Literature Review: Trends and issues

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Introduction

This paper provides a summary of the findings that emerged from a detailed exploration of recent literature describing innovative technology-based projects. The exploration sought to investigate the forms of technology-based learning being reported in the literature with the view to discovering patterns and themes in the forms of learning strategies being employed, the enhanced learning outcomes being reported and the nature of the evaluation methodologies employed.

A series of 5 journals and collections was selected as the basis for the investigation. The journals chosen are commonly used in Australia as reference points for contemporary technology-based research and evaluation. The project explored the issues for the collections across the years 1998 to 2000. There were thirty two papers in total in the 5 collections studies that reported studies of the implementation of technology-based learning projects. The original intention was to report only on-line projects but there were too few such publications of this form. The collections that were reviewed were:

- 6 from *British Journal of Educational Technology* (1998-2000),
- 6 from *Proceedings of Ed-Media Conference* (1999)
- 8 from *Journal of Educational Multimedia and Hypermedia* (1998-2000)
- 6 from *Australian Journal of Educational Technology* (1998-2000) and
- 6 from *Journal of Interactive Learning Research* (1998-2000).

The papers were reviewed and data collected and reported across the following criteria:

- Knowledge domain: the discipline area in which the project was undertaken;
- Students: the population of learners, number of students;
- The forms of learning being sought: the aims of the project reported in the paper;
- The learning strategies: the forms of learning activity supported and enabled through the technology;
- The claimed learning outcomes: the outcomes reported from the study together with a description of the research methodology and the forms of data used in the analyses; and
- The context of the study: how the project fitted the overall learning programs of the students.

The descriptions of the various papers are provided as appendices to this summary document.

What were the forms of learning designs being reported?

In order to seek information that could inform the overall AUTC project, we reviewed the descriptions and information gained from the review process. Some patterns and themes emerged from this process, the first relating to the forms of learning designs reported. The research studies examined could roughly be divided into four types:

1. Efficiency of transfer of information and access:

There were a number of studies which focussed on *presentation designs* and their effect on learning, such as screen design, the position of graphics on the screen, etc.

Other studies looked at *equity and access* issues related to technology, such as catering for disabled students, and the use of technology to cater for a range of abilities.

Claims being made and on what was the evidence based

- Students who used computer-based lesson with good design principles completed a lesson in less time and had a higher completion rate *(Empirical evidence)*
- Those with limited abilities can learn effectively using the internet, if designed with access in mind *(Weak anecdotal evidence)*

2. Impact of technology on learning

There were some comparative studies in this category which examined the *affordances of technologies* such as comparisons of the effectiveness of video vs. lecture, CD-ROM vs. tutorials / lab sessions, multimedia vs. textbook, etc.

There were also studies which sought to assess *the effect of a technology on students' learning* such as, the effect of hypermedia on problem-solving skills, the effect of multimedia on exam performance, the effect of EPPSs on student learning, etc.

These are examples of the type of research study that has been very popular in educational technology over the past 15-20 years, that seek to prove that a technology or innovation is better than a more traditional approach (the kind that usually end up on the no-significant-difference website).

Claims being made and on what was the evidence based

- No evidence of any correlation between use of multimedia and improvement on exams *(Empirical evidence)*
- No decrease in learning regardless of delivery method (full TV, part TV traditional classroom teaching) *(Empirical evidence)*
- The use of CAL improves examination marks *(Weak empirical evidence)*
- The use of CD-ROM resulted in minor improvements in knowledge for average students *(Anecdotal evidence)*

3. Effectiveness of learning environments

Many studies looked at the effects of *theory-based learning environments* and their effect on learning, motivation, self-regulation, completion rates, etc. These included studies on problem-based learning, case-based learning, guided discovery learning, anchored instruction, learning communities, situated learning, cognitive apprenticeship, etc. and most were technology-based environments.

Most of these studies were strongly focussed on investigating a complex, systemic learning environment based on a theoretical framework, rather than testing a single variable. Some of the claims are described below.

Claims being made and on what was the evidence based

- Students exposed to expert stories did better on solving near and far transfer problems than students without stories *(Strong empirical evidence)*
- Motivating questions and reflection helped students to draw connections between activities and larger scientific contexts *(Strong empirical evidence)*
- Hypermedia case studies provide an equally effective learning environment for students regardless of learner differences *(Strong empirical evidence)*
- When designing hypermedia, students' declarative and procedural knowledge increased in complexity, and general problem solving skills increased and became more complex *(Strong empirical evidence)*
- Anchored instruction assisted student performance in cognitive and affective domains *(Empirical evidence)*
- EPPS provided strong cognitive support and learning transferred when EPPS removed *(Empirical evidence)*
- The use of vignettes enhance PBL by requiring students to focus more effort in the problem-definition phase *(Empirical evidence)*
- Structured case based instruction may significantly help novice students *(Empirical evidence)*
- Students using a guided discovery approach performed significantly better (but took longer) than a lecture group when judged on knowledge gain *(Empirical evidence)*
- Learning in holistic learning communities in business transfers to other learning situations *(Strong anecdotal evidence)*

4. Other

A few other studies which do not fit into these broad categories include, for example, a study on the effects of teaching critical technology skills before the start of semester, the influence of learning styles on performance in hypermedia learning environments, and the effect of collaborative groupings on learning.

Claims being made and on what was the evidence based

- Learning styles appear to influence performance in hypermedia learning environments *(Empirical evidence)*
- When taught critical technology skills before the academic programs commenced, students were able to concentrate on subject matter and gained a feeling of being in control of their own learning *(Weak anecdotal evidence)*
- Collaboration improved understanding of difficult scientific issues *(Weak anecdotal evidence)*

How these activities we have done might serve to inform the future activities of the project in selecting existing cases as potential learning designs to copy and model

This literature search has been fruitful in many ways and signals a way forward for the project. Clearly, there is divide between short-term technology driven design or policy driven initiatives

that seek to demonstrate how technology can be used to provide innovative ways of delivering educational services. These studies are not integrated into long-term learning, have little empirical evidence to support them, and are *add hoc* measures.

A number of articles emerged as having strong potential to inform and guide this AUTC project. These tended to be larger studies that focussed on large scale interventions and the creation of learning environments where there was attention paid to teaching & learning principles, student and teacher roles, use of a range of online tools and the creation of student centered learning environments. Examples of such projects reported included:

- Learning through *Collaborative Visualisaton Project* (CoVis): A funded project that explored ways to enhance and rethink how students learn science by introducing computer mediated communications and scientific visualization tools
- *Apprenticeship based learning environments (eg, ABLE)* for undergraduate education using software realized scaffolding to provide process knowledge and conceptual knowledge so that learning can be facilitated;
- The *Collaborative and Multimedia Interactive learning environment (CaMILE),* which uses an online forum for collaboration and reflection.
- Studies based on CSILE's *(Computer supported intentional learning environments)* using databases and RBL models, with peer feedback & communication

These studies were broad-based, integrated and involved long-term research efforts aimed at changing the way students learn and the way teachers teach using ICT. Some reported strong empirical evidence, while others reported strong anecdotal evidence of positive changes to learning, student outcomes and teacher roles. In addition, ongoing research on these projects was reported. Such projects as *Collaborative Visualization Project* (CoVis), *Apprenticeship based learning environments, CSILE's and Apprenticeship based learning environments* share critical features that differentiate them from short term interventions that seek to investigate how technology can assist in flexible delivery. Each is a planned, systematic and holistic integration of technology aimed a improving learning and creating an enhanced environment that has the following features:

- use of technology to scaffold, rather than control student learning
- a constructivist perspective with an emphasis on learners' situated activity
- learner and teacher engagement in a dialogical relationship
- authentic activity and assessment
- peer support, dialogue and collaboration
- provision of resources to support self-direction
- a concern with processes and products of learning
- support for reflective processes

In these environments, learning is not dependent on technology, but is supported by technology. Often the metaphor of "technology of mindtool" is used. This means that students use the technology to communicate, to represent what they know and to approach learning from a different angle (eg more inquiry based, more self-directed). Indeed many of the environments listed above meet the criteria documents in Boud & Prosser's paper.

How to proceed?

One heartening result to come from this review of the literature was apparent confirmation that there has been a shift in emphasis from comparative studies on the effects of a particular medium, to a more systemic approach to research, where theory-based learning environments are investigated in depth. However, the process has suggested a need to seek information on projects from sources other than academic journals and collections. Our overall findings in this project suggested that:

- There is a scarcity of articles and findings published specifically on the subject of online learning environments;
- Many innovative online strategies and designs have not yet been evaluated, and so cannot be published as research studies;
- Those that have been evaluated and written up face a time delay of many months (at least) to be published; and
- Actual learning strategies are not generally described in enough depth to assess their usefulness as models.

In order to provide model learning designs and strategies for online education, we may need take a slightly different approach. As well as using published reports, we need to search existing projects and units on the Internet, access online journals (which have a shorter lead time and have direct links to web sources), follow up on conference presentations and other sources of information to find truly innovative and current strategies. The disadvantage of this approach, of course, is that we are required to rely on our own judgement of quality rather than the judgement of the journal referees.

We still continue to look at journals for corroboration of our findings, but also to look for holistic designs, long term and scalable examples of interventions that have changed the way teachers teach and learners learn with technology. Many of the interesting innovations are described at high school level, but not a tertiary level. What does this tell us? It seems to indicate that higher education is still looking into transmissive, instructivist paradigms where outcomes in the form of prepackaged knowledge and skills are demanded. Also, higher education is still hemmed by the boundaries of disciplinary thinking, and this compartmentalisation militates against holistic design aimed at improving student learning across a broad spectrum of learning achievement.

We should also consider initiatives taken at institutional level to transform learning such as *Teletop* in Twente, and previous CUTSD projects in Australia, and at funded large-scale initiatives in the UK and USA. From these investigations we should be able to compare the micro and macro levels of learning designs with technology and further our understanding of systematic, planned innovations