Weir & John N Wilson**

Department of Computer and Information Sciences  
University of Strathclyde  
Glasgow, UK

**Abstract:** Education is rapidly evolving from an opportunity that was provided mainly for an elite to one that is available to a mass markets and as such is prone to the forces generated by this environment. Where, in the established pattern, commercial interest was limited mainly to the use of skills developed during the educational process, the future model of educational provision will involve extensive commercial activity in the production, delivery and marketing of material. Already there are a number of commercial companies offering framework products enabling “off the shelf solutions” for the construction and delivery of web based courses in any subject area. The commercialisation of education is underway and it is inevitable that it will be viewed, by entrepreneurs and customers alike, as any other commercial product. It would seem reasonable that the consumer should be able to evaluate the performance of these new modes of working in a similar manner to other commercial products. This paper draws together current thinking on the problems associated with evaluating computer and communication based learning.

### 1. INTRODUCTION

Computer technology has made a significant impact in many areas of teaching and learning. The introduction of desktop computers, word-processing packages and presentation preparation tools have improved greatly the quality of the material presented to students and used in lectures. The use of simple database packages and spreadsheets has improved and simplified record keeping at all levels within education. However, the most significant impact has come through the use of supportive learning mechanisms such as computer-aided learning (CAL), computer-based training (CBT) and online learning. These technologies make use of various forms of interactivity to engage the student in effective, and often novel, learning experiences, (Leidner, 1996); Alavi, 1997).

The terms used to refer to the use of computers in education are many and in some cases have conflicting and inconsistent use. Terms include: - computer aided learning, web-based learning, computer managed instruction distance learning, online learning, etc (Smith, 1999; Garrison, 1985). Many of these terms have considerable underpinnings while others are relatively new and are the subject of ongoing research. The focus of this paper lies with the application of computer and communications technologies in general and while these technologies can be included under this umbrella, they are not examined individually.

Bates (Bates, 1995) highlights the following criteria for assessing the properties of different learning technologies: -

- Access – how easy is it for learners to access the technology?

- Costs – what is the economics of using the new structure – the unit cost per learner?
- Teaching and Learning - what approaches to learning are appropriate - what are the pedagogical strengths and weaknesses of different technologies?
- Interactivity – what type of interaction does the technology support?
- Organisation – what changes in the organisation need to be made before the technology can be used successfully?
- Novelty – how new is the technology?
- Speed – how quickly can courses be mounted and updated with this technology?

While there is general agreement that the use of computer and communication technology greatly improves access to learning, evidence of its cost or pedagogical advantage is less obvious. Evaluation efforts into pedagogic issues seek to establish an educational basis for the activity either by empirical measurement or by reflexively evaluating products with a view to their improvement. Economic evaluation on the other hand tries to assess the overall impact of the technology in terms of its viability by comparison with traditional methods.

## 2. PEDAGOGY - EMPIRICAL EVALUATION

The empirical approach to evaluation is typified by work such as that carried out by Lamperti and Sodicoff, (Lamperti, 1997). Investigations of this sort are based on inductive methods of reasoning from observations in the hope of identifying a general theory. The assumptions of this methodology are founded in Mill's Canon of Difference, (Mill, 1879). This states that where a phenomenon that is being investigated occurs in one set of circumstances but not in another and these two sets of circumstances have no other difference, then the difference between the effects of the two sets of circumstances is caused by the phenomenon being investigated.

Many empirical studies have been carried out in this area and the results can be assimilated to provide a more general model of the efficacy of computer / communication based learning by comparison with more traditional methods of teaching. Meta-analytical methods provide a consistent way of combining the results of individual experiments to provide an overall picture. This approach was initially characterised in social scientific studies but is now widely used in many branches of science. The fundamental approach is to take two or more studies that report a statistical measure of the effect of a phenomenon and to combine these statistics to give a more general overall picture of the effect. Such techniques have been applied to studies of computer-aided instruction (CAI) based on pre-multimedia technology (Fletcher-Flinn and Gravatt 1997).

One of the characteristic difficulties of meta-analysis is the assumption required by inductive reasoning that the experimental groups differ in no consistent way from one another other than in the phenomenon under investigation. A common source of compromise of this assumption is neglecting to ensure that teaching materials are the same whether the mode of instruction is computer-mediated or teacher-mediated. Considerable effort is required to ensure empirical rigour in comparing cohorts experiencing teaching in different ways. The novel aspect of computer-based packages may also contribute to differences measured between performance of the new technique and control groups. From the group of 120 case studies used in meta-analysis Fletcher-Flinn and Gravatt report that the most rigorously controlled studies showed no significance in the difference between performance of students taking part in computer based teaching by comparison to those taking part in traditional methods.

### 3. POST-EMPIRICISM EVALUATION

The limitations of summative evaluation typified by meta-analysis of empirical studies of the impact of computer assisted learning have led to the emergence of alternative paradigms of evaluation. (Draper, 1996). Such alternatives focus on the use of the computer as an element in a range of resources that any teacher can bring to bear. The conclusion from this work is that evaluation of the use of computer technology in isolation is unlikely to provide an insight into its efficacy. Draper's ideas are based on work that involved the evaluation of a range of computer-aided learning systems. The initial intention of this work was to provide a summative evaluation of particular learning activities. The results suggest that summative evaluation is not a particularly useful concept in assessing the significance of computer technology in the progress made by students. The effect of the technology intervention may be masked by other activities undertaken by the student before, during or after the intervention. Students with background knowledge of a particular type may find that the intervention is of use whereas without the background, it may be meaningless. The impact of a technology intervention is often significantly influenced by teacher behaviour.

A significant source for concern about the validity of summative evaluation is the effect that evaluation activities have on a student's perception of technology intervention. There is a possibility that the novelty of the system and the novelty of being assessed on their knowledge of the material contained within the system may encourage students to learn from the material. The likely consequence of this is that learning from such systems will attenuate over time as the novelty disappears.

Gunn (Gunn, 1997) also identifies the approach of evaluating computer technology by applying experimental methodology to measurements of its effects as a source of some difficulty. The criticism focuses on the limitations of random assignment of students to experimental and control groups. The result of these limitations is that it is not possible to be certain that both experimental and control groups are homogeneous for the wide range of external factors on post-test performance. Such factors may include willingness to learn, prior knowledge etc.

### 4. ECONOMIC EVALUATION

Considerable expenditure has already been invested on IT in Higher Education. In the United Kingdom it is estimated that in 1997 approximately 10% of the HE budget, i.e. approximately \$15 billion, was spent on communications and information technology (Deering, 1997). Given the large sums of money involved it would seem prudent to examine in detail the costs and the benefits associated with the widespread use of computers in teaching and learning. It is therefore surprising that over the last ten years little has been done to measure the impact of technology in education or to evaluate the costs involved in establishing and maintaining its use.

Claims that IT can lead to considerable cost savings in providing high-quality teaching and learning (Deering, 1997) still have to be examined and substantiated. In 1997 Scott concluded that existing literature did not back up these claims and failed to measure satisfactorily either the cost or the claimed benefits of computer based learning, (Scott, 1997).

Certainly in traditional distance education it is accepted that wherever materials can substitute for face-to-face interaction with students, savings can be made (NBEET, 1994). Theoretically it should be possible, with economies of scale, to cover the initial investment costs incurred in

developing traditional paper based course material. However, one of the greatest differences, and strengths, of online learning compared to the older distance learning structures, is its ability to deal in a more personalised way with student support through feedback mechanisms utilising e-mail, teleconferencing etc. Paradoxically, it is this strength that also leads to what could be argued to be the greatest cost associated with on-line learning. As a result it is being suggested by some that on-line support of students is leading to a cost structure that is nearer the cost of face-to-face learning than traditional distance learning with its economies of scale, (Rumble, 1999).

Boucher (Boucher, 1998) recognises that the key issue is the relationship between costs and benefits of using IT for delivering and supporting teaching and learning. He identifies the following cost framework associated with computer based learning: courseware development costs, incremental capital and recurrent equipment costs, costs associated with provision of appropriate resources, infrastructure costs, maintenance, user support costs, costs of adoption, access costs, security costs, replacement costs, institutional overheads, spill over costs. Few if any of existing studies related to the use of IT assisted teaching make use of this cost framework. However, Rumble (Rumble, 1999) summarises cost associated with on-line learning from a number of sources. For example, work recently published by Arizona Learning Systems (Rumble, 1999) cites development costs for a three unit course, depending on the technologies involved, of \$18000 for text with reference materials, \$37,000 to include images, £120,000 for audio and video, \$250,000 to include simulations and reaching \$1 million with virtual reality.

The economic benefits of computer based learning are similarly difficult to quantify. Boucher (Boucher, 1998) categorises benefits as either internal or external to an organisation. External benefits include the additional revenue generated by on-line learning. Internal benefits are more diverse and include improvements in the way material is presented as well as improvements in the skill level of the teaching workforce as a result of generation of such materials. Also of significance is a measurable increase in the level of mastery of learning outcomes as a result of experiencing computer-based learning. As we have demonstrated, there are fundamental difficulties in providing evidence of this sort of benefit.

## 5. CONCLUDING COMMENTS

Universities in the developed world have traditionally regarded their own national students as essentially a captive market for their services. Foreign students represented a means of both promoting the university on an international stage and providing a lucrative addition to fee income. This localised pattern of education is now being threatened by the potential for students to take online courses from universities in distant countries without the need to relocate, (Ferguson, 1999). The pressures of globalisation are complemented by the development of a mass market for education. The extent of this market precludes it from being provided for using traditional educational methods. The emergence of IT as a viable means of enhancing the competitive edge of a university in carrying out its mainstream activities has generated the perception among university administrators that the status quo may no longer be tenable. A common response to this situation is to develop an online presence in an effort to be part of the global education market. An important characteristic of this response is that it is not based on concern for educational theory but on the need to compete successfully with other organisations.

Learning is a complex process that is modelled by educational theories and can be measured using a variety of reasonably objective methodologies. Educators are applying these theories to new technologies and have tried to use evaluative processes to gauge the ability of

educational theory to model the learning engendered by them. The empirical evaluation of some new technologies has shown no clear evidence for greater efficiency of learning than conventional methods. The process of learning aided by computer technology is not completely understood, neither is it clear how it should be evaluated. Despite this unclear link between educational theory and new practices, the implementation of computer technology can be very successful when handled by educators who are experienced in applying educational theory in practical situations. By contrast, there are many circumstances where the implementation of new technology systems can be seen to be damaging. We have observed that educational management has a tendency to perceive new online forms of learning principally as a solution to globalisation and efficiency problems and not a tool to be used if and only if the right pedagogical conditions exist.

## REFERENCES

- Alavi, M., Yoo, Y. and Vogel, D. 1997. Using information technology to add value to management education. *Academy of Management Journal* 40(6): 1310-1333.
- Bates, A.W. 1995. *Technology, open learning and distance education*. London, Routledge.
- Boucher, A. 1998. Information technology-based teaching and learning in higher education: a view of the economic issues, *Journal of Information Technology for Teacher Education* 7(1): 87-111.
- Deering R. 1997. *Report of the National Committee of Inquiry into Higher Education*. London: Her Majesty's Stationary Office.
- Draper, S.W., M.I. Brown, F.P. Henderson, and E. McAteer. 1996. Integrative evaluation: an emerging role for classroom studies of CAL, *Computers & Education* 26(1-3): 17-32.
- Ferguson, J.D., A.D. McGettrick, and D.N. Smeed. 1999. Quality issues in a virtual university, In *CATE'99. Proceedings of the IASTED International Conference on Computers and Advanced Technology in Education*. pp.8-12. Philadelphia, Pennsylvania.
- Fletcher-Flinn, C.M., and B. Gravatt. 1995. The efficacy of computer assisted instruction CAI: a meta-analysis, *J. Educational Computing Research* 12(3): 219-242.
- Garrison, D.R. 1985. Three generations of technological innovations in distance education, *Distance Education* 6(2): 235-241.
- Gunn, C.1997. CAL evaluation: future directions, *ALT-J* 5(1): 40-47.
- Leidner, D.E. and Jarvenpaa, S.L. 1995 The use of information technology to enhance management school education: a theoretical view, *MIS Quarterly*, September:265-291.
- Lamperti, A., and M. Sodicoff, 1997. Computer-based neuroanatomy laboratory for medical students, *The Anatomical Record* 249(3): 422-428.
- Mill, J.S. 1879. *A system of logic*. London: Longmans Green .
- NBEET, 1994, National Board of Employment, Education and Training report on the Costs and Quality in Resource-based Learning On- and Off-Campus, Report No.33, Australian Government Publishing service
- Rumble, G. 1999. Costs of networked learning: what have we learned. In *FLISH'99. Proceedings of the Conference on Flexible Learning on the Information Superhighway*. Sheffield, England.
- Scott, P. 1997. The economic costs and benefits of information technology assisted teaching and learning in higher education. in *Information Technology Assisted Teaching and Learning in Higher Education* eds Boucher, A., Davis, N., Dillon, P., Hobbs, P. and Teale, P, Bristol, England: Higher Education Funding Council for England.
- Smith, T.L. 1999. A taxonomy of computer usage in training and education. In *Proceedings of the IASTED International Conference Computers and Technology in Education*. pp190-193, Philadelphia, Pennsylvania.