



**The University of Sydney**

# **Alignment of perceptions about the uses of ICT in Australian and New Zealand schools**

---

**Brief Review of Research Literature on the Benefits of  
ICT use in School**

**Peter Freebody, Peter Reimann and Angela Tiu**

**Centre for Research on Computer Supported Learning and Cognition,  
Faculty of Education and Social Work, The University of Sydney,  
Australia**

**August 2008**

## **The authors**

**Peter Freebody** is Professorial Research Fellow and member of the Centre for Research on Computer Supported Learning and Cognition (CoCo) in the Faculty of Education and Social Work at the University of Sydney, New South Wales, Australia.

**Peter Reimann** is Professor and Co-Director of CoCo in the Faculty of Education and Social Work at the University of Sydney, New South Wales, Australia.

**Angela Tiu** is a Research Assistant in the Faculty of Education and Social Work at the University of Sydney, New South Wales, Australia.

## **Acknowledgements**

The authors express their appreciation of the participation of the teachers, principals, other school leaders (such as departmental heads) and sector personnel (consultants and policy developers in regional and head offices) who responded to the survey.

The authors also acknowledge the assistance and support of Ms Margery Hornibrook, consultant to The Le@rning Federation, and The Le@rning Federations's contact liaison officers, who made a significant contribution to the study through their support for the research team.

# Content

---

Research background	4
Trends concerning ICT in schools	4
Studies of TLF materials	9
The research framework	14
References	18

## Research background

---

### Trends concerning ICT in schools

#### What is known about the impact of ICT on students?

While content is a necessary element of any educational ICT strategy, it is not sufficient for bringing about students' engagement and attainment. Many other elements need to be in place, such as access to the content, teachers' awareness of how to integrate it into teaching practices, and its integration into a whole-school e-strategy. All of them entail some measure of alignment with school leaders' visions and management practices.

A recent landscape review (Condie & Munro 2007), which incorporates information from over 350 individual studies, has identified positive impacts of ICT use on attainment '... in some contexts, with some pupils, in some disciplines ...' (p 4). The link between general and specific ICT measures and learning outcomes is still not well established; indeed, inherent methodological problems may mean that such a link cannot be unequivocally established. For instance, since students' ICT use is mediated substantially by teachers, it is difficult to find any direct relation between ICT use and students' learning outcomes; and many studies, in particular of the review and meta-study type, still look for effects of ICT in general, without taking into account the highly specific nature of different types of instructional ICT. The result is that we have no evidence for the benefits of, say, collaborative use of wikis or conferencing technologies for a mathematics tutorial.

Keeping these issues in mind, there is growing evidence in the research literature that certain classroom uses of ICT increase students' motivation to learn, engagement in learning and their independence in learning. The benefits of classroom use of ICT identified in the literature are increased levels of students' collaboration in learning, their higher levels of engagement and persistence in learning, and more on-task behaviour.

Evidence for gains in transcurricular areas such as creativity and critical thinking, however, is so far more mixed. The benefits seem particularly strong for technologies

that involve a visual element, such as digital video, multimedia, and software involving role-play and immersive elements. Language education has profited greatly from access to video and audio materials; science education has profited from animations and interactive simulations; graphic arts education has profited from the availability of software for images and drawing.

### **Trends in pedagogy**

One clear trend in pedagogy relating to ICT is personalisation. This is also a trend with direct implications for those concerned with the creation of digital content. What does personalisation mean for the student? According to 'Harnessing technology', a strategy paper of the UK Department of Children, Schools and Families (DCFS 2005), students are supposed to enjoy:

- multiple approaches to learning and subject matter
- more choice of subject matter
- flexible study time
- easier ways of trying things out before committing
- personal online learning space (with virtual learning environments).

Personalisation is a key element of the UK e-strategy for education, and is obviously dependent on the availability of substantive, high-quality digital content, accessible in a manner that allows for integration into personalised learning plans.

A second important trend is the rise of educational games and immersive environments.

Serious games, as distinct from leisure games, provide users and players with opportunities to explore non-leisure applications using games and immersive world applications for education and training, as well as supporting business and medical uses.

(de Freitas 2008)

A prominent example is Second Life, which now hosts many educational institutions and resources. While the impacts on learning are inconclusive, there is initial evidence that this form of learning resource fosters students' engagement in learning and their motivation to learn.

A third pedagogical trend is the integration of e-portfolios into the repertoire of assessment methods. Portfolio assessment, well established in areas such as graphic arts education, is now to be found in all areas of education. At the time of writing, portfolio assessment methods are probably employed most frequently in higher education, but they are increasingly considered in years K to 12. Portfolios add the important elements of learner-control and long-term 'diagnostic' information to supplement other forms of assessment. They are part of a larger movement towards performance-based assessment that builds on recording students' interactions with computer-based instructional materials, supplying important diagnostic information that is hard to gain from applying (standardised) tests.

### ***Trends in communication***

User-created content (for example, Flickr, YouTube) and net-based collaboration and socialisation (for example, Facebook) are the main drivers of change in user behaviour, converging into what is called Web 2.0. Young people in particular spend increasing amounts of their time on so-called social sites, and are among those that contribute most content to these sites. The social Web is an Internet phenomenon fuelled by the availability of mobile phones, their multimedia capacities and their integration with web technologies.

### ***Trends in technology***

The main trends in technology with direct relevance to the development and deployment of digital educational content are Web 2.0 technologies, learning design technologies and service-oriented architectures. Web 2.0 is not only a social phenomenon; it is also related to a growing number of technical innovations. At its core are technologies such as Ajax, that make possible the creation of data 'mashups' and provide potentially 'richer' user experiences for web content. Tagging technologies, the rise of folksonomies, and in general the (productive) tension between 'bottom-up', social knowledge creation and 'top-down' information (for example, ontology-based semantic web technologies) are all part of the developments that come with Web 2.0.

The trend towards service-oriented architectures in business computing is also beginning to affect educational computing. The idea behind service-oriented architectures is to optimise the re-use of computational resources and to make their

execution independent of their physical location. For educational computing this would mean, for instance, that a certain course structure that is defined at one location can be executed by orchestrating a potentially large number of services provided at other locations. This allows, for instance, the cross-platform mixing of elements such as learning management systems, social sites and immersive sites. A course run mainly on a Moodle server can refer to activities that take place in Second Life and combine them with elements from Google Docs or Facebook.

An important enabler in educational settings for the realisation of service-oriented architectures is the availability of learning design languages and standards. While learning objects encapsulate content and micro-interactions with users (in our case, teachers and students), learning designs encapsulate the process logic – including the roles and resources – required to describe pedagogical structures on a macro level (for example, courses, modules, lessons and collaboration scripts). This is an active field of research, driven not only by the need for standards (such as the evolving IMS learning design language) but also by the requirements of the users of such languages, especially teachers and instructional designers (Botturi, Derntl, Boot & Figl 2006).

### **Trends in the alignment of pedagogy and ICT use**

In the Sites 2006 study Law, Pelgrum and Plomp (2008) administered three questionnaires (for school principals, technology coordinators, and teachers of mathematics and science) to a sample of approximately 400 schools, involving about four teachers per school. Participation extended to 22 countries but not Australia. The main aim of the study was to find out:

- (a) the extent to which the characteristics of the innovative ICT-using pedagogical practices identified in SITES-M2 could be found within the general population of teachers, as opposed to only among those teachers identified as being involved in highly innovative practices
- (b) how the presence of these characteristics related to contextual factors at the school and system levels.

(Law et al 2008, p 9).

The Sites report distinguishes three broad categories of pedagogical orientation among teachers: ‘traditionally important’, ‘lifelong learning’ and ‘connectedness’. The latter refers to the extent to which students collaborate with peers and experts

outside the classroom to create products and publish results. Indicators for each orientation were identified in the three areas of espoused curriculum goals, reported teacher practices and reported student practices. ‘Lifelong learning’ and ‘connectedness’ were taken to be important elements of 21st century pedagogical practices.

In the Sites 2006 study the ‘traditionally important’ orientation was the one most frequently identified among teachers, and ‘connectedness’ the least so. This was also reflected in the stated priorities of school principals, although there was a trend towards seeing increasing value in orientations that reflect 21st century learning. Teachers’ views of students’ practices, however, were lowest on the ‘traditionally important’ orientation, revealing a potentially consequential misalignment between teachers’ aspirations and what they see realised in the classroom.

Significantly for our study, the Sites 2006 study found that, although ICT and Internet were available in almost all schools in the 22 participating countries, only 50% of the mathematics and science teachers interviewed reported having used ICT with their students. However, the variation on this item among the participating national systems ranged from below 20% of teachers to over 80%.

The study found some evidence that the use of ICT affected pedagogy in mathematics and science classrooms. With a few exceptions, teachers who used computers in their classrooms also showed more inclination towards realising elements of 21st-century learning, including, importantly, changes in teachers’ assessment practices. While these correlations cannot be interpreted as causal links, it is safe to conclude that the use of ICT in classrooms creates opportunities for teachers to change their pedagogy to include elements of lifelong learning and connectedness.

The Sites study also looked at factors that might affect teachers’ orientation towards ICT. Neither age nor gender differences were significantly correlated with ICT practices, but academic and professional qualifications, technical and pedagogical ICT competence, and attendance at ICT-related professional development were. Of these three, pedagogical ICT competence was the best predictor of adoption of ICT pedagogical practices. The lack of support from the school for the use of ICT in the classroom was the most frequently mentioned obstacle.

An important finding concerning the alignment of school management and teachers' practices in relation to classroom use of ICT relates to the relationship of teachers' classroom practices to principals' attitudes towards lifelong learning. In cases where the principal avowed lifelong learning in her or his vision of the role of ICT, the number of teachers who shared this orientation in their classroom practices increased significantly, provided that ICT was accessible and its use sufficiently supported. This is positive evidence for the role of leadership in pedagogical change and, more generally, in the alignment of policy and classroom practice.

## **Studies of TLF materials**

### **Observations, interviews, and surveys**

Below is a summary of findings from earlier studies of The Le@rning Federation (TLF) materials across Australia and New Zealand, based on direct observations, interviews and extensive surveys:

Teachers reported using the learning objects mainly:

- as an orienting / task-focusing device
- to help students develop new knowledge, concepts and skills
- to model activities not normally possible in the classroom
- to allow students to work at their own pace and level.

Teachers' ratings of students' learning outcomes were based on the extent to which TLF material assisted students to:

- learn factual content and direct content
- reach conceptual understandings
- build new concepts and apply knowledge to new settings.

On all three measures more than 80% of surveyed teachers indicated that the use of the learning objects was 'valuable'.

The use of learning objects was also in general supported enthusiastically by parent home-tutors and by students for their learning and motivational features.

A clear majority of students rated the learning objects as being ‘interesting’ and ‘fun’ and ‘easy to work through’, and more than half indicated that the learning objects helped them ‘think about new ideas’.

Students nominated the most helpful features of the learning objects to be: ‘providing opportunity to work at my own pace’, ‘getting feedback that tells me if I am right or wrong’ and ‘getting information that tells me how to do the activity better’.

A study of students’ perceptions of the learning objects they use (Freebody & Muspratt 2007a) found that students prefer learning objects that:

- allow them to interact with the learning object
- allow them control over their progress through the learning object
- do not look like conventional classroom activities
- are generally game-like.

There were no significant correlations in the survey data between general approval ratings and school locations, the proportion of students in the school who had language backgrounds other than English, the proportion of Indigenous students in the school, or the SES index of the school based on its surrounding community.

Multi-level modelling showed substantial variation within and between ratings of learning objects, ratings of individual learning objects within some curriculum domains being significantly higher than those in other domains, on various of the measures used.

### **Field experiments**

In addition to the survey, interview and observational studies, two extensive field experiments have been conducted. The first of these (Freebody, Muspratt & McRae 2006) was a pre-test/post-test study using two groups, one of which used learning objects and the other (control group) did not use them. This first experiment was conducted in years 5–7 mathematics in 19 classrooms. Testing was based on items drawn from the results of the Basic Skills Test conducted in each Australian state and territory at each of these year levels, which focus on the topic of ‘number’ (arithmetic) and the more complex topic of ‘chance’ (probability). Findings of the experiment included:

- reliable advantages for the learning object group on ‘chance’ items on the post-test for both year levels
- no reliable advantages for the learning object group on ‘number’ items on the post-test for year 5
- trending, non-significant, advantages for the learning object group on ‘number’ items on the post-test for year 7.

A second experiment involved 31 primary school teachers and 33 secondary school teachers in a pre-test/post-test study with one group using learning objects and a control group not doing so, in years 6–7 mathematics and science classrooms. The design of this study included a comparison between classrooms where the teacher administered the learning objects in a standard way, and those where the teacher used the learning object within the Moodle learning management system use. Findings included:

- predictably significant, strong and consistent effects for differences in entry levels (pre-test scores) on the post-test results, with no indication or trend for any diminution of their advantage as a result of either learning object or Moodle use
- significant positive effects for the use of learning objects in science, effects that were clear and relatively consistent
- no advantage for the group using learning objects in a Moodle learning management system format in science over either the learning object only group or the control group, overall or for any component of the science test
- with one exception, no reliable significant effects for either learning object use or Moodle use in mathematics, the exception being that there was a statistically reliable advantage for the Moodle group on items relating to linear functions. No effects were evident for the other topics.

### **Organisation and usage**

Finally, from site visits and focused case studies, the following conclusions were drawn concerning the rates of use of ICT in classrooms and their integration into classroom curricular work:

- There were common elements in effective use of ICT and its integration into classroom activity:

- commitment to ICT by school leadership
- a champion of ICT within the school
- a working plan for school-wide classroom use of ICT
- well-directed and high-quality ICT resources
- a substantial and effective program of professional learning.
- Teachers stated that they need time to ensure that their selection of learning objects, from an increasingly wide range, is appropriate to their needs.
- Technical difficulties presented ongoing frustrations to teachers and increasingly complex and consequential challenges to systems.
- Potentially new learning environments, as represented by the learning objects, were put to conventional, traditional, pedagogical work.
- School executives and leaders often tended to focus on organisational and procedural matters at a whole-school level, and only rarely on whole-school curriculum matters.
- A strategic approach to building teachers' capacity to integrate ICT into their learning and teaching programs did not typically take the form of cohesive, cumulative professional development at the jurisdiction level.
- Major variations were found in awareness and usage of ICT, and of learning objects more specifically; and in the extent to which learning objects were integrated into everyday classroom activities.
- Curriculum implementation in many schools was compartmentalised and faculty-based, with take-up of ICT and learning objects often varying strongly from department to department within a school, because the institutional ICT or learning object 'champion' had not managed to exert influence beyond his or her own department.

These studies, which have been largely focused on learning objects, have reached some converging findings, especially in relation to:

- the positive ratings of learning objects by all categories of respondents
- the efficacy of learning objects in learning settings, even when standardised assessment items are used (that is, items not generally well tailored to the kinds of learning activities reflected in most learning objects)
- problems with adoption and integration.

We return in particular to this latter issue in subsequent sections of this report, after considering briefly the TLF's digital repository and some related research from other sources.

A small-scale study of teachers' use of TLF's digital resources, undertaken in late 2006 (see Freebody & Muspratt 2007a), indicated that take-up and usage of the digital resources has been patchy. The findings of the study, which, given the size of the study, should be taken as only indicative, were that:

- on the whole, teachers found the digital resources to be educationally useful and valuable, accessible and easy to use, and helpful for motivating students
- the descriptions and guidelines that accompany the digital resources were seen as a crucial aspect of their usefulness and were regarded as clear, helpful and informative
- teachers suggested that their use of the digital resources would benefit from the search engine being refined so as to allow more precise location of relevant materials; and from an expansion of the very limited range of materials in some areas where digital resources would have high curricular value.

### **General**

In the concluding statement to their report on the value of learning objects in classrooms, Freebody and Muspratt (2007b) commented on the issue of adoption and the need for a more concerted approach to understanding adoption and diffusion:

An additional major research and development interest arises from the findings of the site visits: how to build ICT take-up, familiarity and confidence among teachers. This issue connects closely with the general research on ICT dissemination and adoption. It also links with the previously stated need for detailed studies of actual and mature use of ICT: it is only through increased dissemination and adoption that evaluation programs will be able to move beyond the scrutiny of immature practice. Until that happens, an appreciation of the potential benefits of ICT innovation, including those of TLF's learning objects, is unlikely to attract the attention of those who determine educational policy and decisions. (p 63)

The study reported here aims to be, among other things, the first step in research to address these issues.

## The research framework

---

While the provision of learning objects and digital resources can be seen as a curriculum innovation, the ‘end users’ – teachers and school personnel – most probably see these also as a technology innovation, more precisely as an ICT innovation. This is almost certainly the case in those situations where TLF content is not directly presented but rather mediated by the teacher, that is, where students are directly working with TLF content on a computer, in a lab and/or at home, with access perhaps mediated by a portal. In such situations, the use of TLF content is as much a technology innovation as it is a curriculum innovation, and is subject to all the challenges that technology innovations face in schools and other institutions. For instance, ICT innovations have been a particular challenge for the educational system because they require a more than ‘loose coupling’ (Weick 1976) between the components of the organisation than educational organisations traditionally provide. In this section, we therefore provide a brief overview of some of the research on ICT innovations in schools, and describe how our survey study builds on this research.

We focus in particular on research on sustaining and scaling-up technology innovations. This because the early challenges that many technical innovation face in school systems (lack of infrastructure, lack of professional development, non-alignment with curriculum and standards) are no longer the main challenges that TLF content seems to face. TLF content as well as the delivery technologies associated with it (CDs, DVDs, web portals, Learning Management Systems) have been available in (most) schools for a number of years, and are well integrated, both into curriculum and infrastructure.

Although the presence of ICT is now commonplace in schools, its use varies greatly between teachers in quantitative terms (for example, time); and the quality of technology use for learning is generally low (Fishman, Marx, Blumenfeld, Krajcik & Soloway 2004). While ICT-enhanced innovations brought to schools by professional designers and researchers may be initially accepted, sustaining them beyond the time when designers have left the school, and scaling up innovations beyond the local contexts are still hard to achieve. Fishman and others (2004) identified ‘usability’ as a success factor: ‘innovation is usable if a school organisation can adapt the innovation

to local context, enact the innovation ‘successfully’ ... and sustain the innovation’ (p 51).

A variety of other potential reasons have been identified, some of which include: teacher capabilities, technology infrastructure, school culture, and organisational constraints. Given that each of these factors has been found to affect ICT and innovation adoption, the conclusion ought to be that the causes are *systemic*, that is, they are embedded not only in individual attitudes and capacities, but in the interdependencies of different factors and different levels that make up the educational system as whole. The systemic nature of ICT-based innovation is also evident in success stories on technology integration in schools (Kozma 2003; Means, Blando, Olson, Middleton, Morocco, Remz et al. 1993). Further, this argument is congruent with the more general literature on educational and organisational change and innovation (Senge 2000; van de Ven & Hargrave 2004).

Means and others (1993) identified six common features of successful technology implementation efforts:

- ready technology access and technical support
- instructional vision and a rationale linking the vision to technology use
- a critical mass of teachers involved in technology activities
- a high degree of collaboration among teachers
- strong leaders
- support for teacher time for planning, collaboration, and reporting technology use.

Although not explicitly formulated in terms of a systemic framework, these features speak strongly for the importance of alignment among change agents and between organisational levels.

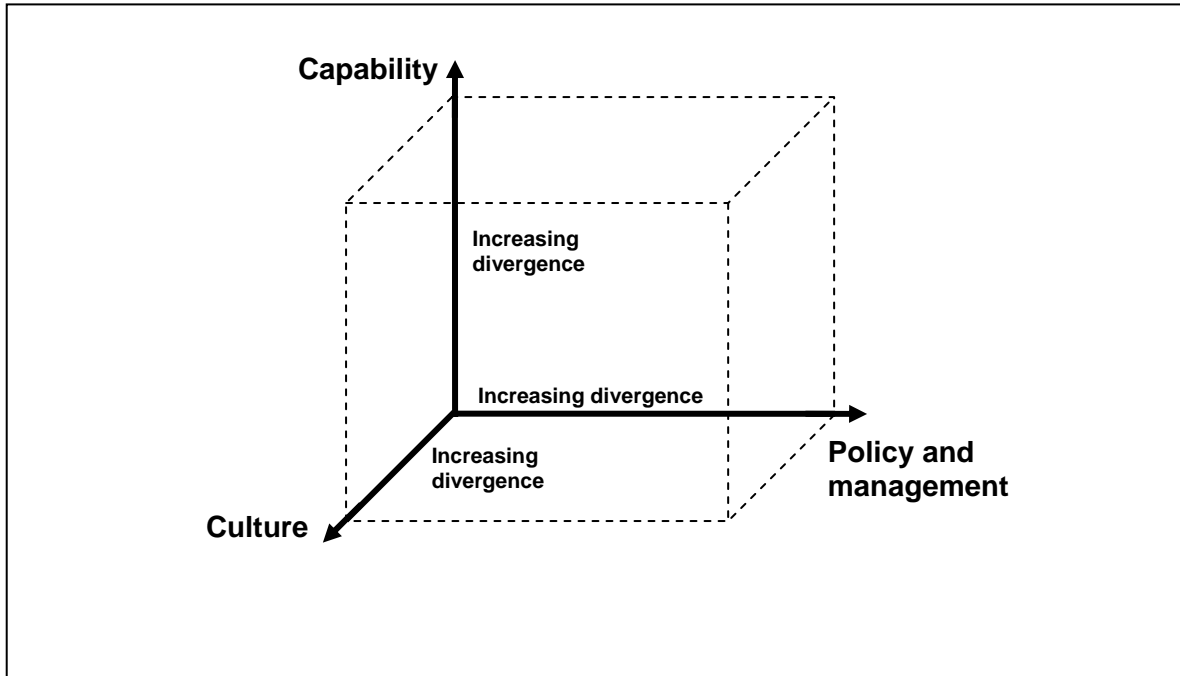
More directly addressing the issue of alignment, Knapp (1997) argued that pivotal to successful reform is that the major ideas are interpreted in a similar manner at all levels of the school system. Indirect evidence for this ‘interpretational alignment’ claim is provided by the numerous studies that show that ‘bottom-up’ innovations in general scale up better and are more sustained than ‘top-down’ reforms (for example, Honey & McMillan-Culp 2000).

Blumenfeld, Fishman, Krajcik, Marx and Soloway (2000) identified organisational culture, capability, and management and policy as three areas impacting on whether instructional innovation will be adopted and sustained. *School culture* refers to local norms, routines, and practices. If an instructional reform is inconsistent with school culture, it will be rejected or subverted (Fullan 2001, Tyack & Cuban 1995). For instance, a school climate that supports risk taking and open communication about what works and does not work is more conducive to the spread of ICT based learning practices. *Capability*, in particular but not only teachers' beliefs, understanding of the reform, and their expertise in carrying it out is another impediment (Blumenfeld et al 2000). As discussed above, and along with other reports, the recent third Sites study shows (Law et al 2008) that ICT is still not used much by many teachers, not even in science and mathematics. Capability development in the form of professional development appears to have been too focused on the merely technical aspects and not enough on pedagogy and classroom integration.

The extent to which instructional innovation will be sustained, according to Blumenfeld and others, depends thirdly on establishing appropriate *policies and management*. While educational policies seem to be increasingly well aligned with the educational potentials of ICT (with the notable exception of assessment and testing, (Fishman et al 2004)), management strategies and practices have, by and large, been less responsive to change. For instance, only a comparatively small number of schools engage in the kind of strategic planning that is required to align ICT with pedagogical and organisational goals and processes (for example, Baldrige National Quality Program 2007).

An educational system needs to develop capacity in all three areas – culture, capability, policy and management – to sustain reform (McLaughlin 1987). Further, successful reform requires working on these aspects *simultaneously* to create capacity (Fullan & Miles 1992). *Systemic reform* has been proposed as a way to overcome the problem of uncoordinated or even contradictory change efforts (Vinovskis 1996). Technical innovation needs typically to be accompanied by curriculum changes, alignment of assessment requirements, and by professional development in order to stand a chance to be sustained. The argument is that, unless a reform is systemic, its *scalability* will be limited.

In summary, challenges to innovation in systemic reform can be conceptualised as located in a space formed by three axes: Culture, Capability, and Policy & Management (see Figure 1).



**Figure 1: Dimensions of innovations in systemic reform (from Blumenfeld et al 2000, p 153)**

## References

---

- Baldrige National Quality Program (2007). Education criteria for performance excellence, [www.quality.nist.gov/Education\\_Criteria.htm](http://www.quality.nist.gov/Education_Criteria.htm) (retrieved 3 September 2008).
- Blumenfeld, P, Fishman, BJ, Krajcik, J, Marx, RW & Soloway, E (2000). 'Creating usable innovations in systemic reform: Scaling-up technology-embedded project-based science in urban schools', *Educational Psychologist*, vol 35, no 3, pp 149–64.
- Botturi, L, Derntl, M, Boot, E & Figl, K (2006). 'A classification framework for educational modeling languages in instructional design', paper presented at the Sixth IEEE International Conference on Advanced Learning Technologies, Kerkrade, Pays-Bas.
- Condie, R & Munro, B (2007). The impact of ICT in schools - a landscape review, *Becta Research*. Quality Education Centre, University of Strathclyde. [http://partners.becta.org.uk/upload-dir/downloads/page\\_documents/research/impact\\_ict\\_schools.pdf](http://partners.becta.org.uk/upload-dir/downloads/page_documents/research/impact_ict_schools.pdf) (retrieved 11 September 2008).
- Dana, NF & Silva, DY (2003). *The Reflective Educator's Guide to Classroom Research: Learning to Teach and Teaching to Learn through Practitioner Inquiry*, Corwin Press, Thousand Oaks, CA.
- De Freitas, S (2008). 'Emerging trends in serious games and virtual worlds', in *Emerging Technologies for Learning*, vol 3.
- Fishman, B, Marx, RW, Blumenfeld, P, Krajcik, J & Soloway, E (2004) 'Creating a framework for research on systemic technology innovations', *The Journal of the Learning Sciences*, vol 13, no 1, pp 43–76.
- Freebody, P & Muspratt, S (2007a). The Le@rning Federation's digital resources: A preliminary study of access, use and value, The Le@rning Federation [http://www.thelearningfederation.edu.au/verve/resources/dr\\_report\\_11\\_02\\_07.pdf](http://www.thelearningfederation.edu.au/verve/resources/dr_report_11_02_07.pdf) (retrieved 11 September 2008).
- Freebody, P & Muspratt, S (2007b). Uses and effects of The Le@rning Federation's learning objects: An experimental and observational study, Ministerial Council on Education, Employment, Training and Youth Affairs [http://www.thelearningfederation.edu.au/verve/resources/tlf\\_report\\_final.pdf](http://www.thelearningfederation.edu.au/verve/resources/tlf_report_final.pdf) (retrieved 11 September 2008).
- Freebody, P, Muspratt, S & McRae, D (2006). Early-stage use of The Le@rning Federation's learning objects in schools: Results of a field review, Ministerial Council on Education, Employment, Training and Youth Affairs [http://www.thelearningfederation.edu.au/verve/resources/freebody\\_tlf\\_report\\_stage2.pdf](http://www.thelearningfederation.edu.au/verve/resources/freebody_tlf_report_stage2.pdf) (retrieved 11 September 2008).
- Fullan, M (2001). *The New Meaning of Educational Change* (3rd edn), Teachers College Press, New York.
- Fullan, MG & Miles, MB (1992). 'Getting reform right: What works and what doesn't', *Phi Delta Kappa*, vol 73, pp 745–52.

- Honey, M & McMillan-Culp, K (2000). 'Scale and localization: The challenge of implementing what works', in M Honey & C Shookhoff (eds), *The Wingspread Conference on Technology's Role in Urban School Reform: Achieving Equity and Quality* The Joyce Foundation, Racine, WI, pp 41–6.
- Knapp, MS (1997). 'Between systemic reforms and the mathematics and science classroom: The dynamics of innovation, implementation, and professional learning'  
[http://archive.wceruw.org/nise/Publications/Research\\_Monographs/KNAPP/Knap pALL.pdf](http://archive.wceruw.org/nise/Publications/Research_Monographs/KNAPP/Knap pALL.pdf) (retrieved 22 August 2008).
- Kozma, RB (ed) (2003). *Technology, Innovation, and Educational Change: A Global Perspective*, ISTE, Eugene OR.
- Law, N, Pelgrum, WJ & Plomp, T (2008). *Pedagogy in ICT Use ('Sites 2006')*, Springer, Berlin.
- Means, B, Blando, J, Olson, K, Middleton, R, Morocco, CC & Remz, AR (1993). Using technology to support education reform, (OR 93-3231), U.Sc Government Printing Office, Washington, DC  
<http://www.ed.gov/pubs/EdReformStudies/TechReforms> (retrieved 9 September).
- Sandoval, WA & Bell, P (2004). 'Design-based research methods for studying learning in context: Introduction', *Educational Psychologist*, vol 39, no 4, pp 199–201.
- Senge, PM (2000). *Schools that Learn: A Fifth Discipline Fieldbook for Educators, Parents and Everyone Who Cares about Education*, Nicholas Brealey, London.
- Tyack, D & Cuban, L (1995). *Tinkering towards Utopia: A Century of Public School Reform*, Cambridge University Press, Cambridge, MA.
- van de Ven, A & Hargrave, TJ (2004). 'Social, technical and institutional change', in MS Poole & Avan de Ven (eds), *Handbook of Organizational Change and Innovation*, Oxford University Press, Oxford, pp 259–303.
- Vinovskis, MS (1996). 'An analysis of the concept and uses of systematic educational reform', *American Educational Research Journal*, vol 33, no 1, pp 53–86.
- Weick, KE (1976). 'Educational organizations as loosely coupled systems', *Administrative Science Quarterly*, vol 21, pp 1–19.