Pedagogies and Digital Content in the Australian School Sector

Robert Baker

Education Services Australia

A merger of curriculum corporation and education.au creative capable connected

THE le@rning FEDERATION

Pedagogies and Digital Content in the Australian School Sector

Robert Baker

Education Services Australia

A merger of curriculum corporation and education.au creative capable connected

THE le@rning FEDERATION

Acknowledgements

The Le@rning Federation, Education Services Australia gratefully acknowledges the work of all the schools and teachers who contributed to this research.

The teachers whose contributions are included in this report are Patricia Corby, Jamie Sharp, Lynette Barker and Nicole McGrath.

Additional teachers and schools were involved in the broader research exercise, and we would like to thank them for their contributions and interest.

Much appreciation and thanks must go to each of the Australian education jurisdictions for their contributions and advice throughout the development of this research.

The project team

The project team for the investigation included Robert Baker, Stuart Tait, Di Kerr, Olivia Clarke, Rachel Kennedy and Jen Aughterson.

Contents

Executive summary **1**

Background 1
Methodology 1
The policy context 2
Theories of student learning 2
Models of teaching and learning 3
Teacher skills and capabilities 4
Collaboration, innovation and communication 5
Digital content 5
Technology-rich learning environments 6

Introduction **9**

Needs of learners and the changing online environment 9
Methodology 10

The digital revolution and schools **11**

ICT enablers 12

Quality of pedagogy **13**

Theories of student learning 13
Models of teaching and learning 18
Teacher skills and capabilities 24
Collaboration, innovation and communication 30

The learning environment **35**

Digital content 35
Technology-rich learning environments 41

Conclusion **49**

Appendix 1 **52**

Glossary **54**

References **59**

How have successive national policies taken account of rapid and continuing advances in technologies that are changing the way that people share, use, develop and process information?

Executive summary

Background

The *Joint Ministerial Statement on Information and Communications Technologies in Australian Education and Training: 2008–2011* (MCEETYA & MCVTE 2008), agreed to by all Australian ministers of education, identifies a goal and supporting strategies for achieving high-quality learning outcomes through the provision and use of technology-enriched learning environments. The *Statement* identifies a number of areas for national collaboration, including educators' capabilities; their access to information and communication technologies (ICT); a secure and robust infrastructure; systems and architectures that enable access to, and the transfer and sharing of, information; and affordable access to appropriate online resources.

In response, Millea and Galatis (2009) developed a cross-sectoral survey report regarding the ICT enablers defined in the *Joint Ministerial Statement.* Their report, which focused on collaboration in teaching and learning, was commissioned by Education.au. The ideas contained in that report have implications for the school, technical, further and higher education sectors. This subsequent report, *Pedagogies and Digital Content for Online Learning*, has been developed by The Le@rning Federation: Schools Online Curriculum Content Initiative (TLF) to build on this cross-sectoral research and focus specifically on appropriate pedagogies for the use of digital content in the Australian school sector.

Methodology

The approach used in developing this report was to investigate relevant international and Australian theory and practice, re-examine contemporary school-based data about how state-of-the-art tools can 'enable new forms of learning, collaboration, innovation and communication' (MCEETYA & MCVTE 2008, p 1), and consult with policy makers and teachers with high-level expertise in the use of digital content in the school sector.

Contemporary school-based data available to the research team about teacher and student collaboration in online environments included student and teacher questionnaires, observations from focus groups, an examination of teacher-developed online learning activities and subsequent student collaborations, and teacher interviews. The data was collected from schools in four education jurisdictions within Australia; the schools included both primary and secondary settings and the government and Catholic education sectors. The initial findings from this data were published in 2009 by TLF (Baker 2009).

The following research questions guided the development of this report:

- How have successive national policies taken account of rapid and continuing advances in technologies that are changing the way that people share, use, develop and process information?
- What learning theories or frameworks are most useful for understanding how students most effectively learn in online environments?
- Are there models of teaching and learning that effectively harness digital content and powerful online tools for information processing, communication and collaboration?
- What skills and capabilities will teachers need in order to access and use repositories of suitable, exciting, culturally appropriate, discoverable and affordable digital content?
- How can digital content be used to support collaboration, innovation and communication?
- What are the attributes of technology-rich learning environments that support innovation and collaboration?

The policy context

The report is informed by the public policy drivers of education reform in Australia, outlined in *The Melbourne Declaration* (MCEETYA 2008), the aforementioned *Joint Ministerial Statement* (MCEETYA & MCVTE 2008) and the Digital Education Revolution (2008–2011). Taken together these documents outline the infrastructure, teacher capabilities, learning resources and leadership required to enable the effective use of ICT in the Australian school sector. These documents were in turn derived from earlier agreed policies and are contextualised by similar policy initiatives internationally.

Rapid and continuing advances in ICT are changing the ways that people share, use, develop and process information technology. However, research in Australia and the United Kingdom has also identified that while there has been considerable investment in infrastructure, digital content and quality teaching, 'only a minority [of teachers and students] are reaping the benefits of the information technology revolution' (COAG Productivity Working Group 2008).

Australia has developed a range of strategies and work plans to support the Digital Education Revolution and to overcome perceived barriers to change. The research team has identified key elements of national ICT policy for schools that relate to pedagogies and digital content for online learning, and the online learning environment. These include:

- 'Australia will have technology enriched learning environments that enable students to achieve high-quality learning outcomes and productively contribute to our society and economy.'
- 'Schools should support the development of skills in areas such as social interaction, cross-disciplinary thinking and the use of digital media.'
- 'Learners are active participants in knowledge creation and will engage with state of the art tools which enable new forms of learning, collaboration, innovation and communication.'
- 'While there has been a significant investment in educational technologies over the last decade, only a minority [of teachers and students] are currently reaping the benefits of the digital revolution.'

Sources: MCEETYA 2008, pp 5, 8; MCEETYA & MCVTE 2008; COAG Productivity Agenda Working Group 2008, p 3

High-quality and relevant digital content can be provided to teachers and students in technology-rich online learning environments which enables new forms of learning, collaboration, innovation and communication (Baker 2009). This report outlines the enablers of and barriers to successful use by students and teachers of such environments.

Theories of student learning

Knowledge about how students learn is essential if teachers are to create learning activities that are intellectually rigorous, use the physical and online environment effectively, and are attuned to new ways of learning in the digital age.

While prior Australian research has found that Australian teachers are generally familiar with constructivist theories of learning design (Holkner et al 2008), TLF research to date (Baker 2009) indicates that many teachers find it difficult to apply these theories to online learning activities. Teachers who are experienced in developing and using online learning are generally familiar with and experienced in using constructivist, social and situational approaches. Less experienced teachers with more limited expectations of their students' capacity for online learning may frequently resort to behaviourist teaching and learning approaches.

The research team found that teachers benefited from receiving an introduction to and outline of a range of learning theories appropriate for the use of digital content and online learning.

The most effective way of linking abstract theories of learning to learning design and learning management is through professional development programs and the provision of online models of effective learning design.

Collaborative online learning provides particular challenges and opportunities for teachers. In planning and managing collaborative learning, teachers can benefit from an understanding and skilled use of Engestrom's Human Activity Theory, Cooperative Learning (Johnson & Johnson 1994) and Connectivism (Siemens 2005).

Findings

The research team made the following findings concerning the role of learning theories in enabling the effective use of digital content for online learning:

- Teachers may require assistance in unpacking the assumptions they make about how students learn and the pedagogical approaches they use to support these.
- Constructivist and situative theories of learning or perspectives are useful for online learning in that they are learner centred and take account of individual and group needs and interactions.
- Connectivism and Cooperative Learning take account of a whole new set of learning requirements brought about by the digital age, and can provide a theoretical basis for collaborative learning.

Models of teaching and learning

Collaborative online learning presents new challenges and opportunities for teachers and students. TLF research (Baker 2009) indicates that it is possible for teachers and students to engage with state-of-the-art tools that enable new forms of learning, collaboration, innovation and communication. This action research indicates that a significant majority of students are highly positive about collaboration for learning in technology-rich learning environments.

However, the preliminary research also found that effective learning activity design was essential if students were to engage positively with digital content in technology-rich online learning environments.

In this current study, a number of models have been used to underpin learning activity design. The most effective of these models ensures that the necessary interconnections take place between the needs of learners, the physical and online environments used, the collaborative dimension, and the intended learning outcomes. While these models can be used in offline as well as online learning, they require new skill sets when applied to online learning, given the nature of digital content and tools as well as the dynamics of online collaboration between teachers and students.

Professional learning should allow teachers to gain confidence and expertise in the use of state-of-the-art tools that can be used for interaction and collaboration.

Findings

The research team made the following findings in relation to learning activity design that supports effective online learning:

- Learning activity design in its varied formulations can provide an effective theoretical and practical model for online learning in that it takes account of interactions between the needs of learners and the learning environment, and between people participating in the online learning activity.
- There is value in defining the theoretical and practical elements of successful design for online learning for teachers who are developing skills and capabilities in the use of online learning.
- Models of learning activity design should be developed or sourced that are relevant to teachers at all levels of schooling and in different learning areas. The interactive and digital curriculum content procured by TLF can be used to provide exemplary learning materials within such models.

Teacher skills and capabilities

A number of international and Australian pedagogical frameworks and ICT continuums are relevant to the skills and capabilities required of teachers who seek to develop pedagogical expertise in the use of both digital content and technology-rich learning environments. These include *A National Framework for Professional Standards for Teaching* (TQELT 2003) and subsequent frameworks and ICT continuums developed by Australian jurisdictions and sectors.

While there is a degree of similarity among these frameworks and continuums, the research team found that there are also fundamental divergences, such as the number of levels of capability required of teachers, and the aspects of ICT that the continuums define. The *Teaching for the Digital Age Work Plan 2009–2012* developed by the Australian Information & Communications Technology in Education Committee (AICTEC) contends that 'Agreed national standards [should be] … used for the incorporation of ICT in teaching and learning for practising teachers at critical career stages' (AICTEC 2009).

International collaboration to define standards that describe the development of teacher capabilities and skills in the use of ICT has resulted in the UNESCO *ICT Competency Standards for Teachers* (UNESCO 2008A, B & C). These standards were intended to be models for countries to adapt in developing local ICT competency standards for teachers.

Findings

The research team made the following findings relating to teacher skills and capabilities enabling the effective use of pedagogies and digital content for online learning:

- Twenty-first-century schools require 21st-century programs and educators capable of using 21st-century resources and strategies for learning (AICTEC 2009, p 3).
- Teachers require detailed pedagogy frameworks that integrate the varied uses of ICT for curriculum and assessment, pedagogy, organisation and administration, and professional learning.
- There is a need for increased collaboration at a national level in the sharing of existing programs and the development of new programs (AICTEC 2009, p 7). Such collaboration might usefully align or develop agreed standards for teachers in the use of ICT in schools.
- There would be an advantage in mapping any new or redeveloped standards against UNESCO's *ICT Competency Standards for Teachers* (2008A, B & C) as well as against the skills defined for students within the ICT continuum to be developed for the Australian curriculum.

Collaboration, innovation and communication

International and Australian research confirms that systematic and sustained professional learning is required if teachers are to enable learners to be active participants in knowledge creation when using online environments for new forms of learning, collaboration, innovation and communication. Such learning should be based on agreed national principles such as those contained in the AICTEC *Work Plan* (AICTEC 2009).

Systematic and 'just-in-time' learning support is required if teachers are to develop effective learning activities for the use of digital content in online environments. The research team identified a range of professional learning activities and materials that have been developed by education jurisdictions and sectors within Australia. These support general skill development, may be targeted to specific learning areas, or provide guidance about learning design for online environments.

The *Joint Ministerial Statement* on ICT calls for 'National collaboration across Australian education and training jurisdictions and sectors to share resources and expertise, and to leverage existing initiatives while recognising the importance of innovation and experimentation'. This provides new opportunities to consider how national approaches to professional learning can fast-track the development of teacher capabilities to meet emerging challenges of 'collaborative communication and knowledge-building tools' within technology-rich learning environments (MCEETYA & MCVTE 2008 p 1).

Collaborative online learning presents new challenges and opportunities for teachers. Professional learning that can take account of such collaboration will be required if teachers are to create effective models of learning activity design that enable students to collaborate, innovate and communicate in online learning environments.

Findings

The research team made the following findings in relation to professional learning that enables collaboration, innovation and communication when using digital content in online environments:

- The design of professional learning needs to conform to standards of best practice that are supported by the Australian education jurisdictions and sectors.
- Professional learning should be developed that meets the needs of teachers at various stages of knowledge, skills, understanding and practice.
- Professional learning should include an understanding of learning theories relevant to the new forms of learning, collaboration, innovation and communication made possible by the availability of accessible, high-quality digital content and technology-rich learning environments.
- Professional development and advice concerning the use of online learning environments needs to move beyond imparting knowledge of the platform and the tools to include resource selection and evaluation, learning activity design and assessment.
- Professional learning should allow teachers to gain confidence and expertise in the use of state-of-the-art tools that can be used for interaction and collaboration.
- National and local online discussion groups and forums that allow teachers to share ideas and best practices can play a role in supporting professional learning.
- Professional learning can target teacher interest in the new Australian curriculum and explore how digital resources can be used to support aspects of the curriculum at all levels of schooling.

Digital content

Since 2001, TLF has developed, procured and quality assured digital content on behalf of the Australian and New Zealand ministers of education to support student learning. This content has included interactive and non-interactive digital curriculum content. For the purposes of this report, discussions of digital content are confined to these resources.

The Le@rning Federation has procured for Australian schools more than 8,800 items of interactive and non-interactive digital curriculum content. Schools are highly positive about the capacity of such content to engage and motivate students at all stages of schooling.

Digital content has been procured by TLF to meet the needs of a number of curriculum priority areas. The new Australian curriculum presents both opportunities and challenges for creating new digital content, for example a new focus in learning areas such as History (eg Prehistory) and the requirement that the Australian curriculum is developed for each year level.

Collaborative online learning presents new challenges and opportunities for providers and users of digital content. While digital content in the form of digitised photographs, images, video and audio can be accessed and used in collaborative learning environments, the use of interactive digital content (ie learning objects) typically involves individual learners engaging with a critical educational concept. Very few interactives developed by TLF cater for multiple users, and there is potential to re-engineer this type of content to enable collaborative online learning.

The *Strategic Plan* for the Digital Education Revolution recognises the need for 'models of learning and teaching that effectively harness digital resources in the delivery of high quality education programs' (COAG Productivity Agenda Working Group 2008, p 7). There is value in ensuring that ICT capability standards provide explicit advice about how teachers can gradually develop confidence and competence in the selection and use of digital content for teaching. The UNESCO *ICT Competency Standards for Teachers: Implementation Guidelines Version 1.0* (UNESCO 2008C) might be used as a model for describing teacher capability and expertise in the use of digital content within a continuum.

Current or newly developed competency standards need to be supported by 'just-in-time', flexible professional learning. Such learning should model for teachers appropriate pedagogies for the use of digital content. The research team believes that there are opportunities for national collaboration by jurisdictions and sectors to create professional learning that can support the effective use of nationally procured digital content.

Findings

The research team made the following findings in relation to the use of digital content in online learning environments:

- While the design of interactive digital content procured by TLF is based on sound constructivist principles, there is an absence of interactive digital content that explicitly caters for social learning and collaboration. Any re-engineering of existing interactives or development of new content should consider this need.
- The structure and content of the new Australian curriculum provides opportunities for the procurement of new digital content for use by teachers.
- Teachers require clear guidelines and advice about the capabilities and skills required to access and use digital content for teaching and learning.
- While education jurisdictions and sectors have developed pedagogy frameworks and ICT continuums, these may not provide consistent or detailed advice about pedagogies that support the use of digital content for online learning.
- National collaboration and cooperation in the development of advice and professional learning about the use of digital content would have benefits for cost, efficiency and comprehensiveness.

Technology-rich learning environments

Discussions about the nature of digital content cannot be divorced from the learning environments in which such content is accessed and used. While major investments have been made in Australia to roll out infrastructure, develop digital content and build teacher capability, 'only a minority [of teachers and students] are reaping the full benefits of the information technology revolution' (COAG Productivity Agenda Working Group 2008, p 3). These Australian findings are mirrored in other developed economies (Green & Hannon 2007, p 16). Research has found that major impediments to the accessing and effective use of digital content, state-of-the-art tools and online learning in Australia include the deployment of computers in schools, bandwidth, the variability

of digital content, and the lack of inclusion of online learning in classroom practices (COAG Productivity Agenda Working Group 2008, p 7). The Working Group (2008, p 7) has identified potential improvements and aspirational goals to resolve these issues.

Teachers in a number of learning areas, particularly secondary school teachers, still lack regular access to ICT infrastructure, and are consequently uncertain about how to develop challenging and authentic design for online learning. Student management can remain an issue for teachers who choose to or are constrained to use computer laboratories as the learning space, particularly if they are inexperienced in managing a technology-rich learning environment. Fewer teachers have a concept of what a technology-rich learning environment comprises and are able to use such an environment to regularly support online learning.

The use of interactive whiteboards is becoming increasingly widespread in schools in developed economies. Significant research in Australia and internationally has indicated the benefits of teachers using this hardware for modelling learning for their students. As with any new technology, effective use of interactive whiteboards requires specific skills. Research in Australia (Hedberg & Freebody 2007; Sweeney, cited in Millea & Galatis 2009) and in the United Kingdom (Becta 2005) has identified the importance of professional learning that enables teachers to progress through a number of stages in their use, ranging from whiteboard replacement to interactive and synergistic use.

What is meant by the term 'state-of-the-art tools' is necessarily influenced by temporal considerations. The *Strategic Plan* for the Digital Education Revolution affirms that 'tools are required for safe and secure knowledge sharing and collaboration' (COAG Productivity Agenda Working Group 2008, p 7). The experiences of Becta in the United Kingdom, The New Media Consortium in the USA and the case studies described in the student trial within TLF's Museum and Education Digital Content Exchange project (2009) indicate that social networking tools are only one type of collaborative tool that is relevant to online learning.

There are a number of Web 2.0 tools relevant to online learning environments and appropriate for the Australian school sector. They include collaborative tools that enable media sharing and manipulation, conversational arenas, virtual worlds, social networking, blogging, social bookmarking, recommender systems, collaborative editing, wikis and syndication (Crook et al 2008).

Findings

The research team made the following findings in relation to the use of pedagogies and digital content in technology-rich learning environments:

- Technology-rich learning environments can include the physical environment in which the learning occurs as well as online environments that incorporate state-of-the-art tools enabling new forms of learning, collaboration, innovation and communication.
- Technology-rich learning environments offer both challenges and opportunities for teachers. Teachers need clear advice and training regarding the most appropriate environment for their own and their students' skills.
- Only a small proportion of Australian teachers currently have the skills required to create learning activity design that can engage students collaboratively in online learning environments.
- Interactive whiteboards and mobile technology offer considerable teaching and learning opportunities for teachers and students. Guidelines and models are required if teachers are to progress beyond the use of interactive whiteboards for solely instructional purposes.
- When students are provided with digital content in technology-rich learning environments they respond positively to the new opportunities for learning and collaboration that are provided.

What learning theories or frameworks are most useful for understanding how students most effectively learn in online environments?

Introduction

In 2008, Australian governments committed to a *Joint Ministerial Statement on Information and Communications Technologies in Australian Education and Training: 2008–2011*. The *Joint Ministerial Statement* acknowledges that technologies are transforming the curriculum and changing the way learners operate, learn and interact. It asserts that 'Learners are active participants in knowledge creation and will engage with state-of-the-art tools which enable new forms of learning, collaboration, innovation and communication' (MCEETYA & MCVTE 2008, p 1).

An initial report for the Museum & Education Digital Content Exchange (M&EDCE) project and trial (Baker 2009) identified the skills required of teachers when designing collaborative learning activities within a technology-rich online environment. The report focused on student responses to the digital content selected by teachers; the models of online learning that teachers used; and the collaborative toolset provided within the online environment.

This current research investigation has been developed out of the results of the trial and as a response to government policy proposals for online learning such as the *Joint Ministerial Statement*. Its aim is to identify appropriate pedagogies, digital content and learning environments for optimum online learning in the digital age.

Needs of learners and the changing online environment

Since 2001, The Le@rning Federation (TLF) has procured and quality assured new digital content to support students' learning of the key concepts and skills detailed in Australian and New Zealand curriculum documents. During this period, TLF has led innovation and research into educationally sound online curriculum content and its use by schools.

To date, TLF has produced more than 8,800 items of digital curriculum content, which has been made available to schools through educational jurisdictions. Research by TLF on behalf of the Australian and New Zealand ministries of education over an eight-year period indicates that this digital content enhances motivation, engagement and learning.

Within Australia, The Le@rning Federation has led innovation and research into educationally sound online curriculum content and its use in schools through the publication of more than 50 reports and strategy papers, including:

- *What to Make and Why: Principles for the Design and Development of Online Curriculum Content* (McRae 2001)
- *Achieving Educational Soundness in the Digital Age* (Atkins 2003)
- *Does the Use of Online Curriculum Content Enhance Motivation, Engagement and Learning?* (Freebody 2005)
- *Uses and Effects of The Le@rning Federation's Learning Objects: An Experimental and Observational Study* (Freebody & Muspratt 2007)
- *Alignment of Perceptions about the Uses of ICT in Australian and New Zealand Schools* (Freebody, Reimann & Tiu 2008)
- *Use of The Le@rning Federation Digital Curriculum Resources in Australian Pre-Service Tertiary Institutions* (TLF 2009)

Atkins's 2003 report argued for the development of educationally sound, interactive digital curriculum resources, and identified a number of key challenges for producers of digital content for the school sector. These included the need for pedagogically based learning design that would take account of engagement and interactivity, successful learning, constructivist learning theory, inquiry models, critical pedagogy, and the appropriate use of the medium. While Atkins highlighted the needs of the learner, TLF specifications arising out of this and other research did not fully anticipate how emerging technologies would develop new forms of learning, collaboration, innovation and communication.

Six years later, there is an opportunity to rethink the connection between educationally sound digital content, the multiplicity of ways that teachers and students engage with this content, and how emerging technologies are creating a new paradigm for the delivery and use of digital content in schools.

The first report for the M&EDCE project (Baker 2009) used a case study approach to examine models of collaborative online learning using digital content provided by a number of cultural organisations. That research has enabled the development of a more general survey report, about digital content and pedagogies for online learning, that can test the findings of the first report against other national and international research. The initial report identified a wide variation in teachers' ability to use technology-rich learning environments to support student learning. This variation was partly the result of differences in values, knowledge, understanding, skills and experience in catering for new kinds of learning when using digital content in an online environment.

Methodology

Developing this second report from the M&EDCE project and trial involved stepping back and reconsidering the challenges for teachers who seek to design authentic, effective learning activities using online learning environments.

An analysis of national policy on the use of ICT in the school sector preceded desk-based research and consultation. This analysis shaped the research questions that have guided this report and are discussed within it. These research questions were designed to identify relevant policy; digital content and tools that assist students to collaborate, innovate and communicate; the qualities of technology-rich learning environments; and curriculum and pedagogical frameworks. They are listed below.

- How have successive national policies taken account of rapid and continuing advances in technologies that are changing the way that people share, use, develop and process information?
- What learning theories or frameworks are most useful for understanding how students most effectively learn in online environments?
- Are there models of teaching and learning that effectively harness digital content and powerful online tools for information processing, communication and collaboration?
- What skills and capabilities will teachers need in order to access and use repositories of suitable, exciting, culturally appropriate, discoverable and affordable digital content?
- How can digital content be used to support collaboration, innovation and communication?
- What are the attributes of technology-rich learning environments that support innovation and collaboration?

The digital revolution and schools

Over the last quarter-century, Australian governments have responded to the needs of school students in a rapidly changing world. New national goals for schooling have been developed at roughly ten-year intervals. Each set of goals attempted to define the current and future needs of learners who as adults would be able to contribute effectively to the social, cultural and economic needs of the nation and to 'face the challenges of the era with confidence' (MCEETYA 2008, p 4). The most recent of these policy responses provides guidance on what will enable students to take full advantage of the state-of-the-art tools and new forms of learning that the digital age has made possible.

The Hobart Declaration of 1989 recognised that Australian students should be able to use 'skills in processing [ie summarising, synthesising and publishing] and computing [eg programming, calculation]' (Australian Educational Council 1989). These skills were appropriately defined for a period preceding the advent of the internet. At the time, there were few computers in Australian schools. Computer skills were confined to a small cohort of teachers, and computer studies was confined to narrow areas of the curriculum. *The Hobart Declaration* was conspicuously silent on the appropriate capabilities of the teachers who were required to impart the skills that were defined as important for students to know. It implied that particular kinds of learning styles were appropriate (eg analysis and problem solving), but largely left issues relating to pedagogy to the jurisdictions and sectors.

By the time of *The Adelaide Declaration* of 1999, public policy developers had become more fully aware of the significant impact of ICT on society. *The Adelaide Declaration* recognised that the world would be shaped by advances in ICT, and its goals included that students should 'be confident, creative and constructive users of new technologies, particularly information and communication technologies, and understand the impact of those technologies on society' (MCEETYA 1999, p 2). The goals regarding the values, knowledge and skills required of students were also more explicit. Whereas the earlier *Hobart Declaration* had defined skills largely in discipline-based terms, *The Adelaide Declaration* for the first time linked analysis and problem solving to the ability to 'plan and organise activities and to collaborate with others'.

How have successive national policies taken account of rapid and continuing advances in technologies that are changing the way that people share, use, develop and process information?

The period covered by this second set of goals for Australian schooling saw a dramatic increase in the number of computers in schools, teacher professional learning about the use of ICT in schools, and the number of programs and projects to engage teachers and students in local, national and global learning networks. National initiatives included the establishment of The Le@rning Federation: Schools Online Curriculum Content Initiative in 2001. National collaboration between jurisdictions also saw the development of a number of frameworks for MCEETYA's ICT in Schools Taskforce that covered areas such as contemporary learning, bandwidth, content, leadership, learning architectures and spaces, pedagogy and research.

The Melbourne Declaration (MCEETYA 2008) further develops the perception within *The Adelaide Declaration* of the importance of ICT to society. It declares that students need to develop skills in sharing, using, developing and processing information and technology if they are to be effective in their use of digital media, which is, along with social interaction and cross-disciplinary thinking, an essential twenty-first century occupation. Similarly, the *Joint Ministerial Statement* of 2008 identifies goals for maximising the use of ICT to enable new ways of learning, innovating and communicating.

1 The Learning in an Online World publications can be accessed from the MCEECDYA website at www.mceetya.edu.au/mceecdya/.

> *Australia will have technology enriched learning environments that enable students to achieve high quality learning outcomes and productively contribute to our society and economy.*
>
> Source: MCEETYA & MCVTE 2008, p 1

The separate but complementary activities of the Education Revolution (2007) and the Digital Education Revolution have reinforced the need to think strategically about how the goals identified in *The Melbourne Declaration* and *The Joint Ministerial Statement* can be realised. The *Strategic Plan* for the Digital Education Revolution recognises that while there have been major investments by state, territory and federal governments in infrastructure, digital content and quality teaching, 'only a minority are reaping the benefits of the information technology revolution' (COAG Productivity Agenda Working Group 2008). The plan identifies four strands of change that may be appropriate for joint national action: leadership, infrastructure, learning resources and teacher capability. The final three strands align with the research focus of this report.

ICT enablers

The recent policy documents outlined above identify many of the factors that will foster the optimum use of ICT in schools. A number of research reports also elaborate on what assists and what gets in the way of effective online learning.

Based on research with students in New South Wales, Groundwater-Smith argues that four main areas need to be addressed: the way in which the environment is organised, the quality of the resources available, the quality of pedagogy, and accessibility to the power of the internet (Groundwater-Smith 2007, p 3).

Green and Hannon, in a report to shape thinking on ICT use in the United Kingdom, refer to the third area that Groundwater-Smith identified. They argue that 'In the last ten years we have seen a staggering change in the amount of hardware in schools, but it has not had a significant impact on teaching and learning styles' (Green & Hannon 2007, p 16). This perception about the gap between past investment and actual achievement is also registered in the strategy produced for the Digital Education Revolution initiative (COAG Productivity Agenda Working Group 2008, p 3).

The *Joint Ministerial Statement* (2008) on ICT identifies a number of enablers of technology-rich learning environments: infrastructure, systems and architectures, online learning resources, and teacher capability (MCEETYA & MCVTE 2008, p 1). Accordingly, much recent research investigates infrastructure, digital content, teacher effectiveness and online learning within the school and other education sectors. Each of these enablers covers a significant amount of territory, and a report focusing primarily on pedagogies and digital content in the Australian school sector cannot and should not attempt to address each one.

Key points

National education and ICT policy for schools includes key elements relevant to pedagogies and digital content for online learning:

- 'Australia will have technology enriched learning environments that enable students to achieve high-quality learning outcomes and productively contribute to our society and economy.'
- 'Schools should support the development of skills in areas such as social interaction, cross-disciplinary thinking and the use of digital media.'
- 'Learners are active participants in knowledge creation and will engage with state of the art tools which enable new forms of learning, collaboration, innovation and communication.'
- 'While there has been a significant investment in educational technologies over the last decade, only a minority [of teachers and students] are currently reaping the benefits of the digital revolution.'

Sources: MCEETYA 2008, pp 5, 8; MCEETYA & MCVTE 2008; COAG Productivity Agenda Working Group 2008, p 3

Quality of pedagogy

Australian and international education jurisdictions have commissioned considerable research over the last ten years to identify how teachers can be assisted to improve their effectiveness when using ICT for learning and teaching. As a result of such research, theories of learning have been promoted and adapted, models of online learning design identified, pedagogy and professional development frameworks developed, standards established for teachers to work towards, and extensive professional support provided centrally and in schools.

Theories of student learning

If teachers are to learn successfully how to use state-of-the-art tools and online environments to assist students to collaborate, innovate and communicate, it is important for them to have an understanding of how students learn in physical and online environments when using digital content. However, the large number of theories and taxonomies in this area of scholarship can be bewildering for educators. As well, knowledge of particular taxonomies of student learning may depend on resources provided by the relevant education sector, or on the country or jurisdiction for which the research was developed.

In a report for the federal Department of Education, Employment and Workplace Relations (DEEWR), Holkner et al (2008, pp 9–10) attempt to identify the dominant learning theories that have underpinned the use of computers in classrooms. They describe an evolving set of theories, including the behaviourist theories of the 1950s, the cognitive theories of the 1970s and the constructivist theories of the 1990s. They argue that constructivism remains the dominant learning theory in the current decade.

What learning theories or frameworks are most useful for understanding how students most effectively learn in online environments?

However, some educational theorists contend that the ways in which students engage with technologies, and each other, in the digital age has led to a paradigm shift. For example, Siemens (2005, p 2) asserts that behaviourist, cognitive and constructivist theories of learning are limited because they 'do not address learning that occurs outside of people (ie learning that is stored and manipulated by technology)', and that they 'fail to describe how learning occurs within organisations'.

The following learning theories are used or have been used in Australian jurisdictions, with varying degrees of suitability to online learning.

Behaviourism

Behaviourist theories of learning assume that the learner is passive and responds to stimuli. Skinner and others argued that positive and negative reinforcement could change behaviours, and as a consequence improve values, knowledge, understanding, skills and practices. Holkner et al (2008, p 9) contend that this led to the idea of the 'computer as teaching machine giving rise to computer aided instruction'.

Social Learning Theory, developed by Bandura, extended the individualistic focus of classic behaviourist theory and suggested that people learned from one another through observation,

imitation and modelling. The theory covers areas such as attention, retention (ie memory), reproduction and motivation, and forms a bridge between behaviourism and other learning theories (Bandura 1977).

Cognitivism

Cognitive theories of learning focus on the importance of understanding how the mind processes information. Cognitive processes include thinking, memory, knowing and problem solving. Theorists such as Gagne and Briggs focused on 'the internal processes of learning and on how the learner comes to know rather than respond in an instructional situation' (Holkner et al 2008, p 9).

Piaget (1896–1980) constructed the Stage Theory of Cognitive Development, which identified four distinct stages of development in children and young people: the Sensorimotor stage (birth to 2 years old), Preoperational stage (ages 2 to 4), Concrete Operations stage (ages 7 to 11), and Formal Operations stage (ages 11 to 15). These stages were defined well before online learning began to impact on large numbers of students, yet they still underpin curriculums and pedagogical approaches, along with other frameworks for developmental stages.

Constructivism and related theories

Constructivist theories of learning argue that learning is an active, contextualised process in which new information is linked to prior knowledge. A significant component of all constructivist theories is the assumption that learners 'build knowledge for themselves, and that the interactions between people and situations are very important in the learning process' (Holkner et al 2008, p 10).

Within Constructivism, a number of theories of learning have been proposed that are relevant to any discourse about pedagogies and digital content in the Australian school sector. They include Communities of Practice, Discovery Learning, Social Development Theory, Problem-Based Learning, and Situated Learning.

Wenger (1998) argues that there are Communities of Practice where learners' interests and motivation are enhanced by interaction, and that this interaction improves learning. The concept of Communities of Practice is dependent on the intersection of three elements: the domain (discipline or topic), the community (shared activities of individuals and groups) and the practice (narratives or resources). While the domain remains relatively fixed, the community may interact synchronously or asynchronously (ie flexibly). The practice varies depending on the resource or evolves over time as the narrative changes.

Bruner described Discovery Learning as a model of inquiry-based instruction, where learners gradually acquire information and awareness of relationships. In Discovery Learning, the learner is required to draw on past experience or existing knowledge to develop new constructs and increase their awareness of relationships. In a Discovery Learning model, students are encouraged to explore, manipulate, question or experiment with learning resources in order to remember and apply concepts, and to develop new and more complex understandings.

Social Development Theory originated in the work of Vygotsky. Its concepts include Social Interaction, the More Knowledgeable Other, and the Zone of Proximal Development. Vygotsky (1978) contended that social interaction is a fundamental contributor to cognitive development. According to his theory, at each stage of learning, social interaction between people precedes internalisation of knowledge. There are a range of players with which the learner interacts, and while the More Knowledgeable Other may be a teacher, it may also be another student or students. The Zone of Proximal Development is where learning takes place. The Zone is the area or distance between the learner's current ability and that of the More Knowledgeable Other.

Problem-Based Learning originated in Canada and was adopted by organisations in a number of other countries. Problem-Based Learning advocates active learning through the investigation of authentic issues and problems and the development of solutions to these. It emphasises the importance of open-ended problems, self-directed learning and the teacher's role as facilitator.

Situated Learning Theory was developed by Lave and Wenger (1998) as a model of learning in a community of practice. Situated learning proposes that learning needs to be developed in authentic contexts, rather than through abstract discussion that is not contextualised. Situated Learning Theory uses the idea of Communities of Practice and aligns with Vygotsky's Zone of Proximal Development, in that the learner is initially on the edge of a community of learners and gradually moves to assume the role of expert. This movement is dependent on the learner acquiring relevant values, knowledge, skills and processes.

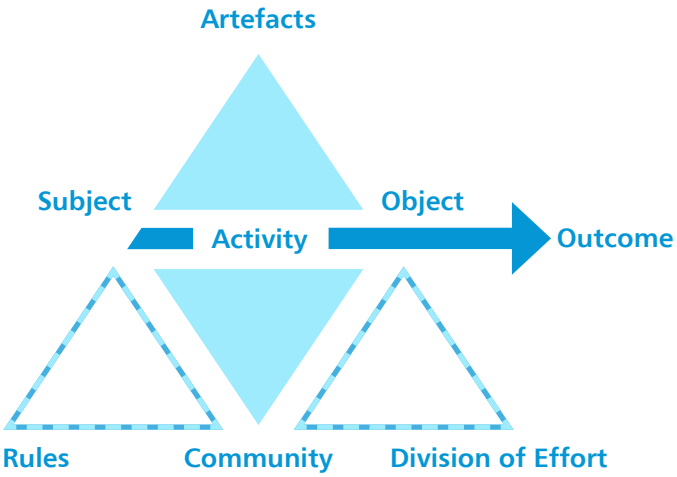
Descriptive and meta-theories

Activity Theory was initially proposed by Leont'ev and Rubinshtein. Engestrom expanded Activity Theory to include the idea of the 'community' as well as the individual and the object. He developed Human Activity Theory as a descriptive meta-theory or framework that could be applied to a system. The idea of the system is important as it moves beyond the single learner and can encompass teams and other groups. In a school learning context the system equates with the school or class. The components of a Human Activity System are depicted in Figure 1.[2]

Engestrom contends that to reach an outcome, it is necessary to produce objects (eg experiences, knowledge, products). Objects are created within activities that are themselves influenced by the tools available (eg digital content, Web 2.0 tools) and the learning context (ie the group team or class). Rules of action and the subject may also affect how the activity is conducted. The Engestrom model takes account of collaborative learning by recognising that an activity may actively involve more than one learner.

Distributed Cognition was proposed by Hutchins in the 1980s. This theory of learning emphasises the social aspects of cognition. It proposes that thinking and knowledge are not confined to the individual actor but are instead 'distributed' across objects, individuals,

Figure 1: Human Activity System (Engestrom, 1987)



Source: Adapted from Engestrom 1987, University of Tasmania website, www.utas.edu.au

artefacts and tools. Distributed Cognition has been widely used in distance learning. Examples of Distributed Cognition include the creation of wikis and the use of social networking through a range of online tools.

Other learning theories and models

A Multiple Intelligences theory was proposed by Gardner and has been redefined over a number of years. The theory argues that there are a number of distinct modes (ie intelligences) by which individuals understand their world. These are linguistic, logical-mathematical, visual-spatial, body-kinaesthetic, musical-rhythmic, interpersonal and intrapersonal. A logical extension of this theory is that learners have preferred learning styles that align with their mode of intelligence. However, learners have more than one mode and may blend and use differing modes based on the context and subject of the learning.

Siemens (2005) argues that rather than continuing to adapt Behaviourism, Cognitivism and Constructivism to new circumstances, a new paradigm is required if learning theories are to account for how individuals and groups learn in the digital age. He proposes Connectivism,

2 The University of Tasmania has published information on the 'Children, on-line learning and authentic teaching skills in primary education' project on its website at www.educ.utas.edu.au/users/ilwebb/Research/activity_theory.htm. This information includes two graphic representations of Human Activity Theory.

which describes how learning often occurs in online environments that contain shifting core elements. 'Actionable knowledge' within these environments can reside in an organisation or a database, and involves connecting 'specialised information sets'.

Siemens argues that 'the connections that enable us to learn more are more important than our current state of knowing' (Siemens 2005, p 3). Personal knowledge is 'comprised of a network, which feeds into organisations and institutions, which in turn feed back into the network, and then continue to provide learning to the individual' (Siemens 2005, p 4). A question to be posed of this theory is whether it can take account of learning that does not occur online or within a network.

Those parts of Connectivism that apply outside of online learning can be identified within learning theories such as Cooperative Learning. This theory was developed by Johnson and Johnson, who contend that 'how students perceive each other and interact with one another is a neglected aspect of instruction' (Johnson & Johnson 1994, p 1). Within Cooperative Learning as they define it, there are three ways in which students interact as they learn: competing to see who is best; individualistically without paying attention to other students; and 'cooperatively with a vested interest in each others' learning as well as their own' (Johnson & Johnson 1994, p 1). Elements of Cooperative Learning can be used to refine aspects of Engestrom's Human Activity Theory (ie the Activity itself, the Community, the Division of Effort, the Object and the Outcome).

Johnson and Johnson argue that teachers need to distinguish between group work and the organising of students to work cooperatively, as Cooperative Learning requires a common and accepted goal. They contend that a number of conditions are required for Cooperative Learning:

> *• Clearly perceived positive independence*
> *• Considerable promotive (face-to-face) interaction*
> *• Clearly perceived individual accountability and personal responsibility to achieve the group's goals*
> *• Frequent use of the relevant interpersonal and small-group skills*
> *• Frequent and regular group processing of current functioning to improve the group's future effectiveness.*
>
> Source: Johnson & Johnson 1994

Key points

A number of theories of learning describe and define for teachers how students learn most effectively in general and online learning situations.

- Teachers may require assistance in unpacking the assumptions they make about how students learn and the pedagogical approaches they use to support these.
- Constructivist and situative theories of learning or perspectives are useful for online learning in that they are learner centred and take account of individual and group needs and interactions.
- Connectivism and Cooperative Learning take account of a whole new set of learning requirements brought about by the digital age, and can provide a theoretical basis for collaborative learning.

Theories of learning in the development of TLF resources

In 2003, in defining educational soundness in the digital age, Atkins identified constructivist theories of learning as being central to how interactive digital content (ie learning objects) should be conceptualised and developed in the TLF initiative. She contended that digital content should 'present the users with ideas and concepts, ask users to make predictions based on their understanding and [ask them] to test these' (Atkins 2003, p 8). Recognition of what the learner knew already and the consequent scaffolding of learning needed to form the basis of the pathways by which users engaged with digital content.

As a result, the educational soundness specifications that TLF developed focused on the engagement of the learner, as well as on the integrity, useability and accessibility of the digital content (TLF 2007). For example, the requirements to ensure a learner focus identified the importance of learner profiles, the learner's interaction with the digital content, that digital content should make explicit the process of learning, and that student learning be contextualised. These are classic constructivist elements for learning design.

Areas of learning theory that remained outside the scope of Atkins's 2003 research included elements of Social Development Theory, Situated Learning and Human Activity Theory. This resulted from the original conception of TLF as a producer of high-quality digital content that would be distributed to jurisdictions and sectors, which would then provide access to the content for teachers and students. This meant that the online environment or the actors in the classroom space were expected to furnish the roles of Vygotsky's Zone of Proximal Development and the More Knowledgeable Other, the authentic and communal contexts of Lave and Wenger's Situated Learning, or the community in Human Activity Theory.

Most interactive digital content developed by TLF is designed to immerse the learner in a learning experience that develops understanding. This learner focus does not prevent teachers and students from collaborating and communicating while using interactive digital content.

Interactives such as the Wishball: Whole Numbers series allow groups of students to engage in a challenge using the same digital resource at different computers. Other interactives such as the Frog Pond Habitat series allow for more than one student at the same computer to investigate, evaluate, model relationships and identify possible causes of the decline of a frog population.

The Jet Force series is one of the few examples of an interactive resource (ie Jet Force Championship) allowing for collaborative gaming activity. In this resource, a student can challenge a friend to see who is best able to combine forces and score a goal.

Much of the digital content sourced by TLF from cultural organisations, government bodies and commercial organisations such as digitised photographs, documents, videos and audio files has no intrinsic learning design. Typically, educational soundness and relevance is included in the text that is bundled with the digital resource, rather than in the resource itself. While this might recommend such digital resources as being more flexible than interactives, they are highly dependent on the capacity of the teacher to use them effectively for individual or cooperative learning.

Models of teaching and learning

As learning management systems and online environments overall become more complex and more capable of supporting different kinds of learning, there is a corresponding increase in the support required for teachers if they are to acquire the skills necessary to use such environments effectively. The first M&EDCE report found that if teachers were encouraged to design, develop and manage authentic online learning activities, they required significant experience, confidence and skill in using the online learning environment.

Are there models of teaching and learning that effectively harness digital content and powerful online tools for information processing, communication and collaboration?

Teachers' use of learning theories in the M&EDCE trial

In February and March 2009, the M&EDCE project conducted trials in schools of digital content sourced from cultural organisations. This digital content was provided in a technology-rich online environment that included a number of state-of-the-art tools to support collaboration. Teachers were asked to select a topic to suit their curriculum, choose relevant digital resources and then design an online learning activity that would engage students collaboratively. Thirteen schools participated.

The trial did not attempt to impose preferred models of learning design on the participants. The report on the trial (Baker 2009) identified that the learning designs that the teachers in the trial created revealed a number of assumptions about how students should and do learn.

Some teachers in the trial were most comfortable using a behaviourist approach. In such cases, collaboration was incidental to the learning, and was rarely supported through the learning design. Activities designed using this approach tended to underestimate the capacity of students to understand complex concepts and relationships, limiting students to making reactive responses to digital content. This approach may have resulted from an inability to understand how students learn in online environments, or from an inability to transfer principles into practice in the learning design.

A number of teachers in the trial were able to provide a richer learning experience by including higher order thinking tasks within the learning design. These teachers used the online environment to prompt learners to develop complex responses, in some cases setting tasks that were progressively more complex. This supported and encouraged scaffolded thinking and learning.

Fewer teachers in the trial chose to use constructivist perspectives that took account of learners' preferences, needs, skills and pre-existing knowledge. The teachers who did explore this approach designed activities that would have been equally appropriate for a single learner and for a pair or group. Learning designs with a constructivist basis were characterised by activities that supported experimentation and the discovery of principles. These activities sometimes provided opportunities for reflection and evaluation but rarely included peer review and peer evaluation.

One teacher in the trial adopted a situative perspective, designing an activity that enabled collaborative inquiry and learning. In addition to having a clear sense of the skills required, the teacher participated (ie collaborated) in the learning activity in order to facilitate the development of learning relationships. The teacher's approach also took account of associative and constructivist perspectives. The model for this approach is included in full as an appendix (Appendix 2: Model 2) in the first report (Baker 2009, pp 113–14). Rather than reproduce the model in this report, it is described in the following case study.[3]

3 The model was developed by Lynette Barker of St Therese's Primary School in New South Wales.

M&EDCE Case study 1

A teacher is planning an online learning activity about Australian identity for years 5 and 6 students. In designing the activity, the teacher wants to use educationally sound digital content (eg film, photographs, images) in a safe and secure online learning environment where students have defined identities and where individual and collective development of knowledge and skills can be monitored.The teacher also aims to test state-of-the-art tools (eg Web 2.0 tools) that support collaboration (eg media sharing, collaborative media manipulation, conversation in online arenas, social networking, social bookmarking, collaborative editing, and use of wikis). In designing the learning activity, the teacher thinks about learners' preferences, skills, knowledge, and ability to collaborate with others. She includes tasks that require students to support and learn from peers. As the teacher is aware of Vygotsky's Zone of Proximal Development she wants to use an online environment in which the teacher or other students can act as the More Knowledgeable Other. The activity needs to clearly define the intended learning outcomes and how the students are to demonstrate these.

The results of the student trial within the M&EDCE project suggest that teachers using online learning environments need to have access to additional advice and resources if they are consistently to use constructivist, social development and situated learning approaches that reflect their current knowledge, experience and practice. They may also require explicit modelling of how effective digital pedagogies can be used to achieve intended learning outcomes.

At the conclusion of the student trial, many teachers indicated an interest in more fully exploiting the digital resources in the online environment provided.

Learning design guidance in the international context

The Joint Information Systems Committee (JISC) in the United Kingdom has been at the forefront of research into the innovative use of digital technologies in the higher, technical and further education sectors. JISC funded preliminary research by Mayes and de Freitas (2004) in order to map learning theory onto pedagogical approaches. Mayes and de Freitas identified three broad clusters or perspectives that make fundamentally different assumptions about what educators need to know about learning: the associative perspective, the constructive perspective and the situative perspective.

More recent JISC research also asserts that 'designing for learning is likely to take place within the context of a preferred pedagogical approach' (JISC Innovation Group 2009, p 10); such an approach will be dependent on the teacher's views or perspectives about how students learn.

The 2009 report outlines the assumptions and associated pedagogies for each of Mayes and de Freitas's perspectives. These are summarised in Table 1 below. As the table indicates, Mayes and de Freitas have created two subcategories within the constructive perspective, the individual focus and the social focus.

Table 1: Perspectives, assumptions and pedagogies underpinning learning design

Perspective	Assumptions	Associated pedagogy
Associative perspective	**Learning as acquiring competence** • Learners acquire knowledge by building associations between different concepts • Learners gain skills by building progressively complex actions from component skills	• Focus on competences • Routines of organised activity • Progressive difficulty • Clear goals and feedback • Individualised pathways matched to the individual's prior performance
Constructive perspective (individual focus)	**Learning as achieving understanding** • Learners actively construct new ideas by building and testing hypotheses	• Interactive environments for knowledge building • Activities that encourage experimentation and discovery of principles • Support for reflection and evaluation
Constructive perspective (social focus)	**Learning as achieving understanding** • Learners actively construct new ideas through collaborative activities and/or dialogue	• Interactive environments for knowledge building • Activities that encourage collaboration and shared expression of ideas • Support for reflection, peer review and evaluation
Situative perspective	**Learning as social practice** • Learners develop their identities through participation in specific communities of practice	• Participation in social practices of enquiry and learning • Support for development of learning skills • Dialogue to facilitate the development of learning relationships

Source: JISC Innovation Group 2009, p 11

These perspectives, assumptions and associated pedagogies have implications for learning in both physical and online environments. Clearly some Australian teachers need to develop their understanding of the constructive and situative perspectives if they are to create effective learning paths for both offline and online learning. These perspectives also suggest the importance of learning resources (eg digital content) and technology-rich learning environments being able to accommodate both individual and collaborative learning.

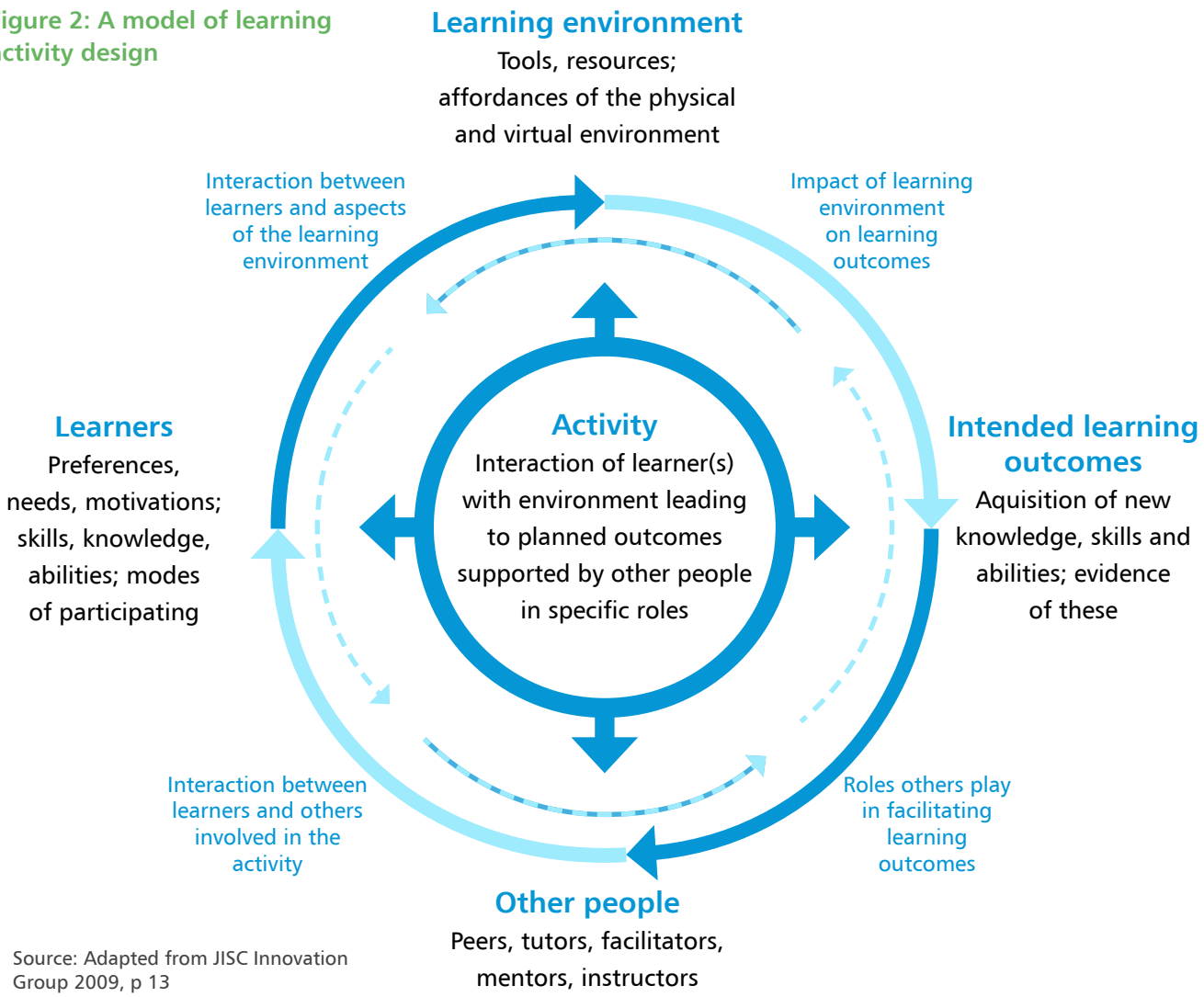
The 2009 JISC report also explores learning activity design. It proposes a model derived from Beetham and Sharpe (2007, pp 26–38), shown in Figure 2.

This model of learning activity design is useful for defining how learners might use digital content and state-of-the-art tools in technology-rich learning environments. The learning environment can encompass not just the online environment in which the activity takes place, but also the online tools that can support the activity and the intended learning outcomes. Such tools can support collaboration, innovation and communication. 'Other people' can encompass what Vygotsky defines as the More Knowledgeable Other, and indicates that learners can actively collaborate with peers and teachers to achieve learning outcomes.

The JISC model of learning activity design can be used to explore the pedagogies required of teachers who are using digital content in classrooms as well as the physical and online environments in which learning occurs.

This model offers a guide to designing learning activities that take account of the needs of learners and the ways in which they will interact within a technology-rich learning environment in order to achieve intended outcomes. The model is intentionally non-hierarchical as the teacher may develop a learning design with either the needs of the students or the intended learning outcomes as the starting point. Whichever is the case, learning design using this model will necessarily involve thinking about not only the design questions but also the pedagogical practices involved.

Figure 2: A model of learning activity design



Source: Adapted from JISC Innovation Group 2009, p 13

Learning design guidance in the Australian context

Not all states and territories have provided explicit guidance on learning activity design that is applicable to online environments. However, there are a number of web-based activities and activity formats that are available to Australian teachers and based on sound learning design principles. These include WebQuests and their variants that incorporate contemporary learning theory and pedagogical approaches, including inquiry-based learning and, in more contemporary versions, Connectivism; Raps; Virtual Field Trips; Travel Buddies; Subject Samplers and Concept Builders. In Australian systems, these learning designs have been incorporated into online education portals such as The Learning Place in Queensland (Education Queensland 2009A), underpinning both subject-based topics and the design and development of collaborative learning activities.

Advice has also been developed by the Northern Territory Government in the resource *Designing for Learning*, one of a number of resources developed for Northern Territory schools. It is based on the ideas of Smith, Lynch and Knight (2007), Marzano et al (1997) and Marzano (2007). In contrast to, yet complementing, the JISC model, *Designing for Learning* advocates a linear set of design questions and pedagogical practices. The overarching questions that form the basis of the model are listed in Table 2.

Table 2: Designing for Learning: overarching questions

Starting with the learner	What does the learner already know?
	Where does the learner need or want to be?
	How does the learner learn best?
Making choices to improve the learning	What resources do I have at my disposal?
	What will constitute the Learning Journey and therefore what is the best context for learning?
	Who will do what?
Monitoring learner progress	How will I check to see the learner has achieved the learning outcomes?
	How will I inform the learner and others about the learner's progress?

Source: Northern Territory Government (n.d.)

Designing for Learning is applicable to mainstream as well as online learning environments. Each high-level question is accompanied by questions and methodologies relating to learning activity design and pedagogical practice. The sections of the resource covering 'How does the learner learn best?' and 'What will constitute the Learning Journey and therefore what is the best context for learning?' directly relate to planning for students' use of the physical and online learning environment.

To indicate the level of advice provided in the resource, Table 3 below shows the more detailed questions and methodologies attached to the question 'What will constitute the Learning Journey and therefore what is the best context for learning?'

Table 3: Designing for Learning: The Learning Journey

		Design questions	Pedagogical practices
Making choices to improve the learning	What will constitute the Learning Journey and therefore what is the best context for learning?	• What methodology will best sequence the learning for these learners? • What choices need to be made in relation to instructional strategies and tactics, and learning environments? • What contexts and experiences will be used to frame learning and assessment tasks? • What learning tasks provide an opportunity for assessment as and for learning?	Methodology • Use a methodology for the learning sequence that matches the science of learning, area of learning and development of knowledge expected Instructional strategies, tactics and learning environments • Use evidence-based strategies and associated tactics that match the nature of the knowledge to be demonstrated • Identify the role and actions of the teacher depending on the nature and level of the knowledge expected Tasks • Use experiences – real or life-like – that will engage and enable knowledge development

Source: Northern Territory Government (n.d.)

The section of the resource relating to 'How does the learner learn best?' deals with issues that are fundamental to quality learning activity design. This section poses a number of questions relating to Attitudes and Perceptions, Learner Intellectual Quality, and Thinking and Learning Habits. The questions on Attitudes and Perceptions cover areas such as task completion and expectations; classroom management; and relationships, including issues such as the development of individual and group identities and dealing with cyberbullying.

Key points

Effective learning activity design is essential if students are to engage positively with digital content in technology-rich learning environments.

- Learning activity design in its varied formulations can provide an effective theoretical and practical model for online learning in that it takes account of interactions between the needs of learners and the learning environment, and between people participating in the online learning activity.
- There is value in defining the theoretical and practical elements of successful design for online learning for teachers who are developing skills and capabilities in the use of online learning.
- Models of learning activity design should be developed or sourced that are relevant to teachers at all levels of schooling and in different learning areas. The interactive and digital curriculum content procured by TLF can be used to provide exemplary learning materials within such models.

Teacher skills and capabilities

A number of general pedagogy frameworks have been developed in Australia during the first decade of the twenty-first century. These have derived from national education initiatives, curriculum projects and special interest organisations.

At a national level, the Teacher Quality and Educational Leadership Taskforce (TQELT) developed a professional standards framework in 2003 for Australian ministers of education. A number of jurisdictions already had, or subsequently developed, pedagogy frameworks to guide teaching and learning in the school sector.

The extent to which these frameworks take account of how ICT is transforming the ways in which 'learners and educators operate, learn and interact' (MCEETYA & MCVTE 2008, p 1) will form the first part of this section of the report. The second part of this section will examine pedagogy frameworks that specifically focus on the skills required by teachers using ICT for learning and teaching.

Quality teaching frameworks

The *National Framework for Professional Standards for Teaching* (TQELT 2003) was developed to provide a 'basis for agreement on and consistency around what constitutes quality teaching and facilitates the articulation of the knowledge, understandings, skills and values for effective teaching through development of standards at the local level'.

The *National Framework* aimed to be comprehensive. It described quality teaching in terms of four Career Dimensions (Graduation, Competence, Accomplishment, Leadership) and four Professional Elements (Professional knowledge, Professional practice, Professional values, Professional relationships) (TQELT 2003, pp 9–11). The framework defined each dimension and element in a paragraph, with the assumption that individual jurisdictions would 'flesh them out'.

The *National Framework* recognised that teachers needed to have a 'detailed understanding of how young people learn and their role in facilitating that learning' (TQELT 2003, p 11). It also stated that teachers should be able to design learning activities using a range of techniques, tools, practices and resources. However, it did not anticipate that teachers might need to encourage cross-disciplinary thinking, social interaction and the use of digital media, or be able to provide students with state-of-the-art tools in technology-rich learning environments.

When jurisdictions created corresponding local frameworks for their teachers, they often resolved this apparent lack of reference to ICT. The Northern Territory's 2007–08 *Teaching and Learning Framework* took a global approach. It did not specify the use of ICT as a separate element or standard; instead, ICT was expected to inform all elements of the framework.

In contrast, Queensland's *Professional Standards for Teachers* lists the ability to 'Integrate information and communication technologies to enhance student learning' as one of 12 standards (Department of Education and Training [Qld] 2005). Standards 6.1–6.5 emphasise the importance of understanding students' learning needs, using appropriate strategies and resources, creating authentic learning experiences, evaluating achievement and using ICT to access and manage information on student learning (DET [Qld] 2005, p 8). Non-hierarchical indicators are provided to amplify each statement. Standards 6.2 and 6.3 anticipate the emerging need for teachers to develop activities that cater for individual learning needs as well as for learning that is highly collaborative (DET [Qld] 2005, pp 20–1).

New South Wales developed a framework for quality teaching that includes three dimensions: 'Intellectual quality', 'Quality learning environment' and 'Significance'. The framework argues that pedagogies, including those used to support student engagement with digital content, need to be underpinned by deep knowledge, deep understanding, problematic knowledge, higher order thinking, metalanguage and substantive communication. The framework also contends that background knowledge, cultural knowledge, knowledge integration, inclusiveness, connectedness and narrative are essential elements of materials 'that will support the full and positive integration of new learning with new media into teaching and learning' (Groundwater-Smith 2007).

In Victoria, *Principles of Learning and Teaching* (DEECD 2009A) were developed to support the introduction of the *Victorian Essential Learning Framework* (VCAA 2005). The Victorian principles take account of a range of theories of learning, and move beyond constructivist theories that focus on the development of the individual to also emphasise the importance of collaborative and situated learning. While each principle is applicable to teaching and learning using ICT, only the third and sixth principles describe the value of technology or ICT for teaching and learning.

Principle 3 advocates that students' experience of a technology-rich world should be recognised and utilised for learning. It suggests that good practice includes the incorporation of contemporary technologies into learning sequences, and supports the recognition and use of student expertise. Software to allow internet chat, the use of mobiles, internet searching and email are all mentioned. Other emerging technologies such

as collaborative online environments, cloud computing, smart objects or the 'personal web' are not referred to or explored. Principle 6 advises that students should learn how to use software, be able to exploit ICT to search for information, use ICT for recording data and for communicating with others, and be able to access and use online simulations. Skills in publishing and presentation are also highlighted.

ICT-specific pedagogy frameworks

What skills and capabilities will teachers need in order to access and use repositories of suitable, exciting, culturally appropriate, discoverable and affordable digital content?

There are a number of ICT-specific pedagogy frameworks or standards in use both nationally and internationally. Those examined in this report include the UNESCO *ICT Competency Standards for Teachers* (2008A, B & C), the *Pedagogy Strategy* (2005) developed by the ICT in Schools Taskforce, Queensland's *Smart Classrooms Professional Development Framework* (2009B), Victoria's e-Potential Continuum of ICT Capabilities (DEECD 2009B) and the *Tasmanian Curriculum Information and Communication Technologies (ICT) K–10 Cross Curricular Framework* (DET [Tas] n.d.). The aim is not to exclude or ignore other commonly used frameworks but rather to provide representative examples of ICT-specific pedagogy frameworks.

International competency standards

UNESCO's *ICT Competency Standards for Teachers* (2008A, B & C) define the ICT-related skills required of teachers in primary and secondary schools. They take as their starting point the assumption that new technologies require new teacher roles, pedagogies, and approaches to teacher training. They also take account of the changing use of ICT in the wider society for both interaction and collaboration, and its impact on the skills required of teachers in managing classrooms in which such ICT-related interaction and collaboration are used for teaching and learning.

The *ICT Competency Standards* describe three approaches that indicate evolving levels of teacher competence within six core components of educational systems. The standards are listed in Table 4 below.

Table 4: UNESCO ICT competency standards

	Technology literacy approach	Knowledge deepening approach	Knowledge creation approach
Policy and vision	Technology literacy	Knowledge deepening	Knowledge creation
Curriculum and assessment	Basic knowledge	Knowledge application	21st-century skills
Pedagogy	Integrating technology	Complex problem solving	Self management
ICT	Basic tools	Complex tools	Pervasive tools
Organisation and administration	Standard classroom	Collaborative groups	Learning organisations
Teacher professional development	Digital literacy	Managing and guiding	Teacher as model learner

Source: UNESCO 2008A, p 11

The Technology literacy approach involves incorporating technological skills into the curriculum. The Knowledge deepening approach involves using ICT to solve complex, real-world problems, and the Knowledge creation approach involves innovating to produce new knowledge. The effectiveness of this three-stage model for developing ICT competencies depends on whether the three progression points in the approaches allow for incremental professional learning in the use of ICT over a period of time.[4]

Table 5 below shows how the *ICT Competency Standards* define competence in relation to pedagogy according to the three stages. The standards seemingly define a fairly basic knowledge of pedagogy at the Technology literacy stage; there appear to be significant leaps in the values, knowledge, skills and practices required of teachers between the Technology literacy, Knowledge deepening and Knowledge creation stages.

The Technology literacy stage in the table above implicitly includes an understanding of how students learn; an understanding of learning design; and skills in using and evaluating software for creating, presenting and researching. However, what initially seems to be a fairly low level of ICT literacy required in Competency I.C.1 actually conceals a deeper understanding of how ICT can be used for teaching and learning in subject areas, as well as an awareness of theories of learning and their impact on the use of ICT in classrooms. This competency also realistically apprehends how teachers use ICT to support lecturing and demonstration. This is particularly pertinent given the growing use by teachers of interactive whiteboards as a medium for instruction. This foundation level competency in the use of ICT for learning is as relevant to continuing teachers as it is to graduates.

It was intended by UNESCO that countries would map their own standards and professional development programs against the *ICT Competency Standards*.

The UNESCO *ICT Competency Standards* are useful in that they provide a neutral model for evaluating or developing ICT-specific pedagogy frameworks. For example, they might appropriately form one of the building blocks for the new ICT continuum that is to be developed during Phase 1 of the Australian curriculum. They might also be used as the basis for any revisions made by Australian education jurisdictions and sectors to their own ICT pedagogy frameworks.

Table 5: UNESCO competency standards – pedagogy

Technology literacy	Knowledge deepening	Knowledge creation
I.C.1 Describe how didactic teaching and ICT can be used to support students' acquisition of school subject-matter knowledge	II.C.1 Describe how collaborative, project-based learning and ICT can support student thinking and social interaction, as students come to understand key concepts, processes and skills in the subject matter and use them to solve real-world problems	III.C.1 Explicitly model their own reasoning, problem solving and knowledge creation while teaching students
I.C.2 Incorporate ICT activities into lesson plans so as to support students' acquisition of school subject-matter knowledge	II.C.2 Identify or design complex, real-world problems and structure them in a way that incorporates key subject-matter concepts and serves as the basis of student projects	III.C.2 Design online materials and activities that engage students in collaborative problem solving, research or artistic creation

Source: UNESCO 2008C, pp 9, 12, 16

4 A three-stage model for describing the development of ICT capabilities is used in Queensland. A four-stage model is used in the Northern Territory and Victoria.

Australian ICT competency standards

The *Teaching for the Digital Age Work Plan*, developed by the Australian Information and Communications Technology in Education Committee (AICTEC), acknowledges that there are already a range of frameworks and professional learning programs developed for, and in use within, Australian jurisdictions and sectors. The *Work Plan* argues that there is a need for agreed national standards for the incorporation of ICT into teaching and learning, both for graduate teachers and practising teachers at critical stages of their professional careers (AICTEC 2009, p 6).

The MCEETYA ICT in Schools Taskforce developed the Learning in an Online World series between 2003 and 2008. In 2005, as part of the series, a *Pedagogy Strategy* was published that specifically focused on pedagogies appropriate to online learning. The *Pedagogy Strategy* describes how ICT should be used in classrooms, the principles that underpin ICT-related pedagogies, the kinds of teaching and learning that ICT makes possible, and the kinds of professional support required by teachers. The *Pedagogy Strategy* does not attempt to provide a continuum of skills development in the way that the UNESCO *ICT Competency Standards for Teachers* or the Northern Territory, Queensland or Victorian frameworks do.

The *Pedagogy Strategy* begins by acknowledging the importance and influence of learner-centred theories of education on Australian curriculum development, and the capacity of ICT to transform learning. This is consistent with the most recent statement about ICT in Australia (MCEETYA & MCVTE 2008). The *Pedagogy Strategy* is forward thinking in its emphasis on using ICT for conceptual development as well as for building learning communities. Like the UNESCO *ICT Competency Standards for Teachers* (2008A, B & C), it recognises a range of situations where teachers might use ICT, for example presenting digital resources and using digital content to create learning activities and sequences. It also encourages the development of problem-based challenges for students and recognises the value of simulations, modelling and creative activities using ICT.

The *Pedagogy Strategy* is an aspirational framework that defines parameters for the effective use of ICT by teachers. However, it does not attempt to guide jurisdictions, schools or teachers in creating more detailed frameworks that outline necessary values, knowledge, skills and practices in relation to teachers' use of ICT. Education jurisdictions and sectors in Australia have provided more specific advice for teachers, and a representative sample of this advice follows.

The Queensland Department of Education and Training provides advice to teachers about online learning and the use of ICT within The Learning Place education portal (Education Queensland 2009A) and through the *Smart Classrooms Professional Development Framework* (Education Queensland 2009B). The *Smart Classrooms* framework provides indicators and pathways within a three-stage 'licence' approach. Within each licence, skills, practices and attributes are grouped in four categories: Professional Values, Professional Relationships, Professional Knowledge and Professional Practice.

Professional Practice within the Queensland ICT continuum recognises that teachers can only gradually develop the capabilities that will allow them to manage student collaboration within and across schools. It recommends that at a foundation level of ICT competence teachers should be able to encourage communication with a known audience; at a median level they should be able to encourage the use of online environments for communication and collaboration; and at an advanced level they should be able to support students in collaborative projects. This scaffolded approach has been developed with whole school transformation in mind, not only from an individual teacher's personal transition perspective.

Victoria, South Australia and the Northern Territory have also developed ICT continuums for teachers in their jurisdictions. These continuums all define ICT capabilities over four stages.

In Victoria, the online *e-Potential ICT Capabilities Resource for Teachers* (DEECD 2009B) includes a Continuum of ICT Capabilities. These ICT capabilities of teachers are expressed at four levels: Foundation, Emergent, Innovative and Transformative. Each of these levels is aligned with aspects of teaching in a school context that might involve the use of ICT: Learning & Teaching, Assessment & Reporting, Classroom Organisation, ICT Ethics, Resources, ICT Professional Learning, and ICT Leadership. The

statements of capability for each level outline progression in relation to values, knowledge, skills and practices. For example, the four progression points for Learning & Teaching are: Some integration of ICT; ICT to support student understandings; ICT to model and support powerful learning; ICT engaging students to learn new things in new ways. Some of these capabilities require considerable thinking by teachers, such as the following example within the Learning & Teaching component: 'At the Transformative Level you are using ICT innovatively to engage students in a way that was never possible before, leading to learning new things in new ways'.

The South Australian *Teacher Educational ICT Capabilities Continuum (EdCap)* (DECS n.d.) describes four phases of development (Developing ICT Skills, Applying ICT in the Classroom, Delivering on Learning Outcomes, and Transforming Practices) within three broad aspects of ICT: Vision and Attitude, Professional Contribution and Learning, and Integration into Teaching and Learning. Each of these aspects is further divided into a number of components. For example, Integration into Teaching and Learning is divided into areas such as Practice, Management, Planning, Resources, Online Learning, and Assessment Recording and Reporting.

The Northern Territory's *ICT Teacher Continuum* (DEET 2003) describes four phases of development (Uncertain and/or hesitant, Willing but dependent, Confident and proficient, and Leading and enabling others) within three broad aspects of ICT: Vision, Approach and Ethics, and Classroom ICT Integration. Each of these aspects is further divided into a number of components. For example, Classroom ICT Integration is divided into areas such as Resources, Classroom Management, Online Interaction, and Recording and Reporting. Each stage is linked to professional learning opportunities.

The components and phases of each of these Australian continuums are compared to the UNESCO *ICT Competency Standards* in Appendix 1.

The experience of the M&EDCE student trial indicates that Australian ICT pedagogy frameworks should be sufficiently detailed in order for teachers to understand the skills and capabilities that they need to develop to use digital content in technology-rich learning environments.

If presented in the form of a three-stage or four-stage model, each part of the model needs to be unpacked, as in the UNESCO *ICT Competency Standards for Teachers*. Australian ICT competency standards would also benefit from including descriptions of the values, knowledge, skills and practices relevant to teaching and learning and to the use of digital content. An analysis of support documents further suggests that such frameworks should provide specific advice about learning activity design that can be used or adapted by teachers at each level of proficiency, such as the information provided in the Northern Territory resource *Designing For Learning* (Northern Territory Government n.d.).

Key points

There are a number of pedagogy frameworks that describe and define how teachers can use ICT for teaching and learning.

- Twenty-first-century schools require 21st-century programs and educators capable of using 21st-century resources and strategies for learning (AICTEC 2009, p 3).
- Teachers require detailed pedagogy frameworks that integrate the varied uses of ICT for curriculum and assessment, pedagogy, organisation and administration, and professional learning.
- There is a need for increased collaboration at a national level in the sharing of existing programs and the development of new programs (AICTEC 2009, p 7). Such collaboration might usefully align or develop agreed standards for teachers in the use of ICT in schools.
- There would be an advantage in mapping any new or redeveloped standards against UNESCO's *ICT Competency Standards for Teachers* (2008A, B & C) as well as against the skills defined for students within the ICT continuum to be developed for the Australian curriculum.

Collaboration, innovation and communication

A number of reports to government in the last decade have highlighted the importance of sustained approaches to professional learning in order to maximise the take-up of ICT in schools.

Models of Teacher Professional Development for the Integration of Information and Communication Technology into Classroom Practice (Downes et al 2001) advised the Australian Government about current and recommended forms of pre-service education and continuing professional development to support the use of ICT in classrooms. The recommendations in the report included that a national set of ICT standards be developed for beginning teachers that covered skills, changing pedagogies, changing content, and curriculum frameworks. To meet the needs of current teachers (and schools), Downes et al also argued that there was a need to develop standards for experienced teachers, and to create professional development programs aimed at beginning and experienced teachers respectively.

Focusing on ICT and education, AICTEC provides strategic policy advice to Australian governments, ministerial bodies and education departments. Central to this advice is its *Work Plan* for 2009–12 to support the Digital Education Revolution. The *Work Plan* contends that while 'a range of professional learning programs offered by groups and jurisdictions already exists … there is a need for increased collaboration at the national levels for the sharing of existing programs and the development of new programs' (AICTEC 2009, p 3). It also acknowledges that such programs need to develop the capabilities of pre-service teachers, current teachers and school leaders.

In calling for 'increased collaboration at the national levels for the sharing of existing programs and the development of new programs', the AICTEC *Work Plan* recognises that effective professional learning cannot and will not occur in all jurisdictions and sectors through piecemeal approaches.

The *Work Plan* sets out eight principles for effective professional learning that are applicable to jurisdictions, sectors and schools:

Principles of professional learning

- Opportunities that are evidence-based and data-driven to guide improvement and to measure impact.
- Opportunities that are just in time and just enough.
- Programs focused on and embedded in teacher practice.
- Opportunities that are collaborative and involve reflection on practice and student learning.
- Engagement that is ongoing, supported and fully integrated into the culture and operations of the system and accredited where possible.
- Programs that take account of teachers' prior knowledge, different learning styles and access to technology.
- Recognition of emerging technologies and their impact on teaching, learning and research.
- Opportunities for school-based learning with close connections to classroom practice.

Source: AICTEC 2009, p 3

Rethinking how professional learning should support new forms of learning, collaboration, innovation and communication is not just an Australian preoccupation. Futurelab in the United Kingdom is a leading promoter of innovation in ICT. A survey report it produced about teachers learning with digital technologies found that while research-based literature frequently addressed teacher learning and digital technologies, there was little that dealt 'directly with … teachers as learners with technologies' (Fisher, Higgins & Loveless, 2006, p 2).

The report contends that the requirements for teacher learning are the same as those for students, and that learning should be active and experiential: a process where knowledge is enacted, constructed and revised. It notes that Vygotsky's concept of a Zone of Proximal Development is important for understanding how teachers learn. Teacher professional learning may be 'situated', or can take place within a 'community of practice'.

Fisher, Higgins and Loveless propose a schema that identifies four areas of 'purposeful activity with digital technologies' (see Table 6 below).

It may be useful to examine the experiences of teachers in the M&EDCE project and trial in relation to the four categories in the above schema.

Knowledge building

Teachers in the M&EDCE trial were expected to have a degree of experience in the use of collaborative learning that they could use in adapting and developing ideas for learning in a technology-rich learning environment.[5] It was also anticipated that they would draw upon prior experience in using digital content for teaching and learning.

The trial demonstrated that a majority of students were comfortable with collaborating online. Teachers were also enthusiastic about the potential of the online environment for engaging with digital content, but indicated that the constraints of the trial sometimes limited their ability to use the software effectively. However, this may also have resulted from the inexperience of some of the teachers in using collaborative learning in mainstream classes, their inability to transfer knowledge of collaborative or cooperative learning to an online learning environment, or their unfamiliarity with using digital content to support student learning. Those teachers who successfully developed, managed and evaluated their learning designs had a clear view of what it means to collaborate, could incorporate this explicitly into the learning design, and could scaffold learning through collaboration.

Table 6: Clusters of purposeful activity with digital technologies

Knowledge building	• Adapting and developing ideas • Modelling • Representing understanding in multimodal and dynamic ways
Distributed cognition	• Accessing resources • Finding things out • Writing, composing and presenting with mediating artefacts and tools
Community and communication	• Exchanging and sharing information • Extending the context of activity • Extending the participating community at local and global levels
Engagement	• Exploring and playing • Acknowledging risk and uncertainty • Working with different dimensions of interactivity • Responding to immediacy

Source: Fisher, Higgins & Loveless 2006, p 20

5 The Museum & Education Digital Content Exchange used Scootle as a virtual learning environment to access resources. The Scootle virtual learning environment provided a range of Web 2.0 tools that could be used by teachers and students for collaborative learning.

While case studies and models of exemplary learning designs are included in the first report, there is clearly a need to educate teachers about the potential of technology-rich environments for instruction and collaboration. While Australian teachers have access to a variety of online learning environments, the challenge for professional learning is to rise above a particular environment or technology in order to reach general principles that are applicable to, and can be transferred across, a range of environments.

During the trial, one model of a collaborative learning activity was provided to teachers. TLF also encouraged teachers to develop and publish learning paths (ie learning activity designs) that could be viewed by other teachers. While the first M&EDCE report identified three exemplary learning designs developed by teachers in the trial, it was apparent that teachers at each level of competency require learning design exemplars that demonstrate both good practice and poor practice. The challenge is to develop exemplars that can be used within a range of online learning environments.

Online learning environments need to incorporate state-of-the-art tools for innovation, collaboration and communication. Within the M&EDCE trial, teachers, with varying degrees of success, used a technology-rich online learning environment that allowed for collaboration by teachers and students. While teachers and students sometimes had difficulty managing the more dynamic elements of this environment, such as the chat facility, both groups were highly positive about engaging with digital curriculum resources in such an environment.

The experience and capabilities of the teacher will shape the extent to which digital content can be used in multimodal or dynamic ways. As with the need to model learning design for the online environment, exemplars can be used to demonstrate effective and non-effective use of digital content.

Distributed cognition

Distributed cognition recognises that knowledge or understanding can be 'distributed' across objects, individuals, artefacts and tools. The schema proposed by Fisher, Higgins and Loveless (2006) proposes that this knowledge and understanding can be used for accessing resources and finding things out, and in writing and presenting with mediating artefacts and tools.

A number of collaborative technologies (eg mailing lists, discussion groups, the online learning environment) can assist distributed cognition in professional learning. The M&EDCE trial was supported by a mailing list. Similar support is essential for the success of any trial involving teachers engaging with new technologies. Accessing digital content can be catered for at a technology-literacy level of competency. At this level it is appropriate for teachers to receive professional support that enables them to discover, access and use one resource didactically using an interactive whiteboard. At higher levels, teachers can be encouraged and assisted to group digital content in sequences that can be used for either didactic or collaborative learning. At this stage, the use of an interactive whiteboard may also be useful, but it could be used by a student or student group as well as by the teacher.

The concept of 'finding things out' is derived from the language of the United Kingdom National Curriculum for ICT (Qualifications and Curriculum Authority n.d.). For students, it encompasses skills such as considering systematically the variety of information required to solve a problem, the selection of sources, and evaluating information. While finding things out might appear very basic in the context of professional learning, the M&EDCE trial indicates that it is an essential component in the development of successful learning activity design.

On one level, TLF resolves issues relating to the quality of digital content for teachers by ensuring the overall educational soundness of the collection. However, within a collection of more than 8,800 resources, teachers' evaluation of the most relevant digital content when designing an online learning activity remains a critical issue. Ultimately, this depends on the teacher having a clear understanding of the needs and capabilities of students as well as the activity's intended outcomes.

To date, TLF's focus for teacher professional learning has been on demonstrating the range of content it provides, rather than on challenging teachers to select appropriate digital content for a topic. There is significant potential to expand professional learning to achieve the latter, as well as to give consideration to the learning context and environment. In this kind of learning for teachers, the focus should be on creating educationally sound learning designs that incorporate the most appropriate digital resources.

Effective learning design was central to the exemplary collaborative activities in the M&EDCE trial. Learning design involved writing, composing and presenting with mediating artefacts and tools. Without knowingly using a model of learning activity design, teachers whose skills allowed them to work at innovative or transformative levels could take account of:

- Learner preferences, needs, skills, knowledge, abilities, and modes of participation
- The learning environment: classroom organisation, digital resources, online learning environment, Web 2.0 tools
- Other people: their own active role as the More Knowledgeable Other, peers.
- Teachers operating at a technology-literacy level did not take account of one or more of these elements.

Active and experiential professional learning needs to deconstruct learning activity design for teachers. They particularly need to be aware of the state-of-the-art tools that can enable new forms of learning, collaboration, innovation and communication.

Community and communication

The M&EDCE trial allowed groups of teachers across schools and jurisdictions, and teachers and students within a school, to exchange and share information and extend the context of an activity. The trial did not focus on extending the participating community at local and global levels as this was outside the scope of the project.

Exchanging and sharing information should have been fundamental to the development of learning designs that aimed to engage and allow for interaction and collaboration. The mailing list used to support teachers in the project engaged those teachers who were used to sharing their ideas in online communities. This is not atypical. The more important need was to engage in online discourse the teachers who were working at a technology-literacy or knowledge-deepening level.

Active and experiential professional learning could involve a group of teachers as leaders or facilitators and as learners within a collaborative learning activity. This is again a form of modelling, where teachers learn to empathise with learners before conducting an online collaborative activity in a classroom.

Very few teachers in the M&EDCE trial chose to extend the context of the online learning activity they had developed beyond completion of the online tasks. Teachers working at a knowledge-deepening or knowledge-creation level scaffolded learning for students through explicit instruction, through linking to prior knowledge and experience, or through intended learning outcomes that students could only achieve by completing the activity.

Engagement

Engagement as defined by Fisher, Higgins and Loveless (2006) includes exploring and playing, acknowledging risk and diversity, working with or at different levels of interactivity and responding to immediacy.

The M&EDCE trial provided teachers and students with a technology-rich online environment where play and exploration could occur. Some teachers in the trial were uncomfortable with the notion of online play, so disabled Web 2.0 tools that allowed for interaction and collaboration. This is acceptable if teachers are working at the technology-literacy level, or if the mode of delivery (eg asynchronous learning) does not allow supervision. While many students brought to the trial experience and interest in social networking, the absence of prior opportunities within typical online learning situations sometimes meant that they were unable to focus on achieving the intended learning outcomes.

When teachers develop designs for online learning that enable cooperation and collaboration there is an element of risk and uncertainty. Teachers need to acknowledge this, as they would want these qualities to be part of their own professional learning.

Active and experiential professional learning about how to create and use learning pathways that are collaborative would liberate teachers working at a technology-literacy level and allow them to move to a knowledge-deepening or knowledge-creation level. Before they can do this, teachers need to have confidence in working with different levels of interactivity. Teachers in the M&EDCE trial were provided with an online learning environment that encouraged high levels of interactivity and collaboration. A number of teachers at technology-literacy or knowledge-deepening levels of proficiency were unready for this. Following the trial, different versions of the online learning environment were developed to cater for teachers who only want to use learning paths didactically, as well as for teachers who are ready to use and allow for interactivity and collaboration.

Key points

Teachers require a range of professional learning opportunities if they are to be effective users of digital resources in a technology-rich learning environment.

- The design of professional learning needs to conform to standards of best practice that are supported by the Australian education jurisdictions and sectors.
- Professional learning should be developed that meets the needs of teachers at various stages of knowledge, skills, understanding and practice.
- Professional learning should include an understanding of learning theories relevant to the new forms of learning, collaboration, innovation and communication made possible by the availability of accessible, high-quality digital content and technology-rich learning environments.
- Professional development and advice concerning the use of online learning environments needs to move beyond imparting knowledge of the platform and the tools to include resource selection and evaluation, learning activity design and assessment.
- Professional learning should allow teachers to gain confidence and expertise in the use of state-of-the-art tools that can be used for interaction and collaboration.
- National and local online discussion groups and forums that allow teachers to share ideas and best practices can play a role in supporting professional learning.
- Professional learning can target teacher interest in the new Australian curriculum and explore how digital resources can be used to support aspects of the curriculum at all levels of schooling.

The learning environment

The development of effective learning environments in which online learning is designed to occur necessarily involves a number of challenges and opportunities for systems, schools and teachers. These challenges and opportunities require discourse about what constitutes technology-rich learning environments, the nature and use of digital resources, and the extent to which resources should be comprehensive in coverage.

This second M&EDCE report takes as a point of reference the model of learning activity design developed by JISC (see 'Models of teaching and learning' section). The learning environment as conceptualised within this model includes 'tools' and 'resources' as well as the 'affordances of the physical and virtual [ie online] environment'.

> Students undertake challenging and stimulating learning activities supported by access to global information resources and powerful tools for information processing, communication and collaboration
>
> Source: COAG Productivity Agenda Working Group 2008, p 4

How can digital content be used to support collaboration, innovation and communication?

Digital content

There are a number of print, digital and physical resources or texts that teachers can use in supporting any online learning activity. This section of the report is limited to an examination of the digital content procured and distributed by TLF. The background to the development of specifications suitable for the procurement of interactive digital content by TLF is outlined in the Introduction. These specifications allowed for the development of high-quality interactive educational multimedia eminently suited to one user and relevant to a subject discipline or a cross-curriculum area at a defined stage of schooling.

As previously noted, few of the interactive digital resources developed to date enable multiple users to interact while using the same object. Teachers and students can, of course, physically compare their knowledge and understandings before, during and after they individually engage with a particular interactive digital curriculum resource. Where teachers have enabled the collaborative features of a technology-rich online environment, students can also discuss and compare their experiences in real time.

Non-interactive digital content is also procured by TLF and is primarily sourced from cultural organisations, government bodies and commercial organisations.[1] Each digital resource has metadata attached that enables discovery in TLF's online learning environment (Scootle) or in a repository provided by a jurisdiction (eg The Learning

1 This finding was made by King and Deighton (2009), based on their analysis of what was then more than 7,500 digital resources provided through TLF. Their report found that 31 per cent of these resources were interactive.

Place, DigiLearn, TaLE). Having discovered and accessed the digital resource, the end user is provided with a brief description of it, an educational value statement, and relevant conditions of use and copyright data.

Resources for the new Australian curriculum

The new Australian curriculum for K–12 in the areas of Arts, English, Geography, History, Languages, Mathematics and Science is being developed in two phases. Phase 1 will be completed in 2010. The curriculum will use each year of schooling in Australia as a progression point, defining the knowledge, skills and understanding required for a particular learning area at a particular year level (eg Mathematics, Year 5).

The Australian curriculum's framing and shaping documents note that it should cover a number of capabilities: literacy, numeracy, ICT, thinking skills, creativity, self-management, teamwork, intercultural understanding, ethical behaviour and social competence. While ICT is defined as a separate capability, with an ICT continuum to be developed during Phase 1, it is intended that ICT will inform every curriculum area that is developed.

When TLF was established, six curriculum priority areas were defined against which content was to be sourced and developed: Mathematics and Numeracy; Science; Languages Other Than English; Studies of Australia; Literacy for Students at Risk; and Innovation, Creativity and Enterprise. These six areas are now extensively resourced, particularly by interactive digital curriculum resources. The changing curriculum priorities of the Australian school sector have opened up new areas for emphasis that represent further opportunities for digital resource development.

King and Deighton's 2009 *Review of Online Curriculum Resources* quantified the digital content provided by TLF against each new learning area in the Australian curriculum at each level of schooling, as shown in Table 7 below. (Since the researchers undertook their analysis, more than 1,200 additional resources have been created.)

Scoping for King and Deighton's report clearly preceded the decision to include the Arts in the Australian curriculum. Digital content for Innovation, Creativity and Enterprise and numerous digitised art works make up a significant portion of the more than 8,800 items developed or acquired to date within the initiative.

Table 7: TLF online curriculum resources for the stages of schooling

	Stage of schooling			
Learning area	Early (P/K–2)	Middle (3–6)	Senior (7–12)	Subtotal/Total
English	47	93	522	662
Geography	0	0	106	106
History	12	106	4256	4374
Languages	52	496	224	772
Mathematics	54	198	313	565
The sciences	89	230	853	1172
TOTAL	**254**	**1123**	**6274**	**7651**

Source: King & Deighton 2009, p 32

The preliminary analysis also identified a number of gaps in provision, such as the need for interactive and digital curriculum resources that cover prehistory in Australia and internationally, as well as world history and geography.

Clearly there will be gaps in the provision of digital content for new priority curriculum areas. On one level, it will be a matter of defining what kinds of digital content need to be sourced or developed. One scenario is that the Australian Curriculum, Assessment and Reporting Authority, a jurisdiction or sector, or, in theory, a teacher could advise that a particular curriculum priority or topic requires educationally sound digital content. Those responsible for procurement and quality assurance might then source or develop digital content to meet perceived needs.

Trialling digital resource procurement

A key feature of the procurement and quality assurance process used in the M&EDCE project was that it streamlined existing resource procurement and quality assurance processes used by TLF. The project also demonstrated the capacity of cultural organisations, government bodies and commercial organisations to use these accelerated processes for the provision of new digital content.

Provision and quality assurance are only one part of the picture. Criteria for inclusion of a resource in a TLF repository include that it be relevant to jurisdictions' curriculums, and educationally sound. One aim of the M&EDCE trial was to ascertain whether Australian teachers could discover, access and embed within online learning activities digital content that was relevant, suitable, exciting, culturally appropriate and affordable. This kind of evaluation (ie about the educational value of the digital resource) was clearly outside King and Deighton's research. The trial was also interested in testing issues relating to affordability by providing guidance to curators and other experts in cultural organisations that enabled them to select, categorise and describe digital curriculum content from their collections.

Teachers and students within the M&EDCE trial were generally positive about the capacity of the online learning environment provided in the trial to enable discovery of digital content. Metadata tagging by the curators and experts assisted teachers to select and evaluate digital resources using their own selection criteria such as learning area, topic and age-appropriateness. Teachers were then able to sequence digital content and build learning activities around it.

Using digital content in an online environment

A number of Australian and international ICT competency frameworks provide guidance about the use of digital content or resources.

The UNESCO *ICT Competency Standards for Teachers* (2008A, B & C) describe the use of digital content at the Technology literacy and Knowledge creation levels of competency, particularly within the components of Pedagogy and Teacher Professional Development. At the foundation level of Technology literacy, the standards describe how teachers can 'Use presentation software and digital resources to support instruction' (UNESCO 2008C, pp 9, 13, 16). Higher levels of competency focus on the design of online materials (ie learning activity design) and on the use of such materials to enable student collaboration within an online learning activity.

In terms of professional development, the standards emphasise the ability of teachers to use digital content to enhance their productivity and to support their own acquisition of subject matter and pedagogical knowledge. The Knowledge deepening level involves teachers being able to share digital content. At the Knowledge creation level, teachers are able to 'Use … ICT resources to participate in professional communities and share and discuss best teaching practices' (UNESCO 2008C, p 17).

The International Society for Technology in Education (ISTE) has developed standards and performance indicators for teachers. These standards and indicators recognise the importance of digital content for developing student learning and creativity, as well as its role in learning activity design and for assessment. ISTE argues that teachers should:

> **1.b.** Engage students in exploring real-world issues and solving authentic problems using digital tools and resources.
>
> **2.a.** Design or adapt relevant learning experiences that incorporate digital tools and resources to promote student learning and creativity.
>
> Source: ISTE 2008

The Australian *Pedagogy Strategy* (ICT in Schools Taskforce 2005, pp 4–5) also describes, within a pedagogy framework, the importance of digital content for teachers seeking to use ICT effectively in the classroom. It suggests that the selection of appropriate [digital] content is important for teachers who are integrating ICT into their pedagogies, teaching for conceptual development, and building learning communities; and that it is also important for planning, programming, assessing and reporting.

The Northern Territory, South Australia and Victoria have produced ICT continuums that describe the use of (digital) resources by teachers at various levels of proficiency. These are provided in tables 8, 9 and 10 below. There is a marked similarity between the Northern Territory and South Australian continuums.

Table 8: Northern Territory

Phase 1 Uncertain and/or hesitant	Phase 2 Willing but dependent
• Use ICT as a stand-alone resource to browse and locate simple learning resources	• Access and store resources on the local network
Phase 3 **Confident and proficient**	**Phase 4** **Leading and enabling others**
• Contribute to shared local electronic resources • Integrate electronic resources into teaching/learning	• Access and contribute to external and systemic resources to enable an ICT-rich curriculum

Source: DEET 2003

Table 9: South Australia

Phase 1 Developing ICT skills	Phase 2 Applying ICT in the classroom
• Accesses and uses some hardware resources in computer rooms, pools, pods and classrooms • Uses ICT as a stand-alone resource to browse and locate simple learning resources	• Accesses and borrows hardware for use in the classroom • Accesses and stores resources on the local network
Phase 3 Confident and proficient	**Phase 4 Leading and enabling others**
• Contributes to the development of local electronic resources • Engages in professional discussions about school, networks, hardware and peripherals	• Provides leadership in the use and development of hardware and electronic resources • Promotes and contributes to external and systemic resources to enable an ICT rich curriculum

Source: DECS (n.d.)

Table 10: Victoria

foundation	emergent
Minimal use of resources	An emerging use in the classroom
innovative	**transformative**
Integrates ICT resources effectively	Leads use for richer learning

Source: DEECD 2009B

Teachers' use of digital resources within the trial

In the student trial for the M&EDCE project, teachers accessed and used digital content in an online learning environment that supported collaboration. The following case study, which maps out teachers' increasing skill and confidence in the use of digital content, is based on the experiences of a diverse group of teachers in the project. The case study presupposes that teachers have already progressed beyond a stage where they see no reason to use ICT in the classroom.

M&EDCE Case study 2

Phase 1

The teacher believes that they need to understand what digital resources are and how they can be accessed. Their jurisdiction or sector encourages them to use a technology-rich online learning environment. They find an appropriate online learning environment through their state or territory education portal and register as a user. They discover that there are many kinds of online educational resources. They download any user guides and use the guides to help them locate interesting digital content relevant to their teaching area. When selecting digital content, they increasingly pay attention to any educational value statement that accompanies the resource. As they develop more confidence, they experiment with selecting more complex resources such as those with interactive digital content.

Phase 2

The teacher decides that they need to know how to create a learning activity that contains sequenced digital content. Initially they select simple digital content (eg photographs, text files) rather than interactive digital content. They decide to select a digital resource to support a lesson using an interactive whiteboard. Their confidence growing, they use a learning path that includes a number of items of digital content. They then decide to demonstrate an

item of interactive digital content or allow a student or students to use the interactive whiteboard to engage with the item. Finally, the teacher might use the online learning environment to design an elementary learning pathway with learning tasks that contextualise the digital content for students.

Phase 3
The teacher uses the learning environment to develop and publish a simple online learning activity that a small group of students can access from a limited number of computers in a classroom or library. They ask a colleague to team-teach or support the remaining group while the activity takes place. The activity initially blends working online to view the digital content and tasks with working using pens and paper. The teacher may practise this kind of approach to develop confidence before moving to a whole-class activity in a computer laboratory. Towards the end of Phase 3, the teacher may 'enable' collaborative aspects of an online learning environment for use by students. Collaboration would be restricted and focused.

Phase 4
The teacher wants to use digital content and an online learning environment to improve student motivation and enable students to develop confidence in managing their own learning. The teacher reads any available documentation about creating and managing collaborative activities. They develop the learning activity outcomes and design a collaborative learning activity. As they become more confident, they are able to develop more complex learning activities that use state-of-the-art tools for collaboration. The teacher is able to interact with other teachers to share learning activities and provide advice about how to use most effectively interactive and digital curriculum resources in online learning environments.

The phases described in the above scenario cover the range of experiences of teachers in the M&EDCE trial. While there were only a small number of teachers in the trial, their various levels of skill and experience were representative of Australian teachers as a whole.

Implications for teacher advice and professional learning

The findings of the trial that helped shape the case study above have implications for the advice provided to teachers about the use of digital resources, and for professional learning.

Currently, TLF provides a range of services to teachers seeking to use digital content. On one level, advice is provided in documentation such as the catalogues, the frequently asked questions and the *Scootle User Guide for Teachers.* The *User Guide* includes sections on discovering and accessing content, creating learning paths (ie learning activity design), and creating and managing collaborative activities. Teachers in each of the phases described in Case Study 2 would be able to use the guide to find out how to use TLF digital content. The *User Guide* also shows teachers how to use an online learning environment to access and use content. This involves demonstrating the capacities of that environment.

Online discussion groups can provide useful advice to teachers, but they need to be focused on particular learning areas or cater for specific levels of teacher readiness. Threaded asynchronous discussions that are open to all users are as important as closed or invitational groups that may cater for only high-level and experienced users.

The introduction of the new Australian curriculum will offer considerable opportunity to provide teachers with national models for learning activity design that range from the simple to the complex to cover a range of skill levels, and that are specific to particular learning areas, themes or topics. Models that demonstrate how to use resources successfully need to engage prospective users at a range of levels of expertise.

The most effective professional learning takes place in schools. School-based professional learning enables the development of a community of practice and meets the actual needs of teachers. Graduated professional learning modules that enable teachers to develop sequentially knowledge, skills, understandings and practice for the use of digital content in

technology-rich learning environments would advance the vision and agenda for the Digital Education Revolution in Australia. These modules could be made available online and could be completed individually or collegiately by teachers at a time that suited them.

Key points

Digital content has been developed, sourced and described through The Le@rning Federation's Schools Online Curriculum Content Initiative. This content is important to the school sector, as agreed procurement and quality assurance processes have ensured its educational soundness and appropriateness.

- While the design of interactive digital content procured by TLF is based on sound constructivist principles, there is an absence of interactive digital content that explicitly caters for social learning and collaboration. Any re-engineering of existing interactives or development of new content should consider this need.
- The structure and content of the new Australian curriculum provides opportunities for the procurement of new digital content for use by teachers.
- Teachers require clear guidelines and advice about the capabilities and skills required to access and use digital content for teaching and learning.
- While education jurisdictions and sectors have developed pedagogy frameworks and ICT continuums, these may not provide consistent or detailed advice about pedagogies that support the use of digital content for online learning.
- National collaboration and cooperation in the development of advice and professional learning about the use of digital content would have benefits for cost, efficiency and comprehensiveness.

Technology-rich learning environments

Infrastructure

The physical environment in which the online learning activity takes place has preoccupied educational jurisdictions in Australia and other countries over the last ten years. A number of definitions have been proposed, rejected and defended. This report understands the physical environment to include the selection of the physical learning space (ie a library, classroom or computer laboratory) as well as the equipment used within that space. The physical and online environment may often determine the kinds of online learning that can take place.

What are the attributes of technology-rich learning environments that support innovation and collaboration?

The physical environment in which contemporary Australian students learn is not always a built space. The use of mobile technologies, such as data-loggers on hand-held devices or laptop computers on a site trip, is as relevant to a discussion of a technology-rich physical environment as is learning on a computer in a classroom, library or computer laboratory. Similarly, distance learning, while it may take place in spaces that are defined by temporal constraints, does not involve conventional face-to-face teaching and learning.

Discussions at a national level about the physical environment have focused on infrastructure (particularly hardware and bandwidth) as well as resources. *The Strategic Plan* (2008) developed for the Digital Education Revolution provides a picture of where Australian schools are at now, what improvements are required and what aspirational goals might be set (COAG Productivity Agenda Working Group 2008, pp 7–9).

The *Strategic Plan* for the Digital Education Revolution defines infrastructure as incorporating access devices (eg computers, laptops, PDAs, ultra-mobile devices), interoperability, connectivity and access portals. Bandwidth continues to be a major issue for many schools seeking to make effective use of content-rich, collaborative online environments. Australian teachers in the M&EDCE project agreed that access devices, connectivity and access portals were essential requirements of technology-rich learning environments. To these they added that the learning environment needed to be able to cater for differentiated work.[2]

Millea and Galatis (2009, p 2) found that access to tools and enabling infrastructure varied across jurisdictions and sectors. They reported a number of findings relating to the services and skills required for the effective use of ICT in the Australian education sectors. These included infrastructure to support reliable, fast and ubiquitous access (2009, p 7).

A national survey of Australian schools in 2008 to identify student–computer ratios found that a number of schools had a ratio of 1:8 or worse (Digital Education Revolution 2009, p 1). The Digital Education Revolution has established targets to improve this ratio, for example a 1:1 computer-to-student ratio for all years 9–12 students by 2011.

The *Strategic Plan* asserts that 'every student [should have] … access to digital resources and tools to enable 21st century learning across the curriculum' (COAG Productivity Agenda Working Group 2008, p 9). While improved access and equity will have immediate effects in schools, the M&EDCE project and trial indicates that access does not guarantee that successful teaching and learning take place, as there can be a mismatch between infrastructure provision on the one hand, and teachers' capacity to manage online learning, as well as their awareness of that capacity, on the other.

The capacity of infrastructure to allow for differentiated work depends on the set-up of computers in schools. Many Australian schools, particularly secondary schools, are still using a laboratory model for computer distribution. While case studies developed from the M&EDCE trial indicate that experienced teachers can cater for different learning styles in such environments, teachers with limited experience in using computers for teaching and learning, or in using computers for collaborative learning, will experience management issues on a far larger scale when more than 20 students engage simultaneously in learning online. Clearly, teachers need to develop confidence in managing computer-based learning using small groups completing defined and limited tasks before engaging whole classes in online learning. Evidence-based research indicates that this is particularly the case with secondary school students.

Interactive whiteboards

Australian research in a number of jurisdictions has explored the use of interactive whiteboards for teaching and learning. Hedberg and Freebody (2007) investigated the use of interactive whiteboards by teachers working with TLF's digital content. In their report they noted the research of Vrasidas and Glass (2005) into the obstacles to integrating ICT into the classroom (Vrasidas & Glass, cited in Hedberg & Freebody 2007, p 7). These obstacles ranged from the resistance of the teacher to change, to the lack of the professional learning that was required to support adoption. Hedberg and Freebody also quoted from research by Moss et al (2007) in the United Kingdom indicating that the use of interactive whiteboards was dependent upon teacher intent and capability.

Research by Becta (2005) outlines three stages through which teachers progress in their use of interactive whiteboards: supported didactic, interactive and enhanced interactive. Millea and Galatis (2009) take these stages further by commending the five stages of an Interactive Whiteboard Development Framework proposed by Sweeney (in Millea & Galatis 2009, pp 75–6): whiteboard replacement, supported didactic, interactive, enhanced interactive, and synergistic user.

2 M&EDCE project focus group, 21 September 2008

In reviewing case studies within the M&EDCE project and trial, Baker (2009) notes the variable success with which teachers used whiteboards in the trial. In some schools the interactive whiteboard was available for use, yet the teacher did not initially use it to introduce the tasks, the features of the online learning environment or any of the digital content, or to review student collaborations. For teachers needing to operate at the 'supported didactic' stage, this would have provided greater coherence and purpose to the collaborative learning activities. Other teachers in the trial did use the interactive whiteboard for didactic purposes. Some confident teachers (and their students) were able to use it within the final three stages of the framework proposed by Sweeney.

Evidence-based research in the United Kingdom and Australia therefore indicates that there is significant potential for more extensive teacher (and student) use of interactive whiteboards – however, this potential is not always taken advantage of when using learning management systems or using digital curriculum resources collaboratively. Clearly, teachers need to progress through levels of competency in their use, such as that described in Phase 2 of Case Study 2. There is a risk that the skill levels of some teachers will stagnate at the supported didactic stage, preventing the occurrence of interaction and collaboration in the classroom.

Content and learning management systems

The *Strategic Plan* (2008) for the Digital Education Revolution recognises that the deployment of TLF content is currently highly variable, and that its full value is yet to be realised. It also contends that 'eLearning' is often regarded as separate to offline learning. The plan sets targets and aspirational goals for improving the quality of online environments for use in schools, for example that there should be 'tools for safe and secure online knowledge sharing and collaboration including social networking (Web 2.0) systems'. An aspirational goal included in the plan is that 'students and teachers [will] routinely collaborate, build and share knowledge using digital technologies – blogs, file sharing, social networking, videoconferencing, etc' (COAG Productivity Agenda Working Group 2008, p 7).

A number of reports published in 2009 have attempted to explore issues and define options for the use of repositories, content and learning management systems in the Australian school sector. Two will be discussed briefly below.

In their review of online curriculum resources that are currently available for use in schools, King and Deighton (2009, pp 50–1) describe how state and territory jurisdictions and sectors provide access to repositories of digital content through a number of content and learning management systems.

However, the real picture in Australian schools can be more varied than the research would indicate. King and Deighton also acknowledge that content is provided to commercial software and hardware suppliers such as ClickView or Smartboard, and is then licensed by schools and jurisdictions. In fact, individual schools within any jurisdiction may use a number of content or learning management systems, such as the open-source Learning Activity Management System (LAMS) developed at Macquarie University.[3]

3 'The LAMS Community' section of the LAMS website (LAMS 2009) includes a forum for K–12 schools, in which a number of Australian schools participate.

The M&EDCE trial (Baker 2009) more narrowly focused on the use of TLF's repository of digital content, available through the Scootle online learning environment. The research found that accessing and using digital content and the learning toolset within this online environment offered significant potential for collaborative online learning.

The overall picture provided by recent research suggests that variations in the quality of infrastructure for accessing suitable digital resources, as well as the quality of the online learning environment across and within jurisdictions, means that both teachers and students require extensive additional support. It also means that teachers and students who seek to interact online with others are, when this is possible, limited through a 'silo effect' to those using the same software systems. This again suggests opportunities for national cooperation and collaboration.

State-of-the-art tools

The *Joint Ministerial Statement on Information and Communications Technologies in Australian Education and Training: 2008–2011* (MCEETYA & MCVTE 2008) asserts that students should 'engage with state-of-the-art tools which will enable new forms of learning, collaboration, innovation and communication'. The Digital Education Revolution *Strategic Plan* defines what these tools might include. It identifies 'tools for safe and secure online knowledge sharing and collaboration including social networking (Web 2.0) systems', and places 'digital technologies – blogs, file sharing, social networking, videoconferencing etc' within the umbrella term 'state of the art tools' (COAG Productivity Agenda Working Group 2008, p 7).

In 2008, Crook et al published a groundbreaking survey of Web 2.0 technologies, commissioned by Becta in the United Kingdom. They define 12 categories of Web 2.0 activity: media sharing, media manipulation, conversational arenas, online games, virtual worlds, social networking, blogging, social bookmarking, recommender systems, collaborative editing, wikis, and syndication. Definitions of each of these technologies are also provided. A subsequent section of Crook et al's report identifies what is conveniently described as Educational Web 2.0.

Most of the examples of the Educational Web 2.0 technologies selected were developed in the United Kingdom, Canada and the USA. While a number of these technologies are already being incorporated into online learning environments, Millea and Galatis (2009, pp 77–88) suggest that within the Australian context they are only available outside the online learning environments provided by education authorities.

In the *Horizon Report 2009: The K–12 Edition*, published by The New Media Consortium in the USA, Johnson et al identify a number of technologies that will have a significant impact on schools in 2009–14. The *Horizon Report* estimates the time period it will take to adopt each of these technologies, with the maximum time being five years. The authors contend that collaborative environments are currently being widely used in schools. The following table provides examples for the six categories of emerging technologies that the report identifies.

Table 11: Technologies to watch

Emerging technology	Examples
Collaborative environments	Scootle, Moodle, Voicethread, Virtual Whiteboard, Exploratree
Online communication tools	TeacherTube, Teachers TV, Skype, instant messaging, chat, videoconferencing
Mobiles	photography, GPS capability, various third-party applications to allow functions such as data logging
Cloud computing	Google docs, Voicethread
Smart objects	Lego Mindstorms
The personal web	Delicious bookmarks, iGoogle

Millea and Galatis (2009, pp 61–80) focus on those technologies and tools that can support collaborative learning. They identify Web 2.0, text-based communication tools, immersive learning environments and 'people networks' as being appropriate for consideration by the three Australian education sectors. They draw upon the definition and categorisations of online collaborative tools developed by the International Organization for Standardization/International Electrotechnical Commission (ISO/IEC).

The ISO/IEC uses the following criteria to identify online collaborative tools:

Ease of use
A collaborative tool enhances productivity by being extremely user-friendly in providing the collaboration. It enables, through open communication among the participants, to assist in achieving a shared purpose.

Collaborative
The tool facilitates an exchange of information, consensus-building and resolving differences.

Temporal
The tool will, without regard for time, space and/or location, ensure that participants can work collaboratively in their own time and space. However, the tool should respect the time requirement for the completion of the task it supports.

Source: ISO/IEC 2006, cited in Millea & Gallatis 2009, p 23

Challenges and opportunities

In defining the challenges and opportunities provided by new technologies for learning, Crook et al (2008, pp 8–9) assert that Web 2.0 has fundamentally changed users' engagement with the internet, enabling greater user participation, joint knowledge building, user manipulation and creation of data and media, as well as new frameworks and resources for research and inquiry. They note that these technological innovations have coincided with, or allowed a parallel development in, identity expression and text-based communication among young people, and safety considerations.

Following this groundbreaking research, a number of Australian and international research projects have used a case study approach to investigate the potential of Web 2.0 for the education sectors.

For example, Becta in the United Kingdom has been at the forefront of research into online tools that can enhance education through online collaboration.[4] In addition to the survey of Web 2.0 technologies commissioned from Crook et al (2008), it has commissioned and published a number of action research projects about Web 2.0 in schools. Its research indicates that:

4 The Becta website (www.becta.org.uk) lists five reports that focus on Web 2.0 technologies for learning.

Web 2.0 helps to encourage student engagement and increase participation – particularly among quieter pupils, who can use it to work collaboratively online, without the anxiety of having to raise questions in front of peers in class – or by enabling expression through less traditional media such as video

Teachers have reported that the use of social networking technology can encourage online discussion amongst students outside school

Web 2.0 can be available any time, anywhere, which encourages some individuals to extend their learning through further investigation into topics that interest them

Pupils feel a sense of ownership and engagement when they publish their work online and this can encourage attention to detail and an overall improved quality of work. Some teachers reported using publication of work to encourage peer assessment.

Source: Becta 2009

Clearly emerging technologies such as the Web 2.0 technologies described by Crook et al (2008) and the *Horizon Report 2009* have implications for jurisdictions, schools and teachers who seek to provide students with a safe and secure online learning environment. The challenge for Australian authorities is to integrate appropriate tools into online learning environments.

Existing support for the use of online tools

A number of education jurisdictions in Australia provide advice for teachers about communication tools. For example, on its website the Department of Education and Training in Western Australia suggests how blogs, chat, podcasts, social bookmarking, videoconferencing, wikis and other communication tools can be used for learning. The educational value of each technology is discussed as well as practical classroom and teacher applications. The Department also suggests how teachers can gain confidence and skill in using individual tools (Department of Education and Training [WA] 2009).

The Department of Education and Training in Queensland, through The Learning Place, provides online collaborative environments for teachers and students that include a wide range of collaborative tools (eg blogging, forums, chat, comic chat, wikis, voice/video/data conferencing, project rooms, polling, podcasting) as well as expert advice and professional development in their use. Support for collaborative practice has been provided through online professional learning resources and courses, exemplars of practice, statewide hosted online learning events and a highly functioning network of expert facilitators, mentors and innovators. Support has also included a significant body of work in research and innovation that has been delivered by the ICT Learning Innovation Centre.

Use of state-of-the-art tools in the trial

The M&EDCE project (2009) trialled with teachers and students a technology-rich online environment to identify what worked and why. The project defined tools more narrowly than Crook et al (2008), the *Horizon Report 2009* or Millea and Galatis (2009). A tool was defined as a technology or feature that could be included in a safe and secure online learning environment; the definition did not include external websites such as Voicethread or Virtual Whiteboard.

Features of, or tools within, the online learning environment provided in the M&EDCE trial included the following:

- A dynamic environment – students could add their own text, comments and online resources, and rearrange the workspace to build a structured, collaborative response to a task
- Feedback – teachers could provide ongoing feedback at any time, for student reflection and meaningful formative assessment
- Online identity – students could create nicknames and choose an avatar for their own use in the live workspace
- Chat – students could chat in real time, take part in informal discussions and receive feedback in the online environment
- File uploading and sharing – students could upload their files and resources to attach to a learning activity
- Spatial and temporal tools – students could interact with digital content using Google maps and a unique timeline display.

Source: Baker 2009, p 28

Most teachers and students were able to use successfully the toolset provided within the trial. The first M&EDCE report suggested that additional Web 2.0 tools such as those included on Futurelab's Exploratree website could also be integrated into the online learning environment.

Key points

Australian teachers should have access to, and be able to use, technology-rich learning environments that enable students to achieve high-quality learning outcomes and productively contribute to our society and economy (MCEETYA & MCVTE 2008).

- Technology-rich learning environments can include the physical environment in which the learning occurs as well as online environments that incorporate state-of-the-art tools enabling new forms of learning, collaboration, innovation and communication.
- Technology-rich learning environments offer both challenges and opportunities for teachers. Teachers need clear advice and training regarding the most appropriate environment for their own and their students' skills.
- Only a small proportion of Australian teachers currently have the skills required to create learning activity designs that can engage students collaboratively in online learning environments.
- Interactive whiteboards and mobile technology offer considerable teaching and learning opportunities for teachers and students. Guidelines and models are required if teachers are to progress beyond the use of interactive whiteboards for solely instructional purposes.
- When students are provided with digital content in technology-rich learning environments they respond positively to the new opportunities for learning and collaboration that are provided.

Learners are active participants in knowledge creation and will engage with state-of-the-art tools which enable new forms of learning, collaboration, innovation and communication.

Conclusion

The following key points cover the seven areas of ICT education policy, theories of learning, learning design, pedagogy frameworks, professional learning, digital content, and technology-rich learning environments.

National education and ICT policy for schools includes key elements relevant to pedagogies and digital content for online learning:

- 'Australia will have technology enriched learning environments that enable students to achieve high-quality learning outcomes and productively contribute to our society and economy.'
- 'Schools should support the development of skills in areas such as social interaction, cross-disciplinary thinking and the use of digital media.'
- 'Learners are active participants in knowledge creation and will engage with state of the art tools which enable new forms of learning, collaboration, innovation and communication.'
- 'While there has been a significant investment in educational technologies over the last decade, only a minority [of teachers and students] are currently reaping the benefits of the digital revolution.'

Sources: MCEETYA 2008, pp 5, 8; MCEETYA & MCVTE 2008; COAG Productivity Agenda Working Group 2008, p 3

A number of theories of learning describe and define for teachers how students learn most effectively in general and online learning situations.

- Teachers may require assistance in unpacking the assumptions they make about how students learn and the pedagogical approaches they use to support these.
- Constructivist and situative theories of learning or perspectives are useful for online learning in that they are learner centred and take account of individual and group needs and interactions.
- Connectivism and Cooperative Learning take account of a whole new set of learning requirements brought about by the digital age, and can provide a theoretical basis for collaborative learning.

Effective learning activity design is essential if students are to engage positively with digital content in technology-rich learning environments.

- Learning activity design in its varied formulations can provide an effective theoretical and practical model for online learning in that it takes account of interactions between the needs of learners and the learning environment, and between people participating in the online learning activity.
- There is value in defining the theoretical and practical elements of successful design for online learning for teachers who are developing skills and capabilities in the use of online learning.
- Models of learning activity design should be developed or sourced that are relevant to teachers at all levels of schooling and in different learning areas. The interactive and digital curriculum content procured by TLF can be used to provide exemplary learning materials within such models.

There are a number of pedagogy frameworks that describe and define how teachers can use ICT for teaching and learning.

- Twenty-first-century schools require 21st-century programs and educators capable of using 21st-century resources and strategies for learning (AICTEC 2009, p 3).
- Teachers require detailed pedagogy frameworks that integrate the varied uses of ICT for curriculum and assessment, pedagogy, organisation and administration, and professional learning.
- There is a need for increased collaboration at a national level in the sharing of existing programs and the development of new programs (AICTEC 2009, p 7). Such collaboration might usefully align or develop agreed standards for teachers in the use of ICT in schools.
- There would be an advantage in mapping any new or redeveloped standards against UNESCO's *ICT Competency Standards for Teachers* (2008A, B & C) as well as against the skills defined for students within the ICT continuum to be developed for the Australian curriculum.

Teachers require a range of professional learning opportunities if they are to be effective users of digital resources in a technology-rich learning environment.

- The design of professional learning needs to conform to standards of best practice that are supported by the Australian education jurisdictions and sectors.
- Professional learning should be developed that meets the needs of teachers at various stages of knowledge, skills, understanding and practice.
- Professional learning should include an understanding of learning theories relevant to the new forms of learning, collaboration, innovation and communication made possible by the availability of accessible, high-quality digital content and technology-rich learning environments.
- Professional development and advice concerning the use of online learning environments needs to move beyond imparting knowledge of the platform and the tools to include resource selection and evaluation, learning activity design and assessment.
- Professional learning should allow teachers to gain confidence and expertise in the use of state-of-the-art tools that can be used for interaction and collaboration.
- National and local online discussion groups and forums that allow teachers to share ideas and best practices can play a role in supporting professional learning.
- Professional learning can target teacher interest in the new Australian curriculum and explore how digital resources can be used to support aspects of the curriculum at all levels of schooling.

Digital content has been developed, sourced and described through The Le@rning Federation's Schools Online Curriculum Content Initiative. This content is important to the school sector, as agreed procurement and quality assurance processes have ensured its educational soundness and appropriateness.

- While the design of interactive digital content procured by TLF is based on sound constructivist principles, there is an absence of interactive digital content that explicitly caters for social learning and collaboration. Any re-engineering of existing interactives or development of new content should consider this need.
- The structure and content of the new Australian curriculum provides opportunities for the procurement of new digital content for use by teachers.
- Teachers require clear guidelines and advice about the capabilities and skills required to access and use digital content for teaching and learning.
- While education jurisdictions and sectors have developed pedagogy frameworks and ICT continuums, these may not provide consistent or detailed advice about pedagogies that support the use of digital content for online learning.
- National collaboration and cooperation in the development of advice and professional learning about the use of digital content would have benefits for cost, efficiency and comprehensiveness.

Australian teachers should have access to, and be able to use, technology-rich learning environments that enable students to achieve high-quality learning outcomes and productively contribute to our society and economy (MCEETYA & MCVTE 2008).

- Technology-rich learning environments can include the physical environment in which the learning occurs as well as online environments that incorporate state-of-the-art tools enabling new forms of learning, collaboration, innovation and communication.
- Technology-rich learning environments offer both challenges and opportunities for teachers. Teachers need clear advice and training regarding the most appropriate environment for their own and their students' skills.
- Only a small proportion of Australian teachers currently have the skills required to create learning activity designs that can engage students collaboratively in online learning environments.
- Interactive whiteboards and mobile technology offer considerable teaching and learning opportunities for teachers and students. Guidelines and models are required if teachers are to progress beyond the use of interactive whiteboards for solely instructional purposes.
- When students are provided with digital content in technology-rich learning environments they respond positively to the new opportunities for learning and collaboration that are provided.

Appendix 1

The following tables compare the UNESCO *ICT Competency Standards for Teachers* (2008) with a number of ICT continuums in use in the Australian states and territories.

Table 12 lists progression points within the ICT standards and the continuums of individual jurisdictions without any deliberate alignment.

Table 12: Progression points in ICT competency

ICT Competency Standards for Teachers (UNESCO)	Technology literacy	Knowledge deepening	Knowledge creation	
ICT Continuum: Self-Evaluation Guide (NT)	Uncertain and/or hesitant	Willing but dependent	Confident and proficient	Leading and enabling others
Smart Classrooms Professional Development Framework (Qld)	ICT Certificate	ICT Certificate	Digital Pedagogy Licence	Digital Pedagogy Licence Advanced
Teacher Educational ICT Capabilities Continuum (EdCap) (SA)	Developing ICT skills	Applying ICT in the classroom	Delivering on learning outcomes	Transforming practices
Continuum of ICT Capabilities (Vic)	Foundation	Emergent	Innovative	Transformative

Sources: UNESCO 2008, DEET [NT] 2003; Education Queensland 2009B, DECS [SA] (n.d.); DEECD [Vic] 2009B

Table 13 below attempts to align the components of individual continuums with the approaches of UNESCO's *ICT Competency Standards for Teachers*. There may be overlap in some areas.

Table 13: Aspects of ICT competency

ICT Competency Standards for Teachers (UNESCO)	Policy and vision	Policy	Curriculum and assessment	Pedagogy	ICT	Organisation and administration	Teacher professional development
ICT Continuum: Self-Evaluation Guide (NT)	Vision	Approach Ethics	Planning Recording and reporting	Classroom practice Classroom management	Resources Online interaction		[Professional learning is aligned to each level]
Smart Classrooms Professional Development Framework (Qld)	Policy and Vision	Professional values Professional knowledge	Professional practice	Professional knowledge	Professional knowledge		Professional relationships
Teacher Educational ICT Capabilities Continuum (EdCap) (SA)	Vision	Attitude	Planning Assessment recording and reporting	Contribution Practice Management	Resources Online learning		Professional learning
Continuum of ICT Capabilities (Vic)		ICT ethics	Learning and teaching Assessment and reporting	Classroom organisation			

Sources: UNESCO 2008; DEET [NT] 2003; Education Queensland 2009B; DECS [SA] (n.d.), DEECD [Vic] 2009B

Glossary

Activity Theory	Theory of learning originally developed by Leont'ev and Rubinshtein. It argues that learning results from an engagement in an activity, and that the activity is influenced by the learner's needs and the learning context.
AICTEC	Australian Information and Communications Technology in Education Committee
Artefacts	Physical and online tools and resources that impact on a learning activity
Associative perspective	Term used by JISC researchers to describe how learners acquire knowledge through association of concepts and through progressively more complex skill development
Becta	British Educational Communications and Technology Agency
Behaviourism	A group of learning theories asserting that knowledge, skills and values are conditioned or learned through modelling, or by trial and error
Blog	Short for web log. Blogging is one of the Web 2.0 technologies identified by Crook et al (2008).
Chat	Synchronous internet discussion, usually occurring in a dedicated chat room
Cloud computing	An emerging online technology identified by Johnson et al (2009)
COAG	Council of Australian Governments
Cognitivism	A group of learning theories proposing that people learn by constructing mental maps, models and frameworks
Collaborative environment	An online environment that can cater for synchronous or asynchronous interaction and collaboration by users. Also an emerging technology identified by Johnson et al 2009)
Communities of Practice	A learning theory proposing that learners' interests, motivations and understandings are developed through social interaction
Connectivism	A learning theory describing how learning occurs in online environments that contain shifting core elements
Constructive perspective	Term used by JISC researchers to categorise constructivist pedagogical approaches to online learning
Constructivism	A group of learning theories arguing that learning is an active, contextualised process where new information is linked to prior knowledge. Some researchers have proposed that constructivism has individual and social dimensions.
Content management system	A software platform that that enables users to upload, modify, manage and or delete digital content online
Continuum	A series of progression points grouped under stages of learning

Conversational arenas	One-to-one or one-to-many conversations using internet software such as videoconferencing. Also category of Web 2.0 technologies identified by Crook et al (2008)
Cooperative Learning	A learning theory proposing that the ways in which students perceive and interact with each other are an important aspect of the learning process
Data logging	Using an electronic device to record data or information concerning an object or event over time
DECS	Department of Education and Children's Services [SA]
DEECD	Department of Education and Early Childhood Development [Vic]
DEET	Department of Education, Employment and Training
DEEWR	Department of Education, Employment and Workforce Relations, Australia
Delicious	A social bookmarking service that allows users to select, describe, annotate and share web pages from any computer
Digital content	Generic term for an array of electronic and internet content such as multimedia, audio, video, digitised photographs and text, and graphic files
Digital Education Revolution	Australian Government program (2008–12) aiming to bring about substantial and meaningful changes to teaching and learning in all schools. Elements include a Fibre Connections to Schools Initiative.
Discovery Learning	A learning theory originated by Jerome Bruner. It argues that learners most effectively acquire information and awareness of relationships through an inquiry approach.
Distributed Cognition	Psychological theory originated by Hutchins that emphasises the social aspects of cognition and that involves the interaction of individuals and artefacts
Exploratree	Online library of digital thinking guides (eg flowcharts) managed by Futurelab, United Kingdom
Google docs	Free web-based word processor and spreadsheet that can be used by a single user or collaboratively
GPS	Global positioning system
Human Activity Theory	Adaptation of Activity Theory that takes account of the role of the community in the learning process
ICT	Information and communication technologies
iGoogle	Software developed by Google that allows registered users to assemble their own web page using various components
Instant messaging	Real-time communication between two or more people using typed text via the internet
Interactive whiteboard	An interactive display that connects the computer desktop to a projector. Users typically control the computer using a pen, finger or other device.
ISO/IEC	International Organization for Standardization/International Electrotechnical Commission

ISTE	International Society for Technology in Education
JISC	Joint Information Systems Committee
K–12	Kindergarten to Year 12
LAMS	Learning Activity Management System
Learning activity design	A clearly developed and sequenced learning activity, possibly including digital resources. A 'learning pathway' is The Le@rning Federation equivalent of learning activity design.
Learning environment	The physical or online environment in which learning takes place
Learning management system	A software platform that delivers content to, tracks and manages users in online learning
Learning object	A term used by The Le@rning Federation to describe self-contained multimedia interactives designed to assist learning
Lego Mindstorms	Commercial educational product that provides programmable sensor blocks
M&EDCE	Museum & Education Digital Content Exchange [project and trial]
MCEECDYA	Ministerial Council for Education, Early Childhood Development and Youth Affairs
MCEETYA	Former Ministerial Council on Education, Employment, Training and Youth Affairs (see MCEECDYA)
MCVTE	Ministerial Council for Vocational and Technical Education
Media manipulation	The use of web tools to design and edit digital media files. Also category of Web 2.0 technologies identified by Crook et al (2008)
Media sharing	Uploading, downloading and sharing digital media files on the web. Also category of Web 2.0 technologies identified by Crook et al (2008)
Mobile	A portable communicative device that may have data capture and third-party software included. Also an emerging technology identified by Johnson et al (2009)
Moodle	A free, open-source online learning platform
More Knowledgeable Other	A term used by Vygotsky to explain how individuals and groups can learn by interacting with others who hold greater knowledge and skills
Multiple Intelligences	A theory proposed by Gardner, which argues that individuals have differing intelligences, and that these intelligences lead to individuals having preferred learning styles
NSW	New South Wales
NT	Northern Territory
Online communication tools	Text, audio and video-based online tools for communication. An emerging technology identified by Johnson et al (2009)

Online games	Rule-governed games played in an online environment. Also category of Web 2.0 technologies identified by Crook et al (2008)
PDA	Personal digital assistant. A handheld device combining phone, fax, computing, internet access and networking features
Pedagogy	Principles and methods of teaching based on theories regarding how students learn
Pedagogy framework	An organised and systematic outline of a range of pedagogies that is appropriate for teacher use
Personal web	Online pages created by individuals that can provide pathways into the World Wide Web
Problem-Based Learning	Theory of learning proposing that individuals and groups learn most effectively when seeking explanations and designing solutions to real-world problems and issues
Qld	Queensland
Recommender system	A form of information filtering that presents types of items of likely interest to a particular user
RSS	Really Simple Syndication
SA	South Australia
Scootle	An online environment, developed by The Le@rning Federation, that provides access to interactive and digital curriculum content
Situated Learning	A learning theory originated by Jean Lave and arguing that the most effective learning occurs in authentic contexts rather than through abstract or uncontextualised discussion
Situative perspective	Term used by JISC researchers to categorise situative pedagogical approaches to online learning
Skype	Commercial voice-over-internet software
Smart objects	Objects combining a unique identifier with sensors and network access. An emerging technology identified by Johnson et al (2009)
Social bookmarking	Collections of online annotated or unannotated bookmarks developed by an individual or a group. Also category of Web 2.0 technologies identified by Crook et al (2008)
Social Development Theory	A learning theory originally developed by Vygotsky that has three main elements: social interaction, the More Knowledgeable Other, and the Zone of Proximal Development
Social networking	Websites that support social interaction. Also category of Web 2.0 technologies identified by Crook et al (2008)
Syndication	Subscription to RSS feeds that indicate when a website has been updated. Also category of Web 2.0 technologies identified by Crook et al (2008)
Tas	Tasmania
TLF	The Le@rning Federation
TQELT	Teacher Quality and Educational Leadership Taskforce
UNESCO	United Nations Scientific and Cultural Organization

VCAA	Victorian Curriculum and Assessment Authority
Vic	Victoria
Virtual Whiteboard	An online environment that provides a 'canvas' for thinking, designing, and collaborating with others in real time
Virtual world	An online themed environment in which a user can interact with others, often using an avatar. Also category of Web 2.0 technologies identified by Crook et al (2008)
Voicethread	A commercial online environment where users can create digital resources as well as communicate and collaborate. It has elements of a learning management system.
Web 2.0	Online environments or tools that facilitate interaction and collaboration
Wiki	A web-based tool that allows multiple users to contribute content. Also category of Web 2.0 technologies identified by Crook et al (2008)
Zone of Proximal Development	The space between what is the learner knows and what others know

References

Atkins, S 2003, *Achieving Educational Soundness in the Digital Age*, The Le@rning Federation, Melbourne.

Australian Education Council 1989, *The Hobart Declaration on Schooling*, MCEETYA, Australia.

Australian Information & Communications Technology in Education Committee 2009, *The Digital Education Revolution: Teaching for the Digital Age Work Plan 2009–2012*, AICTEC, Australia.

Baker, RA 2009, *Museum & Education Digital Content Exchange: Overview and Report on the Student Trial*, Curriculum Corporation, Melbourne.

Bandura, 1977. *Social Learning Theory*, New York: General Learning Press.

Becta 2005*, How Can the Use of an Interactive Whiteboard Enhance the Nature of Teaching and Learning in Secondary Mathematics and Modern Foreign Languages?* Becta, United Kingdom.

Becta 2009, 'Becta report shows benefits of Web 2.0 in the classroom', http://news.becta.org.uk/display.cfm?resID=38417&CFID=3593090&CFTOKEN=9c22fc90c068b692-D5A04B9D-9222-9909-9D9D8370F05C9F1C.

Beetham, H & Sharpe, R 2007, 'An approach to learning activity design', in H Beetham & R Sharpe (eds), *Rethinking Pedagogy for a Digital Age*, Routledge, United Kingdom.

COAG Productivity Agenda Working Group 2008, *Success through Partnership: Achieving a National Vision for ICT in Schools: Strategic Plan to Guide Implementation of the Digital Education Revolution Initiative and Related Initiatives*, Department of Education, Employment and Workforce Relations, Australia.

Crook, C, Cummings, J, Fisher, T, Graber, R, Harrison, C, Lewin, C, Logan, K, Luckin, R, Oliver, M & Sharples, M 2008, *Web 2.0 Technologies for Learning: The Current Landscape – Opportunities, Challenges and Tensions*, Becta, United Kingdom.

Department of Education and Children's Services n.d., *Teacher Educational ICT Capabilities Continuum (EdCap)*, DECS, South Australia.

Department of Education and Early Childhood Development 2009A, *Principles of Learning and Teaching*, www.education.vic.gov.au/studentlearning/teachingprinciples/principles/default.htm.

Department of Education and Early Childhood Development 2009B, *e-Potential ICT Capabilities Resource for Teachers*, DEECD, Victoria.

Department of Education and Training [NSW] 2003, *Quality Teaching in NSW Public Schools: Discussion Paper*, Professional Support and Curriculum Directorate, New South Wales.

Department of Education and Training [Qld] 2005, *Professional Standards for Teachers: Guidelines for Professional Practice*, DET, Queensland.

Department of Education and Training [Tas] n.d., *Tasmanian Curriculum Information and Communication Technologies (ICT) K–10 Cross Curricular Framework,* DET, Tasmania.

Department of Education and Training [WA] 2009, 'ICT in learning', www.det.wa.edu.au/education/cmis/eval/curriculum/ict/index.htm.

Department of Education, Employment and Training 2003, *ICT Teacher Continuum: Self-evaluation Guide*, DEET, Northern Territory.

Digital Education Revolution 2009, *Fact Sheet: March 2009*, Department of Education, Employment and Workforce Relations, Australia.

Downes, T, Fluck, A, Gibbons, P, Leonard, R et al 2001, *Making Better Connections: Models of Teacher Professional Development for the Integration of Information and Communication Technology into Classroom Practice*, Department of Education, Science and Training, Australia.

Education Queensland 2009A, *The Learning Place*, http://education.qld.gov.au/learningplace/.

Education Queensland 2009B, *Smart Classrooms Professional Development Framework*, Department of Education and Training, Queensland.

Fisher, T, Higgins, C & Loveless, A 2006, *Teachers Learning with Digital Technologies: A Review of Research and Projects*, Futurelab, United Kingdom.

Freebody, P 2005, *Does the Use of Online Curriculum Content Enhance Motivation, Engagement and Learning? The Le@rning Federation Trial Review*, TLF, Melbourne.

Freebody, P & Muspratt, S 2007, *Uses and Effects of The Le@rning Federation's Learning Objects: An Experimental and Observational Study*, TLF, Melbourne.

Freebody, P, Reimann, P & Tiu, A 2008, *Alignment of Perceptions about the Uses of ICT in Australian and New Zealand Schools*, Centre for Research on Computer Supported Learning and Cognition, Faculty of Education and Social Work, University of Sydney.

Futurelab 2007, *Exploratree*, www.exploratree.org.uk/.

Green, H & Hannon, C 2007, *Their Space: Education for a Digital Age*, Demos, United Kingdom.

Groundwater-Smith, S 2007, *Supporting Student Learning Environments in a Digital Age: Listening to Young People*, DET, New South Wales.

Hedberg, J & Freebody, K 2007, *Towards a Disruptive Pedagogy: Classroom Practices that Combine Interactive Whiteboards with TLF Digital Content*, TLF, Melbourne.

Holkner, B, Romeo, G, Henderson, M, Auld, G, Russel, G, Seah, WT & Fernando, A 2008, *Exemplar Schools: Using Innovative Learning Technologies*, Department of Education, Employment and Workplace Relations, Australia.

ICT in Schools Taskforce 2001–08, Learning in an Online World series, Ministerial Council on Education, Employment, Training and Youth Affairs, Australia.

ICT in Schools Taskforce 2005, *Pedagogy Strategy*, Learning in an Online World series, Ministerial Council on Education, Employment, Training and Youth Affairs, Australia.

International Society for Technology in Education 2008, *The ISTE National Educational Technology Standards (NETS-T) and Performance Indicators for Teachers*, ISTE, Oregon.

ISO/IEC 2006, 'ISO/IEC JTC1 SC36 Information technology for learning, education and training: SC36 standing document SDnnnn- collaboration tool requirements', http://isotc.iso.org/livelink/livelink/fetch/2000/2122/327993/806742/1056984/36N1348_SC36_Standing_Document_SDnnnn_-_Collaborative_Tools_Requirements.pdf?nodeid=5622189&vernum=0.

JISC Innovation Group 2009, *Effective Practice in a Digital Age: A Guide to Technology-Enhanced Learning and Teaching*, University of Bristol, United Kingdom.

Johnson, L, Levine, A, Smith, R & Smythe, T 2009, *Horizon Report 2009: The K–12 Edition*, New Media Consortium, USA.

Johnson, RT & Johnson, DW 1994, 'An overview of cooperative learning', in J Thousand, A Villa & A Nevin (eds) 1994, *Creativity and Collaborative Learning: The Practical Guide to Empowering Students, Teachers, and Families*, Paul H Brookes Publishing Co, Baltimore.

King, M & Deighton, N 2009, *Review of Online Curriculum Resources*, Curriculum Corporation, Melbourne.

LAMS 2009, *Learning Activity Management System*, www.lamsinternational.com.

McRae, D 2001, *What to Make and Why: Principles for the Design and Development of Online Curriculum Content*, Curriculum Corporation, Melbourne.

Marzano, RJ 2007, *The Art and Science of Teaching: A Comprehensive Framework for Effective Instruction*, Association for Supervision and Curriculum Development, Virginia.

Marzano, RJ, Pickering, DJ, Arredondo, DE, Blackburn, GJ, Brandt, RS, Moffett, CA, Paynter, D, Pollock, J & Whisler, JS 1997, *Dimensions of Learning: Teacher Manual*, Association for Supervision and Curriculum Development, Virginia.

Mayes, T & de Freitas, S 2004, *JISC e-Learning Models Desk Study: Stage 2: Review of e-Learning Theories, Frameworks and Models*, Chimera, Institute of Socio-technical Innovation and Research, University of Essex.

Millea, J & Galatis, H 2009, *Collaboration in Teaching and Learning: Strategic ICT Advisory Service*, Education.au, Australia.

Ministerial Council on Education, Employment, Training and Youth Affairs 1999, *The Adelaide Declaration on National Goals for Schooling in the Twenty-First Century*, MCEETYA, Australia.

Ministerial Council on Education, Employment, Training and Youth Affairs 2008, *The Melbourne Declaration on Educational Goals for Young Australians*, MCEETYA, Australia.

Ministerial Council on Education, Employment, Training and Youth Affairs & Ministerial Council for Vocational and Technical Education 2008, *Joint Ministerial Statement on Information and Communications Technologies in Australian Education and Training: 2008–2011*, Australian Information & Communications Technology in Education Committee, Australia.

Moss, G, Jewitt, C, Levaaic, R, Armstrong, V, Cardini, A & Castle, F 2007, *The Interactive Whiteboards, Pedagogy and Pupil Performance Evaluation: An Evaluation of Schools Whiteboard Expansion (SWE) Project: London Challenge,* School of Educational Foundations and Policy Studies, Institute of Education, University of London.

Northern Territory Government n.d., *Designing for Learning: Design Questions [and] Pedagogical Practices*, DET, Northern Territory.

Qualifications and Curriculum Authority n.d., *National Curriculum: ICT Key Stages 1–4,* QCA, United Kingdom.

Siemens, G 2005, 'Connectivism: a learning theory for the digital age', www.elearnspace.org/Articles/connectivism.htm.

Smith, R, Lynch, D & Knight BA 2007, *Learning Management: Transitioning Teachers for National and International Change*, Pearson Education Australia.

Teacher Quality and Educational Leadership Taskforce 2003, *A National Framework for Professional Standards for Teaching*, Ministerial Council on Education, Employment, Training and Youth Affairs, Australia.

The Le@rning Federation 2007, *Education Soundness Specification v.4.0*, TLF, Australia.

The Le@rning Federation 2009, *Use of The Le@rning Federation Digital Curriculum Resources in Australian Pre-Service Tertiary Institutions*, Curriculum Corporation, Melbourne.

United Nations Educational, Scientific and Cultural Organization 2008A, *ICT Competency Standards for Teachers: Policy Framework*, UNESCO, United Kingdom.

United Nations Educational, Scientific and Cultural Organization 2008B, *ICT Competency Standards for Teachers: Competency Standards Modules*, UNESCO United Kingdom.

United Nations Educational, Scientific and Cultural Organization 2008C, *ICT Competency Standards for Teachers: Implementation Guidelines, Version 1.0*, UNESCO, United Kingdom.

University of Tasmania 2006, *Children, Online Learning and Authentic Teaching Skills in Primary Education*, UTAS, Tasmania.

Victorian Curriculum and Assessment Authority 2005, *Victorian Essential Learning Framework,* VCAA, Victoria.

Vrasidas, C & Glass, GV (eds) 2005, *Preparing Teachers to Teach with Technology*, Information Age Publishing, Greenwich, Connecticut.

Vygotsky, LS 1978, *Mind and Society: The Development of Higher Psychological Processes*, Harvard University Press, Cambridge, Massachusetts.

Wenger, E 1998, *Communities of Practice: Learning, Meaning and Identity*, Cambridge University Press, United Kingdom.