DER MID-PROGRAM REVIEW
ASSESSING PROGRESS OF THE DER AND POTENTIAL FUTURE DIRECTIONS

FINAL REPORT

Contents

Executive summary

The Digital Education Revolution Initiative

In 2008, the Australian Government committed more than $2.1 billion to the Digital Education[1] Revolution (DER) initiative – an intervention designed to generate an immediate, large-scale boost to enhance the integration of information and communication technology (ICT) into teaching and learning in Australian schools. The initiative involved investment in computers and software, school-based infrastructure, leadership, professional development and digital resources across all Australian education systems and sectors. The objective of the DER was to create ubiquitous access to the tools necessary for students to take advantage of new technologies.

Entering into a National Partnership Agreement, the Australian Government committed to working with all State and Territory governments and the Catholic and independent sectors to achieve the following outcomes:

- Deliver sustained and meaningful change in the way teaching and learning is conducted in Australian secondary schools, focusing on four strands of change (infrastructure, leadership, teacher capability and learning resources).
- Provide every student in Years 9–12 with access to technology required for contemporary learning.
- Create the foundations for effective delivery of an online, nationally consistent curriculum as well as providing stimulating and challenging learning resources for students.

The DER was designed to generate the broadest possible impact, and the scale of investment was intended to rapidly level the playing field in effective integration of information and communication technologies (ICT) into teaching and learning. The breadth and quantum of investment under the DER is unique, and reflect the Australian Government's ambition to spark a genuine revolution in the education space.

Purpose and scope of this review

dandolopartners was commissioned to undertake this mid-program review, following the achievement of the one to one (1:1) computer to student ratio target under the National Secondary School Computer Fund (NSSCF), the major component of the DER, and prior to the completion of the DER National Partnership Agreement. This review sought to answer the following fundamental question:

> ***Has the DER been a catalyst for positive change that establishes the foundations for improved use of ICT in education?***

At a more specific level, the objectives of the review[2] are to:

- assess the impact of the DER and its achievements to date[3];
- record stakeholder views on the extent to which the DER is on track to meet its objectives; and
- identify perspectives on current and future trends in educational technology, as well insight from key stakeholders on how to continue to improve the integration of technology into teaching and learning. This includes changes in the technology and education landscape since the DER's inception that have implications for the future use of technology in schools and for different groups of students, including those in remote areas and those from low socio-economic status (SES) backgrounds.

This review involved analysis of reports provided by education authorities; interviews, workshops and focus groups with more than 200 stakeholders; and a literature review. The absence of comparable quantitative research was a significant limitation of the review, requiring a heavy reliance on qualitative views from stakeholders.

[1] Throughout this report, the phrase 'digital education' is used to refer to the effective integration of ICT into education.
[2] While this review is technically past the 'mid-point' of the DER program, the *DER Evaluation Strategy April 2011* had signalled the Mid-Program Review to take place in 2012 following the 1:1 computer to student ratio target being achieved.
[3] It is important to note that this review is not focused on determining whether the objectives set for the DER program were ambitious enough, but rather to assess the progress that has been made against the objectives.

DER Impact Assessment

The DER is broadly regarded as a major success. It is credited with generating a catalytic positive impact across Australian schools, including that:

- A general acknowledgement now exists across Australian education sectors that digital technology leads to enhanced educational outcomes.
- The DER has allowed schools to accelerate and scale activity that was already underway. The impact is most profound in low SES schools, where stakeholders considered that the DER accomplished in two years what may have otherwise taken a decade.
- The DER has directly or indirectly assisted schools to put in place more robust and scalable infrastructure to support the uptake of technology. Even schools that had not been previously convinced of the merits of digital education reported that the DER had caused them to change their attitude and approach to technology and its integration into teaching and learning.
- The basic building blocks for improved digital education performance are now in place. While the DER was responsible for some of those building blocks, it was recognised that the true value of the DER has been the significant, planned and sustained school level engagement it had helped to engender.

The DER has achieved, or is on track to achieve, the vast majority of its objectives. From an infrastructure perspective, the DER has not only achieved its objective of achieving a 1:1 ratio under the NSSCF, but it has also provided a major uplift in technology available to year levels outside of the target group (i.e. outside of years 9 – 12). The DER has also provided direct funding or impetus for schools to improve their school-based infrastructure, such as wireless internet, benefitting all year levels and better positioning schools for the future.

From a leadership perspective, the DER has helped to convince school leaders – particularly those that were unconvinced of technology's value in education – to invest in the integration of technology. This is borne out by consistent feedback that school leaders' roles in ICT decisions is increasing, recognising its increased profile and priority. In the area of teacher capability there was anecdotal evidence of changing attitudes and practice, though there is much work remaining to ensure that the value of capability deployed under the DER is fully harnessed. The body of learning resources continues to increase, in part stimulated by the DER, but also by the explosion in the use of video and interactive content more generally in the market.

Perhaps one of the defining achievements of the DER was the contribution to low SES schools and their students. The ubiquitous nature of the DER rollout enabled less well-resourced schools to benefit from technology and capability that they would otherwise have struggled to afford. The achievements are summarised at an aggregate level in

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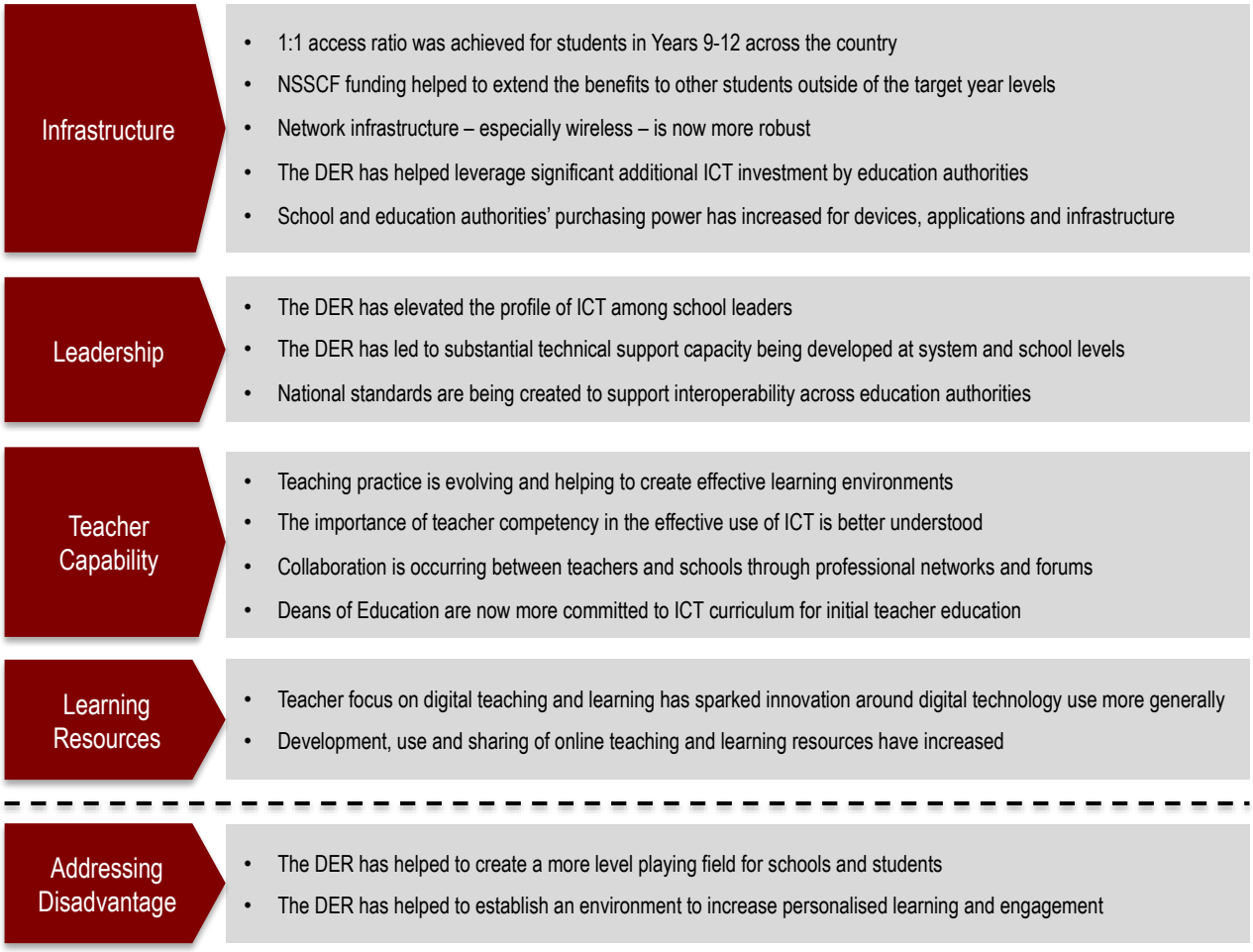
FIGURE ES 1- 1: SUMMARY OF THE DER ACHIEVEMENTS TO DATE



As mentioned above, the DER was unique in its scale. All schools, regardless of sector, socio-economic status and geographic location, had an opportunity to participate in the DER. This approach is rare, particularly in education policy where funds are generally directed towards more specifically targeted programs. With ubiquity also comes complexity and implementation risk, a fact acknowledged by system owners, sectors and schools alike.

Challenges that remain in capitalising on the DER

While there was a general consensus that the DER had made a positive contribution, stakeholders recognised that the initiative's design and implementation did not establish all of the foundation stones for the long-term uptake of ICT in schools. While it was never suggested that the DER would overcome all barriers, it is important to understand where stakeholders believe more effort is required in the future to continue to integrate technology into teaching and learning.

As an example, while the Teacher Capability strand of change is considered to have delivered real benefits, there is acknowledgment that more needs to be done if the teaching profession is to capitalise on the potential value of technology. This outcome is perhaps not surprising given the generational issues at play, and the complexity associated with integrating new tools and techniques across all Australian schools. Additionally, with the continually changing nature of the technology landscape, continued and regular teacher professional development in this area is an integral part of the profession.

The funding proportions of the DER significantly emphasised infrastructure and devices over other issues, recognising the Australian Government's determination of where it could have the greatest impact. Given the desire for wide uptake, and the size and speed of the rollout, there was always a risk that the DER would produce variable results. The general sentiment of stakeholders is that the DER, given its scope and implementation hurdles, produced good outcomes for the majority of participants. One criticism was that the DER provided infrastructure to some schools before they had the full range of capabilities in place, such as leadership and teacher capability. It was argued that in these schools, devices were not used to their full potential.

However, an even greater number of stakeholders suggested that this was a necessary consequence of the DER and that the fundamental question is:

> *Should the Government have waited for the teacher and principal capability to be enhanced before deploying infrastructure, or was the DER `infrastructure first' strategy the right one?*

The answer from stakeholders, almost universally, was that the DER's approach was the only one that would have achieved impacts at scale. To have waited for the capability to be in place would have meant waiting indefinitely. On this basis, the DER's `infrastructure first, and infrastructure for all' strategy was considered appropriate.

Stakeholders also identified a range of other limitations. However, these were less directly related to the DER's performance than the state of 'enabling' infrastructure or resources provided outside of the DER.

Lessons for future educational policy and funding rounds

Trends in the strategic environment

While this evaluation was focused on capturing a snapshot in time – at the mid-point of the DER initiative – it is impossible to ignore the significant change that is occurring in technology and education. In contemplating how schools and education authorities might build on the DER, it is necessary to look at the fundamental shifts that are occurring outside of the DER. The changes in the technology and education landscape therefore form a backdrop for ongoing discussions between the Australian Government, State and Territory governments, sectors and other education stakeholders about the most effective ways to integrate ICT into education.

The evolution of technology means that future investments and approaches will need to be flexible and adaptive. In the period since the DER was announced, a number of changes have occurred that have had implications for the rollout of the DER, and importantly for the future directions of digital education policy. These changes relate to the economy, technological developments, available digital resources, pedagogy, curriculum and education policy. It is important to recognise that these changes are not discrete, nor isolated: many of them converge to create new challenges and opportunities.

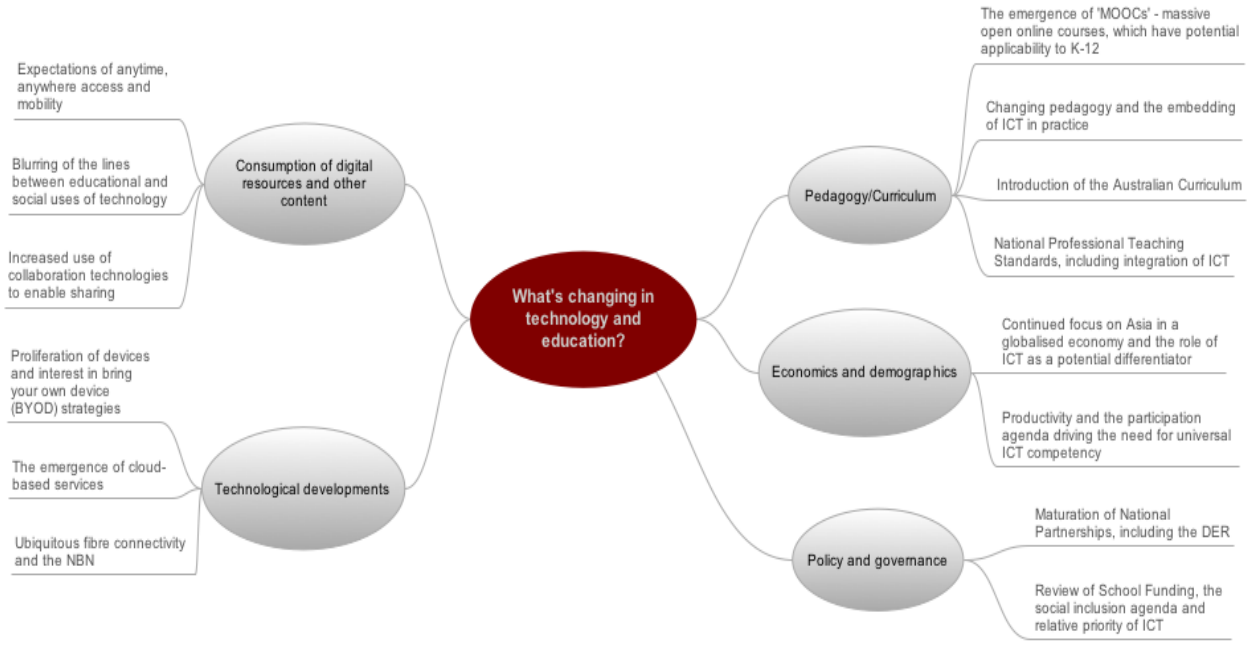
As an example, changes in technology provide the opportunity for teachers to undertake new pedagogical practices to enhance student engagement and learning outcomes, rather than simply delivering the same traditional content through the use of new technologies. To illustrate, device proliferation, particularly among learners, is increasing expectations that learners will be mobile (anywhere, anytime learning), and students' demand for anywhere, anytime learning is driving investment in a range of technologies, 'thin client' applications such as virtual desktops, and cloud-based services. Advances in cloud-based services are creating the potential for improved and accessible media-rich content such as captured video to be effectively collected and delivered as part of the education process. Demand for captured video is putting new strain on school-based infrastructure such as networks, video applications, data storage and access to educational content on demand.

These are all leading to greater personalisation of learning, opportunities to exploit real-time assessment and feedback, new mechanisms and channels to deliver blended learning, and opportunities to deliver new pedagogical approaches including concepts such as flipped learning.[4] A snapshot of these issues is depicted in Figure ES 1– 2.

Figure ES 1– 2.

. WHAT'S CHANGING IN TECHNOLOGY AND EDUCATION?

[4] Flipped learning is a form of blended learning that encompasses the use of technology to leverage learning in the classroom. This allows teachers to take on more of a facilitator role and spend more time interacting with students instead of the traditional role of transmitter of information.



Capitalising on the momentum of the DER

Universal and ongoing integration of ICT into teaching and learning requires greater investment and time than was provided by the DER. In this way, the DER is viewed as having 'catalysed action' rather than 'finished the job'. Stakeholders expressed a number of areas where the DER could be augmented to improve both the uptake and results from integrating technology into teaching and learning. The larger subset of these issues relates to the need for further investment in 'enabling' infrastructure and resources. For example, there is a strong desire for improved connectivity to schools and households to improve the quality of the learning experience in schools and in the home – a role that the National Broadband Network (NBN) is expected to play in the future. While the DER provided On Cost funding to schools for investment in school based infrastructure such as wireless and maintenance, keeping pace with demand remains a challenge, particularly when considering the added complexity associated with network and device security. Another challenge for the future is expanding the uptake of technologies beyond the target cohort of Years 9-12 students. Stakeholders suggested that investment in lower year levels may reap even greater rewards: now and in the future.

While the DER has provided a number of essential ingredients for integrating ICT into teaching and learning, one area where stakeholders have reported 'unfinished business' is teacher development and practices. In some cases the challenge is not necessarily financial, including the suggestion that one of the barriers to increased uptake by teachers is their lack of available time to develop their abilities in effectively integrating ICT into their teaching practices.

Stakeholders also acknowledged that building on the DER would require a fundamentally different role for parents, particularly around the delivery of ICT in schools. The DER has created the expectation among parents that 1:1 computer to student ratios will be maintained going forward without a clear funding stream to support this. While some sectors are less convinced than others, there is activity underway at the school level to identify how parents might contribute to the cost of what has now become an expected educational expense. Part of the ongoing challenge will be to better engage parents in their children's education, including through effective use of new technologies, so that they can better appreciate the role and value of ICT.

Beyond these lessons, in terms of the future, clear themes have emerged from the DER experience:

- The majority of schools suggest that momentum under the DER will be maintained and that they cannot 'turn back the clock' in terms of technology use in teaching and learning. However, planning around the sustainability of 1:1 (or close) beyond the DER is patchy. Consultations with jurisdictions indicate that the most decentralised systems appear to be best prepared for this.
- The focus of future policy in this area will need to shift away from the device infrastructure - but not necessarily school-based ICT infrastructure – and towards continuing to build teacher capability.

Addressing these lessons and themes in future policy and funding rounds will further enhance the impact of the DER, continuing to propel Australia towards greater integration of ICT in teaching and learning, and the improved educational outcomes that this can encourage.

A framework to guide future directions and systemic implications

Looming changes to education and technology are profound and will challenge governments, sectors, school leaders and teachers. Whether governments stimulate this or not, according to stakeholders, an education revolution is taking place. The question is whether schools are sufficiently equipped to respond to existing and emerging challenges. If recent developments in technology and technology consumption demonstrate anything, it is that change will remain a constant rather than something that needs to be conquered once. Stakeholders have consistently cautioned that not everything can be anticipated and planned for. The emergence of new technologies such as the proliferation of tablets such as iPads – a device not even conceived when the DER was announced – and changes to the way that digital content is consumed are examples. To provide effective, timely responses to these issues requires capability to be built into all levels of the education sector.

Drawing upon stakeholder consultations, international research and strategic analysis of the DER's performance to date, a range of good and better practices in ICT integration generally, and 1:1 deployment specifically, have been identified to guide future policy and funding development of and beyond the DER. Broadly, these lessons fall under the four following areas:

- **appropriate governance and policies** – including the need for a long-term, staged approach to digital education planning and greater collaboration between stakeholders at state, sector and school level;
- **strong school leadership and a whole of school approach** – including the need for an explicit educational vision and strategic plan defining the role of ICT in achieving improved student outcomes, and engaging stakeholders in the wider school community;
- **infrastructure that is fit for purpose, flexible, supported and sustainable** – including the need to ensure that selection and design of physical infrastructure devices, school-based infrastructure and software take account of the requirements of the learners and the school environment; and
- **teacher professional preparation and development** – including integrating content, pedagogy and technology, and the development of professional networks both within, and beyond the school.

Guided by this framework, a range of implications for future ICT integration can be identified across the schooling system.

Implications for schools

A significant focus for the future must be on encouraging and equipping school leaders, teachers, parents and students to make sound decisions about all aspects of technology in teaching and learning. To effectively build upon the DER, there must also be leadership and activity at the school level. Research and stakeholder perspectives provide a clear sense of what works effectively to achieve school-level reform and results. The importance of leadership is significant, including school leaders' personal leadership style and their capacity to demonstrate the behaviours they seek to promote within the school. The leader's capacity to create a culture that encourages teachers to innovate and respond to their own context is also critical.

Governance arrangements, including the appropriate use policies, will also need to evolve. As a result of both device proliferation and social media, much learning will occur outside the classroom and the undertaking of 'non-traditional activities', such as students collaborating with their peers from across the world on social media sites, will continue to grow within schools: the education system will need to keep pace with such changing practices and ensure that social media and device-usage policies are responsive.

From a teacher capability perspective, the lessons are equally profound and consistently promoted. These include the need for teachers to evolve their pedagogical practices in response to major technology changes, and change their role in the classroom to more of a facilitator of learning rather than a transmitter of information. Teachers are being challenged to fully exploit the strengths of digital technologies that enable more regular assessment of students, both formative and summative, as well as informing teacher planning for more personalised learning for students. Research[5] identifies that it is features such as this that mean digital technologies provide the opportunity to enhance student outcomes like no other medium. Keeping pace with current 'best practices' is a significant challenge for teachers in a time-pressured environment, increasing the role for, and reliance on, peer-to-peer collaboration and professional development.

Implications at the national level

The Australian Government's intervention through the DER has been successful in catalysing action at a school and sector level, and achieved results that would have taken much longer to achieve without a program of such a scale. The magnitude of this investment demonstrated to schools and school leaders that technology is an essential part of schooling. In that context, it is generally acknowledged that funding of this magnitude would be repeated in the foreseeable future.

[5] Griffin, P., McGaw, B. & Care, E. (eds) (2012) *Assessment and Teaching of 21st-Century Skills*, Springer, Dordrecht; Woods, K., Griffin, P. & Care, E. (2011) *Evaluation of the Ultra Mobile Personal Optimised Devices Trial in Victorian Schools: Addendum to the Final Report*, Assessment Research Centre, University of Melbourne.

From a national perspective, there remains a strong role for governments to play in facilitating and supporting ongoing activity to ensure the gains of the DER are maintained and expanded. Three areas stand out as worthy of further work at the national level, with the objective of sustaining the momentum of the DER:

1. monitor momentum and specifically assess the impact on low SES schools and families on the expiry of the DER National Partnership;
2. facilitate ongoing collaboration and support for activities through an existing forum[6] or event that would benefit from national collaboration and which would unlikely be achieved without it; and
3. provide targeted support for transitioning to sustainability and maintaining momentum at the level of the school.

Given their responsibility for education delivery, there is clearly a significant role for States and Territories to play. It is not the intent, or place, of this review to speculate on the appropriate role or investments by States and Territories except that most stakeholders agree that continued focus on the uptake of ICT in education is a given. Similarly, the role of the Catholic and independent sectors will be critical if the DER's momentum is to be sustained and built upon.

Conclusion

Overall, the DER represents a significant investment towards an ambitious education agenda. The underlying message emerging from this review is that the investment in 1:1 technology has created significant achievements to date, and the potential exists to further leverage this investment towards even greater achievement in the future.

[6] One example includes the forum for Chief Information Officers (CIOs) where they come together to share, and where possible, leverage other jurisdictions' learnings.

1 Context and scope of the review

1.1 Context for the DER

ICT in the economy, society and education

Australia, along with many other countries, recognises that a well-educated population is a crucial component of social and economic prosperity. ICT has long been recognised as having an important role to play in education, particularly around improving educational outcomes. As such, governments and school communities around Australia have been working, for several decades in some cases, to exploit the power of ICT.

Reforming the way in which education is delivered has become a priority for Australian governments and is emphasised through the:

- *Melbourne Declaration on Educational Goals for Young Australians*, which identified goals for achievement such as equity and excellence promoted by Australian schooling, and all young Australians becoming successful learners, confident and creative individuals, and active and informed citizens.[7]
- *National Education Agreement,* which articulates the commitment of all Australian governments to ensuring that all school students acquire the knowledge and skills to participate effectively in society and employment in a globalised economy. A number of policy directions are set out, one of which specifies 'modern, world-class teaching and learning environments, including ICT'.[8]

Recent Australian progress in digital literacy has been encouraging, as demonstrated by the Programme for International Student Assessment (PISA) 2009 Digital Reading Literacy Assessment, in which Australia achieved a mean score that was significantly higher than the OECD average in terms of digital literacy for 15-year-olds.[9] However, while this is true at an aggregate level, the rate of improvement remains inconsistent, with a proportion of learners yet to reap the full benefits of using ICT in education.

The prominence of ICT in education has manifested in many ways, including through a growing movement towards a 1:1 (computer to student) learning environment. The rationale for the move towards a 1:1 learning environment in schools varies, with contributing factors including increasing equity of access to digital resources, reducing the digital divide, and the desire of educators to more effectively prepare students for today's technology-saturated workplaces.

A growing body of international research shows that 1:1 learning environments in education can significantly improve student engagement and learning. This research compares the achievement of students in classes that have 1:1 computer ratios with students in classes that have a lower ratio of computers to students, or no computers. While the deployment of 1:1 computer ratios does not in itself guarantee improved student achievement, research undertaken as part of *Project RED (Revolutionizing Education through Technology*) found that, in general, schools with a 1:1 program outperform non-1:1 schools in both academic and financial measures. The research emphasises that the 1:1 environment is critical for achieving these improved outcomes. Data shows that schools with a 1:2 ratio are closer in outcomes to schools with a 1:3 ratio than they are to schools with a 1:1 environment.[10]

One reason for this, as reported by Greaves et al. (2012), is that there are considerable differences in the attitudes and approaches of teachers and students in 1:1 schools. Teachers are significantly more likely to adopt problem-based learning, to encourage small-group work, and to take a more personalised approach to teaching and learning. Students who have continuous access to a computing device clearly can take more control of their own learning than students with infrequent access to a variety of different devices, where links and materials cannot be stored and exploration is limited.[11]

Research indicates that 1:1 has a causal impact on student achievement. This impact registers on a number of different measures, including literacy, numeracy, engagement and discipline, retention and graduation rates. A large-scale evaluation of a 1:1 netbook device trial in 252 Victorian Government schools between 2009 and 2010 reported positive responses from the majority of teachers

[7] Ministerial Council on Education, Employment, Training and Youth Affairs (2008) *Melbourne Declaration on Educational Goals for Young Australians.*
[8] Council of Australian Governments (2009) *National Education Agreement*, paragraph 8.
[9] Thomson, S. & De Bortoli, L. (2012) *Preparing Australian Students for the Digital World: Results from the PISA 2009 Digital Reading Literacy Assessment*, ACER Press, Camberwell, Vic.
[10] Greaves, T., Hayes, J., Wilson, L., Gielniak, M. & Peterson, E. (2012) *Revolutionizing Education through Technology: the Project RED Roadmap for Transformation*, International Society for Technology in Education, Washington DC.
[11] ibid, p. 66.

involved. Of the 2600 students whose literacy and numeracy skills were assessed, most made positive gains in learning.[12] While it was not possible to isolate the impact of the netbook device specifically, 86 per cent of teachers perceived that netbooks had improved literacy proficiency for at least some of their students, and 85 per cent of teachers responded that netbooks had improved numeracy proficiency for at least some students. Over 80 per cent of teachers reported improved pedagogy and differentiated learning opportunities.[13] A three-year research study undertaken by Gulek and Demirtas (2005) compared the outcomes for students with laptops to those without laptops. The comprehensive study found that there were positive associations between computer use and improvements in student achievement as a result of increased engagement and motivation.[14]

The benefits of ubiquitous access to devices are said to include improved access to a wide range of learning resources, enhanced communication between peers and teachers, and the development of competent users of technological tools for 21st-century workplaces. These benefits are seen to increase when students are able to take their device home, promoting an 'anywhere anytime' approach to learning. In addition, a take-home device makes the computer and learning experience more 'personal'.[15]

The DER: intervening to revolutionise ICT in education

To ensure the widest possible impact, and to take advantage of the transformative potential of ICT in education, the Australian Government committed more than $2.1 billion in 2008 to the DER. The initiative was established to provide computers and software, reliable infrastructure, professional development and digital resources. In May 2009, the Australian Government entered into the National Partnership Agreement on the DER to work with all States and Territories, including government and non-government school systems, to achieve the following outcomes:

- Sustained and meaningful change will take place in the way teaching and learning are delivered in Australian secondary schools in relation to the four strands of change (leadership, infrastructure, teacher capability and learning resources).
- Every secondary school in Australia provides each student in Years 9–12 with access to ICT to enable them to engage with educational tools of the 21st-century.
- Access to educational tools of the 21st-century will enable the effective delivery of an online, nationally consistent curriculum as well as providing stimulating and challenging learning resources for students.
- The teacher workforce will be equipped through initial teacher education and in-service training to effectively utilise ICT in the classroom.[16]

1.1.1 Components of the DER

The DER is made up of a number of components, including:

- **National Secondary Schools Computer Fund (NSSCF)** – The NSSCF provide schools with new computers and other ICT equipment for students in Years 9–12, as well as providing infrastructure to support the installation and maintenance of equipment supplied.[17] Two funding rounds existed under the NSSCF:
    - The first round commenced in March 2008 and was designed to target schools that were most disadvantaged (i.e. a computer to student ratio of 1:8 or greater).
    - The second round commenced in July 2008 and was designed to bring all participating schools to a computer to student ratio of 1:2. A further opportunity was provided for eligible schools that had not previously applied for funding via a supplementary round (round 2.1).
    - As at Term 1 2012, a 1:1 computer to student ratio had been achieved nationally for Australian students in Years 9–12.
- **Supporting the Australian Curriculum Online (SACOL)** – This program was designed to significantly enhance the pool of national, State and Territory digital curriculum resources to support all teachers in implementing the Australian Curriculum. It includes a focus on filling resource gaps identified for English, mathematics, science and history, and providing extra resources to help teachers to teach geography, languages and the arts. Funding will also provide support for teachers developing flexible learning approaches and integrating resources into the classroom.

[12] Griffin, P., Care, E., Tsurutani, H. & Woods, K. (2010) *Evaluation of the Ultra Mobile Personal Optimised Devices Trial in Victorian Schools (the Netbook Trial Evaluation), Phase Three and Four Report,* Assessment Research Centre, University of Melbourne.
[13] ibid.
[14] Gulek, J.C. & Demirtas, H. (2005) 'Learning with technology: the impact of laptop use on student achievement', *Journal of Technology, Learning and Assessment*, 3 (2), pp. 1–39.
[15] Apple Computer Inc., op. cit., p. 3.
[16] Council of Australian Governments, op. cit., paragraph 13.
[17] Additional funding to support the effective deployment of devices was provided to education authorities in 2008–09 through On Costs funding agreements.

- **Information and Communications Technology (ICT) Innovation Fund** – The fund supports four projects[18] to assist teachers and school leaders to take up technology, and encourage teachers to creatively and effectively integrate the use of ICT into the classroom. Specifically, the projects aim to:
    - embed ICT into everyday learning through changing the way education and support is delivered to teachers (Teaching Teachers for the Future).
    - create a repository for new and existing online teaching resources that represent good strategies for improving teachers' skills and teaching approaches around engaging students through the use of technology in the key areas of the Australian Curriculum (ICT in Everyday Learning – Online Teacher Toolkit).
    - provide teachers and school leaders with a safe virtual environment to assess and enhance their ICT skills (Anywhere, Anytime Teacher Professional Learning).
    - facilitate access for principals and school leaders to expert ICT advice and tools to facilitate better planning around the use of ICT in their school and ICT professional development of teachers (Leading ICT in Learning).
- **National Schools Interoperability Program (NSIP)** – This program was established by the Australian Education, Early Childhood and Youth Senior Officials Committee to provide technical advice and support for national initiatives relating to technical interoperability.
- **Australian Curriculum Connect** – This project supports the implementation of the Australian Curriculum by enabling the use, sharing and discovery of digital resources aligned with the new Australian Curriculum.

1.1.2 Structure of the DER

The DER is designed as a universal access initiative, with funding made available to all government and non-government schools through the DER National Partnership Agreement. Under this agreement, the Australian Government provides payments to all State and Territory Governments and Block Grant Authorities[19], who are then responsible for providing the funding to all government and non-government (Catholic and independent) schools respectively. Funding under the DER National Partnership Agreement, which is due to expire on 30 June 2013, was designed as a 'point in time' investment to improve the way technology is utilised to enhance teaching and learning in Australian schools.

Under the DER National Partnership Agreement, which was signed in May 2009, all State and Territory governments agreed to facilitate its implementation and committed to achieving a 1:1 ratio of computers to students for all Years 9–12 school students by 31 December 2011. State and Territory governments also committed to addressing the four strands of change[20] below:

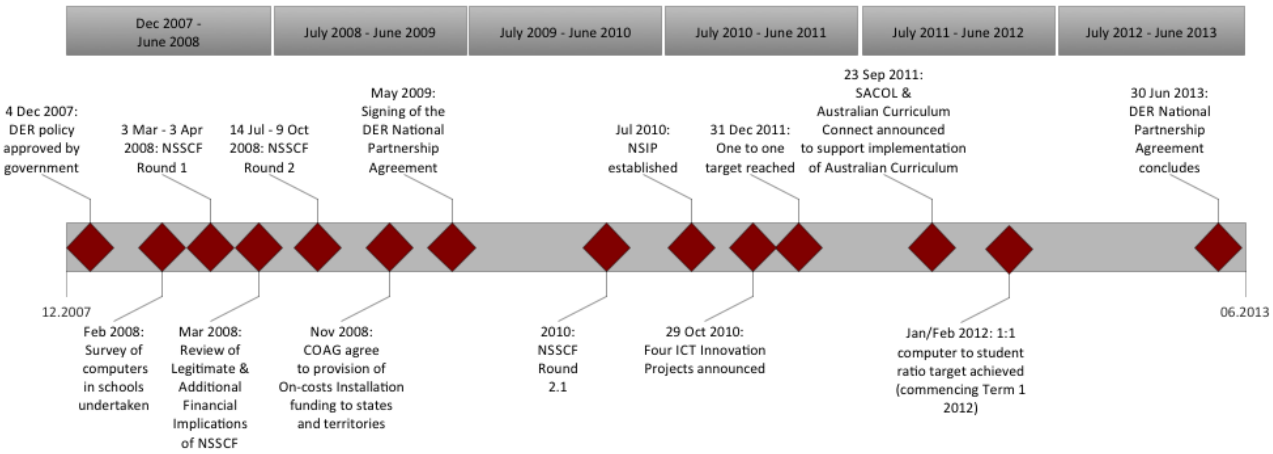
- **leadership** that ensures schools have a coordinated plan for the provision of infrastructure, learning resources and teacher capability to address the educational challenges of the 21st-century.
- **infrastructure** access to digital teaching and learning resources and tools for processing information, building knowledge and for communication and collaboration.
- **teacher capability** to ensure teachers have the skills and tools to design and deliver programs that meet students' needs and harness the benefits and resources of the digital revolution.
- **learning resources** that stimulate, challenge and assist students in achieving the desired learning outcomes. These include collaborative and interactive activities as well as instructional and reference materials.[21]

1.1.3 Timeline for the DER

The DER policy was a 2007 Australian Government election commitment, with the NSSCF being the first element to be rolled out under the initiative. This was followed by the introduction of the DER National Partnership Agreement in May 2009 and other DER initiatives in 2010 and 2011. The timelines for introducing the key DER components are outlined in Figure 1-1.

[18] These projects are: Teaching Teachers for the Future; ICT in Everyday Learning: Teacher Online Toolkit; Anywhere, Anytime Teacher Professional Learning; and Leading ICT in Learning.
[19] Block Grant Authorities are incorporated bodies that receive and distribute capital funds to Catholic and independent schools.
[20] The four strands of change are outlined in the DER National Partnership Agreement, which was agreed by the Australian Government, and States and Territories in May 2009. This accounts for more than a 12-month gap between the introduction of the NSSCF and the implementation of the four strands of change.
[21] Council of Australian Governments, op. cit., paragraphs 5–6.

FIGURE 1-1: DER TIMELINES



1.2 Objectives and scope of this review

1.2.1 Objectives of the review

The review by dandolopartners was undertaken prior to the conclusion of the DER National Partnership Agreement. The conduct of a review was an explicit commitment as part of the DER Evaluation Strategy. The objectives of the review[22] are to:

- assess the impact of the DER and its achievements to date[23];
- record stakeholder views on the extent to which the DER is on track to meet its objectives; and
- identify perspectives on current and future trends in educational technology, as well insight from key stakeholders on how to continue to improve the integration of technology into teaching and learning. This includes changes in the technology and education landscape since the DER's inception that have implications for the future use of technology in schools and for different groups of students, including those in remote areas and those from low socio-economic status (SES) backgrounds.

In order to achieve these objectives, the review has sought to answer the governing question: ***Has the DER been a catalyst for positive change that establishes the foundations for improved use of ICT in education?***

1.2.2 Scope of the review

The following areas are **in scope** for this review:

1. **Looking backwards** – This involved an assessment of the impact of the DER to date, including its achievements around the four strands of change and addressing disadvantage, and identification of perceived limitations and shortcomings of the DER design and implementation.
2. **Looking forwards** – This involved examining perspectives on what is required for effective use of technology in education, the emerging trends in educational technology, and the implications that these have for future policy directions moving beyond the DER.

The following areas are **out of scope** for this review:

1. **Review of the DER program management by the Department of Education, Employment and Workplace Relations (DEEWR) and implementation** – The major element of the implementation - the NSSCF -has been previously covered by the Australian National Audit Office in its Audit Report, Digital Education Revolution program – National Secondary Schools Computer Fund (NSSCF).

[22] While the review is technically past the 'mid-point' of the DER program, the *DER Evaluation Strategy April 2011* had signalled for the review to take place in 2012 following the 1:1 computer to student ratio target being achieved.
[23] It is important to note that this review is not focused on determining whether the objectives set for the DER program were ambitious enough, but rather to assess the progress that has been made against the objectives.

2. **Validation of the number of computers deployed under the NSSCF** – This is subject to an independent audit being commissioned by the DEEWR.
3. **Assessment of the value for money or the quality of implementation by jurisdictions and systems.**

1.3 Approach and methodology

The review was conducted in three phases:

1. refinement of the DER Evaluation Framework;
2. collection and analysis of data; and
3. presentation of findings and recommendations.

1.3.1 Refinement of the DER Evaluation Framework

The DER Evaluation Framework was developed by DEEWR, following consultation with the Australian Information and Communications Technology in Education Committee (AICTEC) and education authorities shortly after the DER was announced. The Framework was intended to provide a set of measures against which the impact of the DER could be assessed. The following principles guided the design of the Evaluation Framework for the DER:

- develop the framework in consultation with jurisdictions and key stakeholders;
- avoid placing an undue administrative burden on schools and systems;
- complement evaluation activities being undertaken by jurisdictions and avoid duplication;
- use of a range of quantitative and qualitative data to provide an accurate and useful evidence base;
- ensure that the evaluation cost and methodology take into account the scope, investment and potential impact of the DER; and
- ensure accessibility of findings to stakeholders in a timely and transparent manner.

At the outset of this review, dandolopartners assessed the DER Evaluation Framework against the fundamental review questions and the quality of the existing data sources to support the framework. This included making adjustments to the Framework to reflect the scope of this review. Following consultation with DEEWR, a slightly revised Evaluation Framework was developed (see Attachment 2) to allow for the efficient capture and reporting of quantitative and qualitative data concerning the impacts of the DER to date.

1.3.2 Collection and analysis of data

A number of research methods were used to generate the evidence base required for this review, including a literature review, stakeholder consultations and data analysis.

Literature review

For this review, the evaluation team reviewed:

- State and Territory bilateral agreements and implementation plans;
- relevant Australian Government and State/Territory government policy statements and documentation;
- relevant audit reports;
- existing evaluation reports, survey data and research reports that have been undertaken concerning the DER and the use of ICT in education more broadly; and
- national and international research reports concerning trends in technology and the impact on education in schools.

Data analysis

Data analysis for this review focused on the following four datasets:

- NSSCF Progress Reports – these reports are issued to each education authority by DEEWR for completion on a bi-annual basis. Information and data is collected in the following areas: funding allocation and computer installations, activities against the four strands of change, expenditure of On Costs associated with the NSSCF, and flexible funding for students with a disability. Education authorities are also asked to present a case study to showcase schools' growth and development in ICT under the DER initiative as part of the progress report.
- Staff in Australia's Schools (SiAS) survey – an Australia-wide survey distributed by the Australian Council for Educational Research (ACER) to collect information from school teachers and leaders about their backgrounds and qualifications, work, career intentions and school staffing issues. The survey is distributed to all primary and secondary schools, and government, Catholic and independent schools, across Australia. The survey was first conducted in 2007 and then again in 2010.
- Schools Broadband Connectivity survey – distributed by DEEWR, this survey goes to all education authorities (government, Catholic and independent) and collects information on school connectivity across jurisdictions and sectors. The first survey was distributed to education authorities in 2008, with survey data continuing to be collected annually.
- Schools Education Management Information Systems (SEMIS) DER application and reporting data – this is the primary grants management system utilised by the program areas in the Schools and Youth Cluster of DEEWR.[24] The School Entry Point (SEP)[25] is an Internet-based reporting tool for computer installations under the NSSCF. The SEP is the primary tool used by schools and education authorities to provide real-time computer installations and is used in conjunction with the NSSCF progress reports. Installation data reported in SEP feeds directly into the 'back end' interface, SEMIS.

A summary of the findings from the data analysis is presented in section 2 of this report and a detailed report analysing the available data has been provided separately to DEEWR.[26]

Stakeholder consultations

A range of stakeholders were consulted as part of the review through interviews, workshops and focus groups. In total, more than 200 stakeholders were consulted as part of this review, including:

- DEEWR executive staff;
- Digital Education Advisory Group (DEAG) representatives;
- national agencies;
- State and Territory Government education authorities, including Chief Information Officers;
- Catholic Education Offices and Dioceses;
- Independent Schools Associations and Block Grant Authorities;
- education practitioners and researchers;
- technology industry representatives;
- principals, teachers and students from government, Catholic and independent schools; and
- parents.

Further information about the number of stakeholders and how they were engaged is presented in Attachment 3.

1.3.3 Methodology considerations

Complexities surrounding the measurement of educational outcomes

There are a number of complexities in measuring the causal impact of specific interventions on educational outcomes. These complexities make it difficult to definitively attribute the level of effectiveness of the DER initiative in terms of it achieving its stated outcomes.

[24] The SEMIS was developed in response to a 2005-06 strategic review of the existing Commonwealth Assistance to Schools and Program Administration (CASPA) and Schools Service Point (SSP) business system suite, which recommended that a single grants management system be developed incorporating all funding and grants programs currently managed by the Schools Cluster in the former Department of Education, Science and Training (DEST).
[25] The School Entry Point website is at: https://schools.deewr.gov.au/SchoolEntryPoint/Default.aspx
[26] This report is titled *DER Mid-Program Review: Summary of Quantitative Research*.

This is largely due to the fact that:

- Many reform activities are implemented concurrently in the education sector, making it difficult to isolate and prove causality between improvements in student outcomes and any single reform;
- The ubiquitous nature of the initiative makes it difficult to establish appropriate control groups;
- The 1:1 computer to student ratio across all secondary schools was only achieved nine months prior to this report being completed. Seeing systemic effects, even if causality could be established, is unlikely in such a short timeframe; and
- The National Assessment Program – Literacy and Numeracy (NAPLAN) provides the only available national assessment data. This data is confined to assessing students in Years 3, 5, 7 and 9 in regard to Reading, Writing, Language Conventions (Spelling, Grammar and Punctuation) and Numeracy. The fact that NSSCF targeted Years 9–12 students reduces the usefulness of the NAPLAN data for this program.

Lack of available, comparative quantitative data

A range of evaluation indicators and data collection instruments were identified in the DER Evaluation Strategy – and agreed across education authorities through AICTEC – to report on progress being made in each of the DER's four strands of change. Those instruments included NSSCF Progress Reports (the source of data identified for most of the identified indicators), the Staff in Australia's Schools survey, the Schools Broadband Connectivity survey, and the SEMIS DER application and reporting data. The preference was to utilise quantitative data to evaluate the DER, where possible.

Aside from the difficulties proving causality outlined previously, several limitations were identified relating to the quality and consistency of the available quantitative data relevant to this review. In general, quantitative data was insufficient to provide evidence against the agreed evaluation indicators. Contributing factors included the following:

- Decisions about indicators and collection mechanisms were not made until after the DER began. As such, limited benchmark data was captured against which progress could be monitored.[27]
- NSSCF progress reporting requirements were captured at the sectoral or jurisdictional level, and predominantly in narrative form. This approach was taken to simplify the reporting burden on education authorities in line with one of the principles of the Intergovernmental Agreement on Federal Financial Relations.[28] As a result, the reported data is largely qualitative. In addition, the level of detail provided in these reports varies between education authorities.
- Some changes were made to survey instruments over the course of the DER.[29] This reduced the consistency of data captured, creating difficulties in accessing data that provided year-to-year comparisons.

As a result, the review collected qualitative data through synthesising information presented in NSSCF Progress Reports and engagement of stakeholders in interviews, workshops and focus groups across jurisdictions.[30] It should be noted that the views expressed by stakeholders were not based on statistically significant representative samples, but rather a purposive sample[31], allowing for in-depth discussions with those most engaged in and/or impacted by the DER initiative and thus creating a rich understanding of the DER initiative and its complexities; one advantage of using qualitative data. Where possible, the review tried to elicit feedback from a broad cross-section of stakeholders from the education field. This review also considered the outcomes of reviews that were commissioned in specific jurisdictions, such as NSW, as well as independent secondary research conducted in Australia and overseas.

1.4 Structure of this report

This report is divided into the following sections:

- **Section 2: Impact of the DER to date and perceived achievements/shortcomings** – a summary of the quantitative and qualitative research concerning the DER's achievements to date, progress against the defined evaluation indictors and shortcomings identified by stakeholders.
- **Section 3: Perspectives on what is required to effectively use technology in education** – a summary of the international policy trends relating to the use of technology in education, and the presentation of factors critical to the effective use of technology in education as supported by research and stakeholder consultations, including what works and the remaining challenges.

[27] This issue was identified by the Australian National Audit Office in its performance audit of the DER Program – NSSCF.
[28] Intergovernmental Agreement on Federal Financial Relations, *Schedule C: Public Accountability and Performance Reporting*, available at http://www.federalfinancialrelations.gov.au/content/inter_agreement_and_schedules/current/schedule_c.pdf, accessed on 20 July 2012.
[29] Data collected in the 2007 Staff in Australia's Schools (SiAS) survey indicated that the highest professional learning need for Australian secondary teachers was to find more opportunities to learn about *making more effective use of computers in student learning* – 60 per cent of secondary teachers expressed a major (24 per cent) or moderate (36 per cent) need for professional learning in this area. Despite the priority it was given by teachers in 2007, subsequent SiAS surveys did assess the need for professional learning in that field.
[30] There was a desire by DEEWR to limit additional reporting requirements on principals and teachers. Therefore, there was limited scope to supplement existing data collection (through, for example, administering additional surveys).
[31] Purposive sampling is an evaluation technique used to select a sample that is representative of the population.

- **Section 4: Changes in the technology and education landscape** – identifies the fundamental changes that have occurred since the introduction of the DER initiative that relate to the economy, technological developments, available digital resources, pedagogy/curriculum and education policy.
- **Conclusion** – remarks on the implications of the report's findings and potential future policy directions beyond the DER initiative.

A number of attachments are also included in this report:

- *Attachment 1*: Practical insights from the DER review.
- *Attachment 2*: DER Mid-Program Review Evaluation Framework.
- *Attachment 3*: Stakeholder engagement list.
- *Attachment 4*: Reference list.

2 Impact of the DER to date and perceived achievements/challenges

2.1 Introduction

This chapter summarises findings from quantitative and qualitative research to present a summary of:

- the DER's achievements to date against the four strands of change targeted by the DER. Achievements are also identified against a fifth indicator – the extent to which the DER has addressed disadvantage;
- progress against the pre-defined Evaluation Framework indicators; and
- challenges that were identified by stakeholders in the context of the DER.

A note on the relationship between assessment of achievements and progress against indicators

Given the limited availability of quantitative data, as described in section 1, this review has relied on rich qualitative evidence from stakeholders, supplemented by a literature review and analysis of the available quantitative data. The assessment of achievements and challenges discussions draw largely on an extensive range of interviews and focus groups, and represent a broader-ranging set of findings than covered in the progress against indicators discussion.

High-level findings

The DER has made a significant, catalytic impact on schools across Australia. In many cases, schools reported that the DER had allowed them to accelerate and scale activity that was already underway. The DER also provided schools with a more robust and scalable infrastructure base upon which to build. Other schools that had not embraced digital education in a meaningful way reported that the DER had caused them to fundamentally change their attitude and approach to technology.

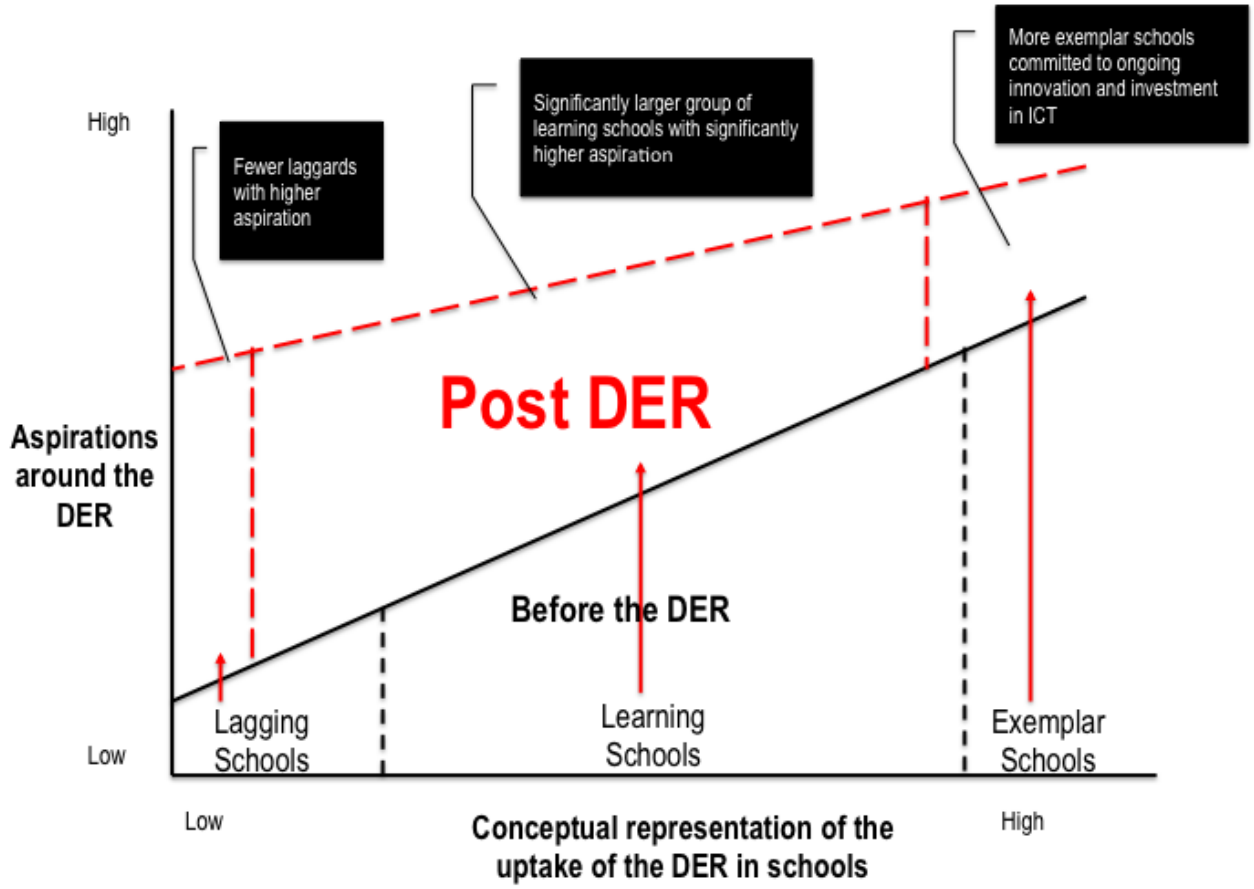
A consistent message was that the DER provided the basic building blocks for better integration of technology into teaching and learning, but the uptake and commitment to the DER initiative was not universal. Results did not occur unless there was significant, planned and sustained school level engagement. Stakeholders also identified potential limitations and challenges in the DER design and implementation that may have lessened the positive impact of the DER.

Stakeholders generally agreed that there were three broad categories of schools, with many schools appearing at some point on the continuum (see

Figure 2-1).

1. Exemplars – For the most part these schools were convinced of digital education benefits before the DER and treated the DER as an accelerant rather than a change in direction. These schools already do many of the things identified in section 3 as good practice.
2. Learning schools – These schools were receptive to the aspirations of digital education and are learning how to effectively exploit it; they used the DER as a catalyst for change.
3. Lagging schools – In most cases these schools were not necessarily convinced of the benefits of digital education and treated the DER as an infrastructure injection than a change in approach to teaching and learning.

FIGURE 2-1: UPTAKE OF AND COMMITMENT TO THE DER INITIATIVE BY SCHOOLS



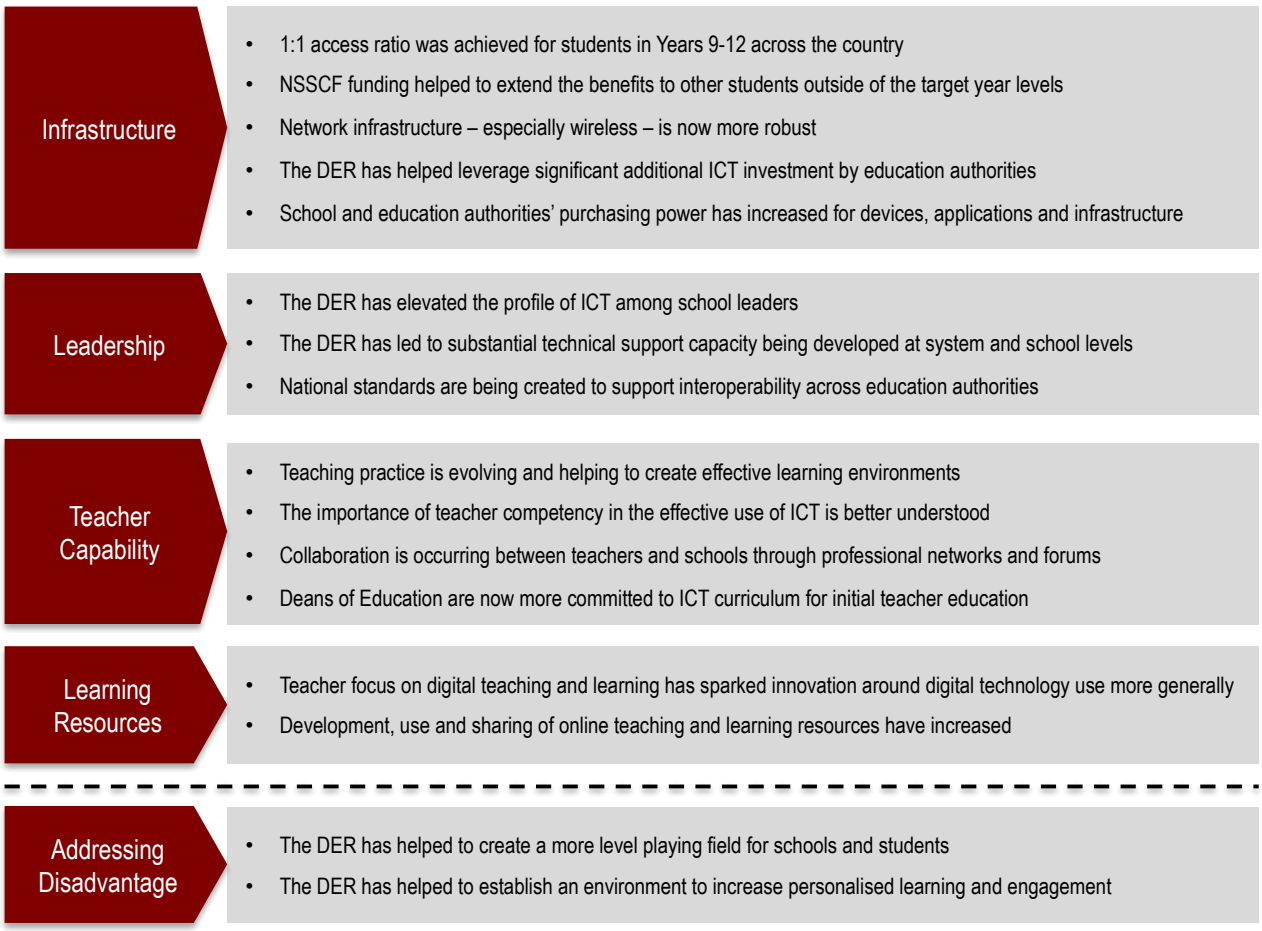
Achievements to date

Figure 2-2 presents a summary of the DER's achievements to date, based on research conducted as part of the review. The achievements are presented against the four strands of change that have been focused upon under the DER, as well as a fifth element (addressing disadvantage). Promoting social inclusion and reducing educational disadvantage is a major outcome identified in the National Education Agreement (this Agreement provides the basis for delivering an Education Revolution in all Australian schools) as well as the Melbourne Declaration and as such, has been identified as an important point of consideration for this review. It is important to recognise that while the four strands of change were equally prioritised in the DER National Partnership Agreement, the funding flowing to each of these strands was not even. The vast majority of funding under the DER was directed towards infrastructure, and therefore the assessment of achievements of the DER are naturally more focused on, and fully explored, in regard to this issue.

Stakeholder views provide the basis for findings described in this section. Findings are presented at the national level, as commentary on the individual implementation approaches by education authorities is outside the scope of this review. However, some quantitative evidence and findings from State and Territory government reports are also sourced to support the findings. A decision was taken to provide findings at a whole of Australia level where possible, and to avoid comparisons in performance between States and Territories. The same applies to comparisons between sectors; for example, government, independent and Catholic sectors. This decision was taken for two reasons:

1. to focus attention on what had been achieved at an aggregate level; and
2. to avoid making potentially misleading comparisons between States and Territories, and sectors, which can occur when comparing data that is not necessarily context specific.

FIGURE 2-2: SUMMARY OF THE DER ACHIEVEMENTS TO DATE



2.1.1 Infrastructure

1:1 access ratio was achieved for students in Years 9–12 across the country

Education authorities have met their target of providing 1:1 device access ratios for all students in Years 9–12, in line with the timeline of Term 1 2012 set out by the Australian Government. One of the DER's most significant achievements was considered to be its universal coverage, with funding provided to schools from all sectors. The ubiquitous nature of the initiative was considered to have had a particularly significant impact on education sectors, with differing levels of commitment to digital education prior to the DER. Many schools and education authorities indicated that the DER – coupled with the Building the Education Revolution (BER) – accelerated planned ICT infrastructure investments in schools. For example, one non-government education authority indicated that DER and BER funding enabled them to deliver in 18 months what would otherwise have taken a decade or more. Table 2-1 indicates that education authorities had exceeded device deployment targets across the country.

TABLE 2-1: NSSCF COMPUTER INSTALLATION, BY STATE AND SECTOR (15 JULY 2012)

Sector	NSW	Vic	Qld	WA	SA	Tas	NT	ACT	Total
CATHOLIC									
Computers Required	59,049	41,323	29,759	16,735	10,133	3,199	1,085	2,389	**163,672**
Computers Installed	75,205	53,968	36,676	17,081	11,980	4,391	1,073	2,574	**202,948**
Computers Installed %	127%	131%	123%	102%	118%	137%	99%*	108%	**124%**
GOVERNMENT									
Computers Required	173,121	117,186	104,251	46,776	38,716	12,725	4,799	9,558	**507,132**
Computers Installed	254,169	142,903	111,110	49,517	41,066	13,046	7,108	9,716	**628,633**
Computers Installed %	147%	122%	107%	106%	106%	103%	148%	102%	**124%**
INDEPENDENT									
Computers Required	34,676	23,974	25,724	14,462	10,108	2,100	1,006	3,994	**116,044**
Computers Installed	40,333	28,730	30,486	17,588	11,900	2,230	1,055	3,807	**136,086**
Computers Installed %	116%	120%	119%	122%	118%	106%	105%	95%*	**117%**
Total Computers Required	**266,846**	**182,483**	**159,734**	**77,973**	**58,957**	**18,024**	**6,890**	**6,383**	**786,848**
Total Computers Installed	**369,707**	**239,711**	**178,272**	**84,186**	**64,946**	**19,667**	**9,236**	**6,381**	**967,667**
Total Computers Installed %	**139%**	**131%**	**112%**	**108%**	**110%**	**109%**	**134%**	**99%**	**123%**

**DEEWR notes that the Northern Territory Catholic sector has experienced a drop in eligible student numbers since the preliminary survey was conducted in 2008 and is considered to have achieved a 1:1 computer to student ratio, with the apparent shortfall due to a reduction in the number of computers required. The ACT independent sector installation ratio is less than 100 per cent because a few of the larger ACT Independent schools choose to withdraw from the DER initiative at a 1:2 ratio, reducing the overall installation percentage to 95 per cent. However, all ACT Independent schools that continued in the DER initiative achieved a 1:1 computer to student ratio.*

Source: SEMIS DER application and reporting data

Validation of the 1:1 computer to student ratios was outside of the scope of this review, and DEEWR has separately commissioned a sample audit of deployed devices to verify the reports by education authorities. The audit was a direct response to a recommendation by the Australian National Audit Office, which conducted a review of the NSSCF, including the DER's program management.[32] The results of that audit should be known by late 2012.

While 1:1 was achieved across all educational authorities, the approach taken to achieve this differed considerably. Some authorities managed the procurement and deployment of devices in a highly centralised manner and were specific about the types of devices that could be procured under the DER. Other education authorities afforded schools significant autonomy, including for device type/specification and procurement processes. Various approaches were considered to have relative merits based on feedback from interviews with education authorities. For example, controlled deployment was seen to generate economies of scale in device procurement and support, while devolved decisions were seen to increase schools' ability to meet the specific needs of students.

Education authorities were generally supportive of the flexibility extended under the DER initiative. The DER enabled authorities to adapt procurement and deployment decisions to meet schools' and students' needs.[33] Round 1 funding, however, was considered to be too prescriptive in terms of the device specifications. The decision to provide greater flexibility around the types of devices that could be purchased through Rounds 2 and 2.1 was considered a major achievement, enabling schools to deploy devices that were more portable and practical for students as they moved from class to class, and to support access outside of their school.

[32] The Auditor-General (2011) *Digital Education Revolution Program – National Secondary Schools Computer Fund*, Audit Report No. 30 2010–11 Performance Audit, Australian National Audit Office, Canberra.
[33] This flexibility came with the NSSCF Funding Rounds 2 and 2.1.

NSSCF funding helped to extend the benefits to other students outside of the target year levels

While the NCCSF was focused on providing 1:1 access for students in Years 9–12, a potentially unintended consequence was that schools used this base funding to extend 1:1 access beyond the identified year levels. Schools were able to do this for two reasons:

1. The NSSCF (On Cost) funding established infrastructure that was accessible to the whole school (e.g., wireless networks). Overall, $807 million was provided to education authorities to contribute to the costs of installation, connectivity, maintenance and technical support of computers purchased through the fund.
2. The NSSCF component funded schools to provide devices for students in Years 9–12, thereby freeing up resources to provide devices in lower year levels.

The infrastructure provided under the NSSCF, such as wireless networks, technical support and Internet connectivity, had broader implications outside of the targeted years (i.e. not just students in years 9–12). This made it more attractive for schools considering investing their own resources in devices for lower year levels. These school-wide investments also encouraged schools to invest in other technologies, such as electronic white boards, digital cameras, Internet-capable projectors, smartphones, game consoles and interactive televisions, to leverage this infrastructure. These technologies were applied to a range of purposes, including collaboration with other schools, teachers and students through channels such as virtual classrooms, videoconferencing and portals dedicated to sharing knowledge and resources (these are discussed in more detail in the section on teacher capability below). Once again, the benefits associated with the use of these technologies were seen to apply across the whole school, not just to students in Years 9–12.

Network infrastructure – especially wireless – is now more robust

A significant outcome of the DER was that education authorities were provided with an injection of funding to establish enterprise-grade wireless networks in schools. The state of school-based wireless networks, whilst inconsistent, is considered a significant improvement on the networks in place prior to the DER. Not only are the networks now generally considered to more effectively meet the current requirements, in most cases they are also inherently more scalable to meet future requirements. The presence of robust wireless infrastructure at the school level was said to provide school leaders with greater confidence that they would be able to effectively exploit devices.

Wireless infrastructure was also considered important to the rollout of mobile devices that could be moved from classroom to classroom. This reduced the need for dedicated computer labs in schools, which are commonplace for non-wireless broadband connections. The NSW Department of Education and Training's wireless network provides an example of the scale and impact of this investment. Fuelled in part by the DER initiative, the Department now has the largest managed wireless network in the southern hemisphere, with 21,000 access points supporting 300,000 laptops daily. In NSW, the wireless networks were considered to support greater mobility of devices, which stakeholders saw as essential to the effective use of computers and online resources in teaching and learning inside and outside the classroom. Enterprise-grade wireless networks were also considered to provide superior security and management benefits for schools in terms of managing connectivity. Notwithstanding the generally positive sentiment, other schools and education authorities with improved wireless networks were concerned about keeping pace with the significant growth in demand for wireless in schools.

The DER has helped leverage significant additional ICT investment by education authorities

In addition to Australian Government funding of $2.1 billion for the DER initiative, education authorities contributed significant additional funding to support the deployment of devices and provision of infrastructure and support over the course of the DER. Leveraged investments made by education authorities beyond what was funded explicitly under DER included:

- the establishment and support of school-based network infrastructure. For example, the Northern Territory (NT) Government invested in the development of a large-scale wireless network to support consistent connectivity across government and non-government schools. They also reported that the bulk of government school ICT services (including school file and print services, Internet and email, service and help desks, and software licensing) are centrally funded;
- infrastructure to support improved Internet connectivity in remote schools or schools in 'black spots';
- contributions towards insurance/warranty of devices against loss or damage;
- the development of policies, templates and resources for schools, teachers, parents and students to guide the appropriate use of computers and online resources. For example, the Queensland Government developed the *Smart Classrooms* strategy to bring together policy, frameworks and resources to help teachers and schools to plan and prepare for 1:1 access and increased digital education;
- computers for teachers so that they also had 1:1 access;

- devices for lower-year levels of schooling. For example, the Western Australia (WA) Government reported that it provided its schools with an annual ICT grant to allow for one-quarter of schools' computer fleets to be replaced each year and for technical support and the replacement of switch and server infrastructure;
- the provision of technical support resources and staff that can be deployed to regions and schools; and
- other investments, such as the Victorian Government's support for ICT equipment in government schools in the forms of the *Student Resource Package* ($7.7 million) and *Increase Access to Curriculum Computers* ($28 million).

It is important to note that most education authorities had already implemented or planned strategies to progress the digital education agenda ahead of the DER. The DER helped to achieve what had been planned sooner or at a greater scale. The DER also helped to extract additional value from existing and new programs and investments that had already been made by education authorities. For example, the Victorian Government had made a significant investment in its student management system – the Ultranet – in advance of the DER initiative. Stakeholders acknowledged that one of the impediments to capturing full value from the Ultranet was the absence of a highly resourced (e.g. 1:1) computing environment. Similar stories emerged in other sectors where the DER helped to better exploit the value of legacy applications.

School and education authorities' purchasing power has increased for devices, applications and infrastructure

The scale of the DER significantly improved the ability of education authorities and schools to purchase devices, infrastructure, software and support services. This was felt particularly in smaller jurisdictions and sectors that lacked critical mass before the DER to establish purchasing leverage. Improved purchasing power has enabled schools and education authorities to negotiate terms with suppliers that have:

- driven down costs for devices to an extent perhaps unexpected at the start of the DER;
- established system-wide licence arrangements for software and digital resources; and
- helped to achieve economies of scale in support services, such as technical support.

The flexibility provided to education authorities in the implementation of the Computer Fund, along with the economies of scale that have been achieved, has meant that a number of education authorities have been able to realise savings on projected costs of the device rollout including on cost funding.[34] These savings created the potential for some education authorities to invest in devices for other year levels, in the other strands of change (leadership, teacher capability and learning resources) or the possible retention of some funding for the final year of the DER National Partnership. These savings on the initial estimated costs vary between jurisdictions but were sufficient in all cases to meet the target ratios.

TABLE 2-2: UNEXPENDED FUNDING OF EDUCATION AUTHORITIES (15 JULY 2012)[35]

Sector	NSW	VIC	QLD	WA	SA	TAS	NT	ACT	Total
Government									
DER NP Funding	$17,365,000	$2,489,000	$4,407,110	$11,546,000	$6,994,907	- *	- *	$2,042,383	**$44,844,400**
On-Cost Funding	$45,551,500	$37,668,928	$13,245,307	$12,500,988	$8,696,519	$3,407,813	$705,778	$3,808,938	**$125,585,771**
Total Unexpended Funding	**$62,916,500**	**$40,157,928**	**$17,652,417**	**$24,046,988**	**$15,691,426**	**$3,407,813**	**$705,778**	**$5,851,321**	**$170,430,171**
Non-Government (including Catholic and independent sectors) **									
DER FA Funding	$7,394,953	$12,363,606	$3,637,118	$6,447,394	$3,178,876	$390,165	$756,000	-*	$34,168,113
On-Cost Funding	$17,909,362	$6,552,164	$5,623,472	$4,300,149	$75,107	$469,876	$470,911	- *	$35,401,041
Total Unexpended Funding	**$25,304,315**	**$18,915,770**	**$9,260,590**	**$10,747,543**	**$3,253,983**	**$860,041**	**$1,226,911**	**-***	$69,569,154

** Represents education authorities who, according to DEEWR's records, have, as at July 2012, no residual funding under the DER NP/FA. This does not take into account potential interest earned on the allocated funding.*

***The calculations of unexpended funding has been aggregated across both sectors.*

[34] This information was sourced from Progress Reports which were provided to DEEWR under the NSSCF..
[35] This information was sourced from Progress Reports which were provided to DEEWR under the National Secondary School Computer Fund.

Two large government education authorities indicated that they had been able to secure a lower total cost of ownership for deployed devices through aggregated purchasing, lower than benchmarks for large corporates. Education authorities also indicated that the scale of the DER enabled them to establish powerful positions in their relationships with major ICT vendors for a range of infrastructure/services. For example:

- In the ACT, a whole-of-system arrangement was established with a software provider to support videoconferencing infrastructure that would otherwise not have been possible or affordable.
- In NSW, the Government established a relationship with a device manufacturer that reportedly drove down device costs but also enabled the Government to influence the design and manufacturing standards of devices to make them more robust for student use.

In some jurisdictions, this enhanced buying power was extended across systems. For example, Catholic and independent schools in WA benefited from the WA Government's purchasing agreements with technology vendors by being granted access to purchase from government contracts. Based on feedback from education authorities, the government and Catholic sectors were particularly effective in using their centralised purchasing power to create significant cost savings for schools under their jurisdiction.

2.1.2 Leadership

The DER has elevated the profile of ICT among school leaders

School leaders reported giving ICT more prominence in strategic planning and operational budgeting as a result of the DER. While some school leaders acknowledged that the importance of ICT was established long before the DER and they were already actioning this as a priority, the DER prompted others to prioritise ICT in their strategic and financial planning. Education authorities reported that almost all schools now have an ICT plan in place (or are in the process of developing one) and a dedicated ICT budget. While this cannot be attributed solely to the DER, many stakeholders acknowledged it had a strong impact by elevating the importance of ICT and ICT expenditure as a strategic issue.

Principals also indicated that their emphasis for ICT planning had moved beyond the technical considerations around device and infrastructure deployment to encouraging a more effective and integrated use of technology in teaching and learning. School leaders reported having adopted a range of ICT governance and support strategies to sustain them in their roles, including:

- establishing ICT committees and ICT leadership groups within schools;
- engaging parents and students in device selection and other technology matters;
- creating roles such as eLearning coordinators to assist in the integration of ICT in teaching and professional learning; and
- identifying ICT 'champions' who can assist with ICT deployment, use and professional learning at faculty level and amongst peers.

Education authorities have also extended support to school leaders to help them plan, prepare for and manage the digital education environments created under the DER. For example, as part of its *Smart Classrooms* program, the Queensland Government adapted work undertaken by the Anytime Anywhere Learning Foundation[36] to develop its *21 Steps to 21st-Century 1-to-1 Success* to help guide school leaders to prepare for the deployment of 1:1 devices in their schools. The Victorian Government adapted a similar guide for their schools as well as advocating that schools adopt an ICT Progression Strategy and formulate and publish an ICT vision statement. Similarly, the South Australian (SA) Government reported that it is introducing ICT performance measures as part of its performance-management processes for schools. The ACT Government encourages individual schools to adopt their own ICT vision statements and to publicise that within their own communities, while the Queensland Government developed the *eLearning Leaders Framework*, adapted to support school leaders in the use of ICT in teaching and learning.

School leaders reported increased levels of comfort and confidence in articulating their expectations about the use of ICT in education. A recent survey of 461 principals across NSW government schools supported this, revealing that 87 per cent of principals agreed with the statement: '*As a leader, I have a strong vision for what is "best practice" in teaching and learning with laptops*'.[37] Many education authorities indicated that they are now seeing principals take responsibility for ICT decisions that were previously left to technicians in their school and/or education authority.

The DER has led to substantial technical support capacity being developed at system and school levels

For technology to be used seamlessly in the classroom, adequate support is required throughout the school. When it works effectively, it can be described as an indicator of good leadership. The scale of the DER demanded the establishment of significant

[36] Anytime Anywhere Learning Foundation (2009) *21 Steps to 21st Century Learning*, available at http://www.aalf.org/cms/?page=AALF%20-%2021%20Steps%20to%2021st%20Century%20Learning , accessed on 28 July 2012.
[37] NSW Department of Education and Training (2010) *DERNSW Professional Learning Principals' Survey*.

technical support capacity for schools, teachers and students. For many schools, ICT support capacity was limited, and often the part-time responsibility of teachers with skills and interest in particular technologies or applications.

Most government and Catholic education authorities reported that they have established, or in some cases enhanced, centralised technical support desks to support device deployment and maintenance, complemented by school-based infrastructure and applications. Many education authorities deployed technical support staff to regions and schools, including the NSW Government, which deployed more than 500 Technical Support Officers to support government schools across the state to coincide with the rollout of the DER. Some schools also reported using staff or contractors to provide technical support to schools rather than centralised support strategies.

Education authorities have also provided leadership support to schools through the development of templates, advice and policies to help manage the deployment and use of devices and online resources, in areas ranging from data privacy and security to digital citizenship and the appropriate use of computers and applications. The DER was not the sole driver of these investments, but in many cases it was seen as a catalyst for action.

National standards are being created to support interoperability across education authorities

The National Schools Interoperability Program (NSIP) was funded under the DER to facilitate the effective delivery of digital learning projects across the country.[38] NSIP is led by government education Chief Information Officers (CIOs) across all States and Territories and representatives from non-government education sectors, the Australian Curriculum, Assessment and Reporting Authority (ACARA) and DEEWR. System-level leadership was identified as a critical success measure for the DER, including effective collaboration between technical leaders in State and Territory governments.

Education authorities recognised that working together on a common platform, with reusable assets and shared services, will deliver greater value from ICT, especially in the context of funding constraints across the country. Interviewed CIOs indicated that NSIP and the adoption of the Systems Interoperability Framework (SIF) has already helped schools and education authorities improve technical interoperability by setting standards for ICT integration in important areas such as student data and administration, the integration of online learning resources across jurisdictions, cloud-based services and vendor engagement. The *Tri-Borders Project* is an example identified by stakeholders of tangible results from greater collaboration across education authorities. The project operates across WA, NT and SA to track student attendance across all three jurisdictions to gain a better understanding of students' progress and wellbeing. While this project is still in progress, it is acknowledged as having created a foundation for improved sharing of student information that potentially has national applicability.

CIOs from government departments indicated that the level of collaboration with their peers in other jurisdictions had increased since the DER was established. They now meet regularly (four to five times a year) and are collaborating to address important interoperability barriers that have persisted for years without significant progress. CIOs indicated that the scale of the deployment challenge had been the catalyst for bringing them together, including issues/concerns related to the program management of the DER. However they also reported that momentum was created and their collaboration was now much broader than just around the DER.

2.1.3 Teacher capability

Teaching practice is evolving and helping to create effective learning environments

Achieving 1:1 ratios was identified by many school-level stakeholders as a driver of changes in teaching practice. 1:1 was the point at which the ubiquity of devices present in the classroom prompted action and changed behaviour. It was suggested that at a 1:1 ratio meant that the ability of individual students to access resources was realistic, which in turn created higher student expectations of teachers and the integration of ICT into the learning process. Where it has been most transformative, principals described teacher behaviour moving from being a 'sage on a stage' or subject matter expert to being a facilitator who supports learning. As one teacher explained '*the DER has been the biggest impact on teaching pedagogy in our careers*'. Teachers spoke positively about the DER and its impacts on teaching practice and students. For example, they indicated that the DER has enabled changes that have helped to:

- change the way teachers think about lessons by exploring online resources to assist in lesson planning and student activities. Many teachers indicated that 1:1 access enabled them to 'flip' activities to support inquiry-based research in the class rather than exclusively as part of homework, which had been the practice;
- access resources and tools that enabled students to customise tasks to their individual preferences and learning styles, helping to address barriers to engagement and to support students with diverse abilities and special needs;

[38] National Schools Interoperability Program (2012) *About NSIP*, available at http://www.nsip.edu.au, accessed on 24 July 2012.

- deliver more interactive and interesting activities to engage students, which in turn helped them develop their knowledge of subject matter as well as their contemporary study and work skills. One teacher provided an example of how she used interactive online resources to make the teaching of the big bang theory easier for students to grasp – a theory that had proven difficult to explore using traditional resources. Some teachers indicated that when students publish their work in a public domain for (often immediate) review by peers, they are part of a more authentic learning process;
- increase online communication with parents and students outside of the classroom around student work, albeit at a small scale and reasonably isolated. Those who cited being able to more effectively and regularly communicate with teachers reported being more productive when they could confidently email teachers during out-of-school hours to clarify issues or ask for help;
- improve productivity and efficiency in the classroom, as it was no longer necessary to spend time accessing computer labs;
- reduce the amount of time teachers spend on lower-value tasks such as photocopying and writing on blackboards to deliver lessons, giving them more time to work on higher-value activities such as planning; and
- drive teachers and staff to familiarise themselves with digital technology by removing offline options for undertaking some standard activities such as booking rooms, or appointments with parents.

Students also spoke about the impact that the DER has had on them. For example, they indicated that the DER has enabled them to become more productive in classrooms. Students spoke of having previously wasted a lot of time during class accessing computer labs, retrieving laptop trolleys and logging onto different machines.

Access to a device, and in particular a take-home computer, was beneficial as students no longer had to compete with their parents and/or siblings for time on the household computer:

> *It used to be that if we needed a computer, the teacher would book the computer pod and we would get about five minutes work done and then have to finish it at home.*

Despite the presence of positive anecdotes, stakeholders cautioned against believing that the transformation of teaching and learning was complete. While the DER focused primarily on devices/infrastructure, much more was required in the area of professional development for teachers. This type of development was considered to assist in ensuring that ICT was applied to high-value functions such as increased parental engagement, assessment and personalised learning, which some had expected under the DER.

The importance of teacher competency in the effective use of ICT is better understood

Most stakeholders indicated that teacher skill and confidence levels, at the aggregated level, are one of the most critical success factors for the uptake of digital education in our schools. Stakeholders also indicated that there was room for improvement on this front.

A number of teachers reported that professional learning activities around ICT had increased in step with the rollout of the DER and that teacher skill levels and confidence was improving. There was a reported evolution from an almost exclusive focus on digital literacy skills (i.e., how to use ICT) to a focus on the application of ICT and online resources into pedagogy – a much more complex and higher-value focus. Data from the DER NSW Professional Learning Principals' Survey indicated that 88 per cent of respondents felt that teachers' confidence had increased since the beginning of the DER initiative around the integration of laptops into their lesson plans.[39] No such evidence exists for the confidence of teachers in fully integrating ICT into pedagogy.

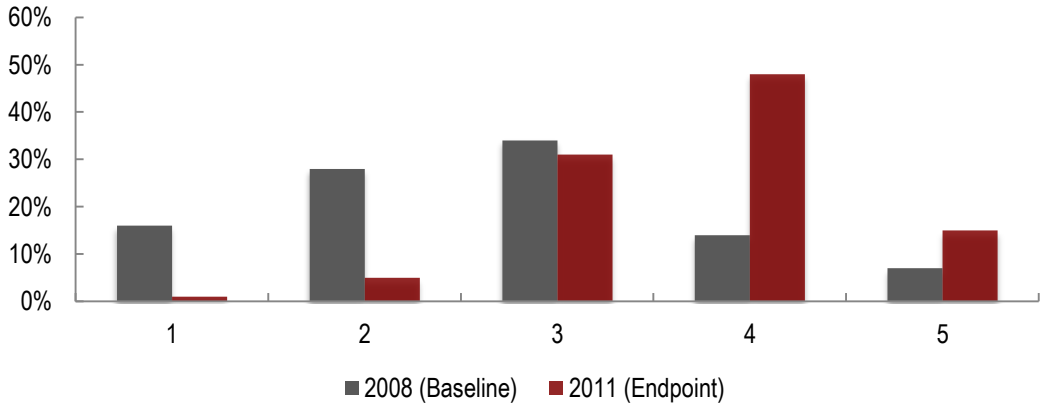
One education authority conducted its own survey of teachers and the results supported views expressed in the course of this review. In 2011, the Archdiocese of Sydney conducted a survey of 836 secondary teachers. Results from this survey indicated that the vast majority of them (88 per cent) had undertaken professional learning in using technology in the classroom over the course of the DER (2008–11).[40] It was also found that there had been an improvement in teachers' rating of their skills and improvements in their ability to use computer technology as a professional tool and as a classroom-learning tool, as illustrated in

[39] NSW Department of Education and Training, op. cit.
[40] Catholic Education Office Sydney (2011) *Secondary Teacher Engagement in Digital Learning.*

Figure 2-3 (where a rating of 1 is for a beginner and 5 is for advanced).[41]

[41] ibid.

FIGURE 2-3: SECONDARY TEACHERS' RATING OF THEIR SKILLS AND ABILITY TO USE COMPUTER TECHNOLOGY AS A PROFESSIONAL TOOL AND AS A CLASSROOM-LEARNING TOOL



Source: Catholic Education Office Sydney

Education authorities and national agencies reported they had created opportunities for teachers to develop their ICT skills through structured professional learning programs. For example:

- The Queensland Government has developed the *Smart Classroom Professional Development Framework* to help teachers achieve the:
    - *ICT Certificate*: foundation skills expected of all teachers to be able to use ICT in their classroom.
    - *Digital Pedagogy Licence*: to help teachers apply ICT and digital resources in teaching.
    - *Digital Pedagogy Licence (Advanced)*: to help teachers lead their peers in applying ICT and digital resources.
- The NT Government has developed *Action Mapped Personalised eLearning (AMPeL)*, a structured eLearning program that helps teachers plan and undertake professional learning in digital education. Teachers participate within a community of peers over a 30-hour online course that is explicitly linked to the National Professional Standards for Teachers. It is also accredited by Charles Darwin University and provides credits towards a Masters of Education.
- The WA Government has introduced the *PD21* portal to support online teacher professional learning. This portal provides online, self-paced, on-demand and instructor-led courses allowing teachers to engage with best-practice pedagogies. For example, *Teachers have Class!* is a free online professional learning program for teachers and education assistants, delivered using the PD21 portal.
- The Australian Institute for Teaching and School Leadership (AITSL) introduced the *Professional Learning Flagship Program: Leading Curriculum Change*, an online and facilitated community of practice that connects Australian teachers with each other and with the latest knowledge in curriculum change.[42]

In addition to 'traditional' models of professional learning, there appears to be an increased focus on alternative methods of in-service training to develop teachers' digital education skills and confidence, including informal professional learning sessions at school. As with students, teachers and schools are seeking to adopt more personalised approaches to instruction, including in a format that suits their learning needs. These sessions explore digital resources and their application. The sessions are typically on-site, short in duration, and frequently conducted and led by peers.

In 2010, the NSW Government surveyed 461 principals on professional learning. The survey found that 87 per cent of principals were employing individualised learning opportunities to cater for diversity in teacher experience in terms of leading and managing the DER in their school.[43]

Coaches and mentors have also been used to help teachers use ICT in teaching and learning, including the creation of student ICT teams to actively support teachers in the classroom. Most government departments have established coaches and accreditation programs to expand the network of professional learning and support available to teachers. Modelling of other staff using devices was also seen to be a vitally important strategy for improving staff pedagogical knowledge.[44]

[42] Australian Institute for Teaching and School Leadership (AITSL) (2012) *Professional Learning – Leading Curriculum Change*, available at http://www.aitsl.edu.au/leading-curriculum-change.html, accessed on 27 July 2012.
[43] NSW Department of Education and Training, op. cit.
[44] All Hallows' School (2011) *Blended Learning – Netbook Report 2011.*

Finally, partnership programs with industry have been used to develop ICT skills. For example, schools and teachers across all States and Territories have participated in the *Microsoft Partners in Learning* program[45] to address specific skill-development needs in their regions. This program is a partnership between Microsoft Australia and Australian education authorities designed to support schools, teachers and students with the resources and capability to leverage ICT in education. Since 2004 the program has contributed to the training of over 211,000 students, teachers and leaders.

Collaboration is occurring between teachers and schools through professional networks and forums

Education authorities, schools and national agencies reported that a number of networks and forums had been established to support collaboration and knowledge sharing between schools and teachers in relation to digital education practice, online resources and professional learning. Examples of forums and networks established by education authorities to support collaboration in digital education include the following:

- The NSW Government has established the 1:1 *Learning Unconference* and *Brekkie with a Techy* videoconferences to facilitate collaboration amongst teachers and to share knowledge about digital resources.
- The ACT Government conducts quarterly ICT network meetings to provide a forum for the sharing of information about new ICT initiatives, as well as information and assessment of ICT best practice from other jurisdictions.
- The SA Government has established a number of Moodle sites that were specifically created to support collaboration between teachers involved in particular aspects of the State and national curriculum.
- AITSL has established *Teacher Feature*, a portal for teachers to upload and access vignettes about teaching practice. Topics include how ICT has changed the nature of teaching and the most valuable professional development undertaken.[46]

Education authorities also reported a number of examples of forums that have been established to support collaboration across education sectors and jurisdictions. For example:

- The *Virtual Conference Centre* offers free web conference sessions for meeting, learning and collaborating online. This facility is available for use by Victorian educators in government, Catholic and independent schools, and Victorian Department of Education and Early Childhood Development staff in regional and central offices.
- *Catholic Network Australia* (CNA) and *Catholic Education Learning Tool* (CELT) were implemented, providing a vehicle to facilitate collaboration across all Catholic schools in Australia and to publish and share models of learning and online resources to support contemporary learning and professional learning programs.
- Social media networks and tools such as *Edmodo* and *Yammer* are also being used by teachers and students to collaborate and share knowledge about digital resources and technologies and their application.

It would appear that these forums are working well, with some education authorities, principals and teachers indicating that they have seen an increase in collaboration amongst schools and teachers around digital education over the course of the DER. An unanticipated impact expressed by some stakeholders was that this level of collaboration has provided a large and informed market for resources, many of which were developed by peers.

At school level, teachers are using digital education resources to collaborate locally, nationally and internationally to extend offerings to students. For example, virtual classrooms have been established to teach Japanese to government school students in remote NSW schools, and the Australasian Association of Distance Education Schools is helping schools to develop partnerships between schools, students and teachers through their *Second Life* educational space. To illustrate, distance education students collaborated online with students in a New York school to develop a comic strip for a virtual gallery. This was exhibited in *Second Life*, the online 3D virtual world where students are depicted as their own avatar (see

[45] Further information on the *Microsoft Partners in Learning* program can be found at: http://www.microsoft.com/education/en-au/partners-in-learning/Pages/index.aspx.
[46] Australian Institute for Teaching and School Leadership (AITSL) (2012) *Teacher Feature*, available at http://teacherfeature.aitsl.edu.au, accessed on 24 July 2012.

Figure 2-4).

FIGURE 2-4: EXHIBITS OF A COMIC STRIP DEVELOPED COLLABORATIVELY BETWEEN SCHOOLS IN AUSTRALIA AND NEW YORK

Source: Australasian Association of Distance Education Schools

While there have been greater instances of inter-school collaboration, this was considered to be more serendipitous and opportunistic than systematic. A common view expressed was that some teachers lacked the understanding, and time, to effectively tap into the vast knowledge that exists within schools inside and outside of their jurisdiction.

Deans of Education are now more committed to ICT curriculum for initial teacher education

The Deans of Education[47] believe that the DER helped them to coordinate a more systematic approach to initial teacher education. The DER acted as an accelerant for activity that was already planned. It was observed that the Deans of Education are constantly challenged to adapt initial teacher education to fulfil emerging policy priorities. The DER, with its attached funding, lifted the profile of ICT's role in education and, the Deans believe, resulted in significant additional focus on initial teacher education. For example, all Deans have made a substantial combined investment, in conjunction with the Australian Government, in the *Teaching Teachers for the Future* (TTF) project. TTF specifically targets the development of ICT in Education (ICTE) proficiency of graduate teachers across Australia by building the ICTE capacity of teacher educators and developing online resources to provide rich professional learning. The project involves all 39 Australian teacher education institutions and has developed a collection of digital resources to support graduate teachers, teacher educators and teachers.[48]

Notwithstanding this, several stakeholders argued that progress around initial teacher education had been hindered by the lack of funding dedicated to this activity compared with other activities funded under the DER. There were also reports that while there had been obvious increases in focus, this was not necessarily evidenced by improved standards of ICT capability among graduating teachers. However, this view was countered by the Deans of Education themselves, who suggested that creating systemic change in classroom practice was not a short-term, nor a straightforward, proposition.

2.1.4 Learning resources

Teacher focus on digital teaching and learning has sparked innovation around digital technology use more generally

Education authorities reported a strong sense that many schools were generating digital learning resources that could be shared with peers (vehicles that have been established to collate and share resources are discussed in more detail later in this report). This innovation is occurring across all sectors and jurisdictions. For example (taken from where data was available) teachers in more than 84 per cent of NSW Independent schools reportedly create or develop digital resources. A similar picture emerged in SA Independent schools, where teachers in 87 per cent of schools create or develop digital resources; in Tasmania the rate was 81 per cent, and in Queensland Independent schools it was 71 per cent. In addition, teachers in 95 per cent of NSW Catholic schools identified that they are now developing digital learning resources.

Education authorities reported that teachers are utilising a wide range of tools to generate these digital resources, including:

- traditional tools such as PowerPoint, video clips and photo stories;
- podcasts, YouTube clips, blogs and wikis;
- content creation tools to create eBooks and ePubs; and

[47] Deans of Education represent Deans of faculties and Heads of Schools of Education in universities and other higher education institutions in Australia.
[48] Education Services Australia (2012) *Teaching Teachers for the Future*, available at http://www.ttf.edu.au, accessed on 24 July 2012.

- Web 2.0 tools to support communities of teachers with shared interest in subject matter or digital learning tools.

The level of development activity around learning resources is significant, resulting in the generation of a substantial amount of online resources. On the issue of quality, education authorities indicated that many of the early creators/adopters of online learning resources have set high expectations, which could be seen as difficult for other teachers to consistently achieve. This also hints at what many education authorities saw as a potential barrier to the generation and sharing of resources – fear of peer review and criticism. To help address that, the Queensland Government has established the *Smart Classroom* Awards to recognise digital education practice and encourage the generation and sharing of resources. Other education authorities suggested that while the rate of content creation had been encouraging, more work was required to enable teachers to more effectively share and access pre-existing content. The sheer volume of resources available made it difficult for some teachers to identify and access particular content, representing a missed opportunity to extract value from developed content.

Development, use and sharing of online teaching and learning resources have increased

As outlined above, a large quantity of digital teaching and learning resources has been developed by practitioners, purchased (e.g., subscription resources) or commissioned by schools and education authorities. Education authorities reported that teachers in their jurisdictions have access, and are encouraged, to use available digital resources. To help manage the collection of, and access to, digital resources, education authorities and national agencies have established a range of portals using common platforms such as *Scootle* and *Moodle*. These portals provide a vehicle for collaboration amongst teachers and schools enabling them to share resources, as well as knowledge and experience in enhancing pedagogical practices. Resources are also available on most of those portals for use by students and parents. Examples of portals that have been established across the country and that are typically shared across sectors within jurisdictions include the following:

- *TaLe* (NSW): provides teachers with access to over 30,000 resources such as learning objects, downloadable teaching resources, links to websites and online resources that can be used in conjunction with the State's Learning Management Systems.
- *FUSE* (Victoria): provides a library of over 40,000 digital resources for teachers to access on the Ultranet. Resources include images, videos, audios and guides to support teachers.
- *The Learning Place* (Queensland): provides a wide range of teaching and learning digital resources, and eSpaces for collaboration and networking amongst teachers and school leaders.

Portals and resources now appear to be widely and increasingly used. For example, the NSW Government reported that since the beginning of the DER in NSW (September 2009), 460,000 digital resources had been downloaded by the end of 2011. As of 30 June 2012, this had increased to 601,822 digital resources.[49]

Education authorities indicated that plans were in place to organise and expand the use of available digital resources. For example, NSIP is looking to develop protocols and standards that support greater integration of online learning tools. Progress in this field should facilitate sharing of resources and potentially student information across jurisdictions and sectors. In addition, the convergence of capabilities established under the DER and the introduction of the Australian Curriculum is seen as an important opportunity and framework to organise, promote and integrate digital resources that support the curriculum. One initiative currently being undertaken by the Queensland Government is the *Curriculum into the Classroom* (C2C) program, which aims to support teachers as they plan, prepare and deliver the Australian Curriculum. C2C contains unit plans, lesson overviews, assessment and marking guides and other documents for teachers. Since its introduction this year, more than 65,000 C2C units have been downloaded.[50]

2.1.5 Addressing disadvantage

The DER has helped to create a more level playing field for schools and students

The universal, multi-sector nature of the DER created broad benefits across Australia. Stakeholders, particularly those in the independent sector where up to one-third of schools are considered low fee paying and low SES, acknowledged that one of the DER's greatest virtues was its ubiquitous nature. They reported that this type investment across all sectors created equity in a way that has rarely, if ever, been seen before in education. It was widely acknowledged that the scale of this change would not have occurred in the timeframe achieved – or at all in some cases – without the DER support.

Stakeholders consistently indicated that the impact of the DER was greatest for:

- students and schools in rural and remote locations;

[49] NSW Department of Education and Training (2012) *CLIC DER-NSW report, September 2009 to 30 June 2012.*
[50] Lippett, T. (2011) *Thumbs Up for C2C Ahead of Australian Curriculum*, Queensland Department of Education, Training and Employment.

- students and schools in low SES areas; and
- students with special needs.

At the school level, the DER has provided a platform for all schools to collaborate and share resources, ideas, infrastructure and costs for ICT and digital education. Prior to the DER, the presence of these pre-conditions for digital education success were seen to be confined to schools that could afford them and/or that were innovators in the field of digital education. Some government school principals reported that the DER has helped them become more competitive. They report that this has in turn resulted in increased enrolments, citing parents placing a high value on digital education capabilities as increasingly prominent enrolment/re-enrolment criteria.

At the student level, the DER was identified as having helped to deliver equitable access to devices for all Australian students in Years 9–12. Some education authorities and principals indicated that for some low SES students, the DER provided them with access to 'their own' computer for the first time in their life. As one interviewed teacher stated, '*It's a godsend to give a child – regardless of status – access to a computer. This is teaching kids the power and social responsibility of IT*'. Schools are also supporting greater access by students to the Internet and digital resources outside of school. For example, most schools reported that they had established networks that support remote connectivity to school local area networks (LANs), with the Queensland Government establishing an arrangement with a telecommunications carrier for 3G access to provide students with connectivity when they are not at school.

While the DER was not expected to impact on the inequality in home broadband standards, stakeholders indicated that this was an important issue for future policy considerations. Given that most stakeholders believed that take-home devices provided additional learning benefits, the inability of some students (due to cost reasons) to connect to the Internet at home put them at a significant disadvantage. This had been addressed in part by some States and Territories, including in Victoria with the Education Maintenance Allowance. However, this was not necessarily a universal solution for students, particularly those in remote areas where connectivity issues were more related to geography than financial obstacles.

The DER has helped to establish an environment to increase personalised learning and engagement

Education authorities, principals, teachers and teaching specialists believe that digital learning environments made possible by the DER have provided teachers with more tools to support engagement of some of the most disadvantaged and disengaged students. The DER stimulated access to devices, resources and methods to personalise teaching to student needs, preferences and learning styles. Teachers and schools, supported by the DER, reported having gained access to resources that were previously unaffordable or underexploited, including games for kinaesthetic learners, virtual classrooms for students in remote locations and dedicated networks for gifted children.

Digital environments also open up options for students with disabilities, with some suggesting that this group of students have been the greatest beneficiaries of the DER initiative. New and existing technologies, emerging practices and greater ubiquity of devices and online communications are providing opportunities to mitigate poor learning experiences and educational outcomes for students with disabilities. Schools reported the evolution of technologies such as touch-based tablets had created new possibilities for visual stimulation, communication and content creation among students with special needs.

> *We have one student who for the first time in his life is communicating. He is very disabled and high on the autism scale and he has turned from what was a very angry and isolated child to a bright and engaged and interesting fellow who can communicate with others.*

Interactive White Boards (IWBs) and their ability to be used as giant touch screens were also thought to be instrumental in increasing student engagement and helping students with disabilities communicate in more effective ways. As one teacher noted, *'We had students who had never interacted with technology being able to start touching and interacting.'*

Some teachers also suggested that a digital learning environment, which enables access to a variety of resources to support student preferences and learning styles, had allowed those students who are less confident to 'speak up' using their devices and as such they were more engaged in learning.

> *Disengaged students are now posting thoughtful comments online, whereas before they wouldn't have participated.*

2.2 Progress against evaluation indicators

In developing the DER Evaluation Strategy, DEEWR defined a range of evaluation indicators and data sources that could be used to assess the impact of the DER initiative.[51] Those indicators were reviewed by dandolopartners on commencement of this project to develop a refined Evaluation Framework for this review – this is presented in Attachment 2.

[51] Australian Government (2011) *Digital Education Revolution Evaluation Strategy, April 2011*, Department of Education, Employment and Workplace Relations, Canberra.

The revised framework used for the review, which is consistent with the *Digital Education Revolution Evaluation Strategy, April 2011*[52] covers the four strands of change that guided the implementation of the DER National Partnership Agreement and incorporates and expands on the key evaluation indicators contained in the original framework. The framework used in this report has a number of components against which progress has been recorded:

- what will be measured – i.e., the key questions to be addressed.
- description of aspirations associated with those measures.
- indicators to be applied to measure progress and test whether aspirations are being met.
- sources of data used to generate the evidence needed to complete this evaluation, including:
    - **literature review** – of relevant international, Australian Government and State/Territory government reports and research, such as DEEWR documentation, targeted research reports and existing evaluations;
    - **data analysis** – of identified datasets including NSSCF Progress Reports, SiAS survey, Schools Broadband Connectivity survey and SEMIS DER application and reporting data; and
    - **stakeholder consultations** – via interviews, workshops and focus groups (see Attachment 3).

The table below provides a summary assessment of progress that has been made by the DER against the refined Evaluation Framework. It identifies whether:

- indicators have been **achieved** – all (or almost all) education authorities or surveyed/interviewed stakeholders report achievement of the defined indicator;
- **significant progress** has been made – the majority of education authorities or surveyed/interviewed stakeholders report achievement of the defined indicator; and
- there has been **some progress** – some (but not the majority) of education authorities or surveyed/interviewed stakeholders report achievement of the defined indicator. This may reflect the fact that good progress is being made in some States and Territories, sectors or schools, but not across the country, or it may suggest that progress has been limited universally.

2.2.1 Infrastructure

Measure	Evaluation indicators	Progress to date
Have access targets been achieved?	Schools provide 1:1 ratios for access to computers for all Year 9–12 students across the country	Achieved
	The DER has helped address inequality of access to computers	Achieved
Have schools established the network infrastructure needed to support the use of computers/devices in the classroom?	Schools support broadband networks that are used within the school for teaching and learning (e.g., wireless networks)	Achieved
	Schools support fibre (broadband) connectivity to the Internet	Significant progress
Has the DER been a catalyst for broader utilisation of ICT in the classroom?	Schools use other technologies and non-computer hardware for teaching and learning	Achieved

[52] Thirty-eight evaluation indicators are identified in the DER Evaluation Strategy and correspond to data that is contained in the NSSCF Progress Reports, SiAS survey, Schools Broadband Connectivity survey and SEMIS DER application and reporting data.

Are computers and networks reliable and well supported?	Schools provide teachers with access to technical support	Significant progress
	Infrastructure and support is seen as adequate and reliable	Achieved
Are schools actively planning beyond the DER?	Schools have a dedicated technology budget	Achieved
	Schools have a planned and budgeted approach to ICT refresh	Some progress

2.2.2 Leadership

Measure	Evaluation indicators	Progress to date
How have authorities changed the way they work with ICT – and each other?	Schools and education authorities collaborate to share sound practice about the use of ICT for teaching and learning	Some progress
	Knowledge sharing and collaboration activities are seen as effective	Some progress
How are the authorities leading and supporting schools in their use of ICT in classrooms?	Education authorities support schools in the use of ICT in teaching and learning	Achieved
Are school leaders committed to greater use of ICT for teaching and learning?	Principals are driving ICT integration in the school and in teaching and learning	Significant progress
	School leaders participate in professional learning about the use of ICT	Significant progress
	School leaders see the importance of ICT in teaching and learning, including benefits for teachers, students and parents	Achieved
	School leaders see that ICT has changed roles, responsibilities and practice	Significant progress
How are school leaders planning and supporting the use of ICT in classrooms?	Schools have an ICT strategy or plan	Achieved
	Principals have an ICT deployment plan for the provision of infrastructure, learning resources and teacher capability	Achieved
	Policies are in place for the use of ICT in the classroom	Significant progress

2.2.3 Teacher capability

Measure	Evaluation indicators	Progress to date
Are teachers committed to greater use of ICT in the classroom?	Teachers are using ICT more since the DER was introduced	Achieved
	Teachers see the benefits associated with the use of computers and digital resources in teaching and learning	Significant progress
Do teachers feel adequately skilled and prepared to use ICT and online tools/resources in the classroom?	Teachers identified the importance of professional learning in ICT	Achieved
	Teachers are provided with opportunities for professional learning about the use of ICT for teaching and learning	Significant progress
	Teachers are undertaking professional learning about the use of ICT for teaching and learning	Significant progress
	Teachers are confident and competent in using ICT and digital resources in the classroom	Significant progress
	ICT is included in initial teacher education courses	Some progress
	Initial teacher education courses are believed to effectively prepare teachers for the use of ICT	Some progress
Do teachers feel adequately supported to use ICT and online tools/resources in the classroom?	Schools facilitate teachers' access to coaching about the use of ICT for teaching and learning	Significant progress
	Schools facilitate collaboration and networking around the use of ICT for teaching and learning	Significant progress

2.2.4 Learning resources

Measure	Evaluation indicators	Progress to date
Are schools providing access to online learning resources?	Schools provide teachers with or allow access to digital learning resources	Achieved
	Teachers and education authorities create or develop digital learning resources	Achieved
	Schools and education authorities facilitate the sharing of digital learning resources with teachers outside of their school/jurisdiction	Significant progress
	Digital learning resources are delivered/shared through a variety of channels	Achieved
	Digital learning resources are perceived as accessible	Achieved
Are teachers increasing their use of online resources?	Teachers are confident in using digital learning resources	Some progress
	Teachers extensively use online learning resources	Significant progress

Are online resources supporting personalised learning?	Available digital learning resources are of a high quality and are having an impact	Some progress

2.3 Challenges around the DER

This section presents a summary of challenges that were identified by stakeholders in the context of the DER.

A DER-style initiative could usefully focus on early years as well as later years

Early access to devices by lower-year levels, including primary schools was considered to be high value, with many stakeholders suggesting that impacts could be much more far reaching. The reasons for this position included:

- Getting ICT into the hands of students early had significant pedagogical value.
- The curriculum in the later years of secondary schooling is much more difficult to manipulate, given the reliance on formal examination, and therefore it is more difficult to customise pedagogy in these year levels.
- The transition period between primary and secondary school could have been made smoother with devices provided on both sides of that transition.
- The demands of senior secondary students for up-to-date devices were higher, which fitted less with the DER's typical four-year lifecycle for devices.

The issue of when, exactly, is the optimal time to introduce 1:1 computing into schools was a point of contention amongst stakeholders. The majority suggested that Year 5 in primary school was appropriate, mainly because it was well in advance of the critical transition to secondary school. The views on this issue were mostly mixed among parents, with a significant proportion of those interviewed indicating concerns with access to devices, particularly take-home laptops, for primary aged students.

Whilst infrastructure and devices are important, other investments are also necessary

Many stakeholders acknowledged that achieving 1:1 access and reliable infrastructure were a necessary pre-requisite to engaging teachers in the process of changing practice and actively seeking opportunities for professional learning. However, almost all reiterated the necessity of continued professional learning to build the skills and confidence of teachers in a digital education environment.

There is a consistent view that teacher professional learning needs significant additional focus to equip teachers to perform best in a 21st-century teaching and learning environment. The recently developed *National Professional Standards for Teachers* provides a framework for the discussion and development of professional learning. However, experience to date indicates that professional learning delivered in schools by peers will continue to be one of the most effective methods of developing the skills and confidence of teachers.

Stakeholders also suggested that digital teaching and new learning environments introduced new styles of pedagogy. This increases opportunities for the personalisation of learning for individual students to cater for specific interest, abilities and preferences. This is also seen to increase the 'intensity' of teaching and learning, with more resources and activities available to students and teachers. Without the time available to effectively learn and plan for the use of ICT in everyday teaching practices, teachers will struggle to improve their capability to operate effectively in the digital environment. While most acknowledged that the DER could not have reasonably included more time for lesson planning as a component, there is a strong sense that this issue is important in capitalising on ICT in the future.

Greater broadband connectivity will enhance and expand the impacts of digital learning in some schools

The increased take-up of digital education has driven demand for bandwidth across schools, with demand likely to continue. Data collected by the NSW Government showed significant growth in monthly Internet downloads. For example, the average terabyte (TB) download has gone from 24.97 TB per month to 151.6 TB per month between January 2008 and May 2011. Research undertaken globally suggests that schools need to meet the following minimum bandwidth targets to support teaching and learning in a digital environment: at least 1 gigabyte (GB) per 1000 students by 2015 and 10 GBs per 1000 students by 2018.[53] While a number of Australian schools are well placed to do this, particularly those with fibre-to-the-premise connectivity, the pricing of high-speed connectivity could be seen as a barrier.

[53] Fox, C., Waters, J., Fletcher, G. & Levin, D. (2012) *The Broadband Imperative: Recommendations to Address K-12 Education Infrastructure Needs*, State Educational Technology Directors Association (SETDA), Washington DC.

While there has been a shift towards fibre broadband connections in schools, it is estimated that more than 30 per cent of schools were reliant on copper infrastructure when the last Schools Broadband Connectivity Survey results were published.[54] Another cohort of schools was also reliant on mobile (3G) connections. Schools not connected to fibre were considered less able to realise the full benefits of devices provided under the DER. This issue is most acutely felt in rural and remote locations and by schools that are located in 'black spots' for broadband connectivity. Addressing this issue is an expensive challenge for those schools, particularly in a state such as WA (2.5 million square kilometres) where establishing the infrastructure to support 1:1 access across the state was complex, time intensive and expensive. Education authorities acknowledged that inequality existed in both the availability and cost of high-speed connectivity. Schools in remote areas (typically small) not only had reduced access to infrastructure, but they often simultaneously had the lowest capacity to afford it and the greatest need for fast, reliable broadband to overcome geographic isolation.

The DER initiative has increased parental expectations about the potential of technology and the desirability of the 1:1 ratio

The DER initiative has increased expectations and understanding of the value of digital education to support teaching and learning among parents, teachers and students. The expectation is that teaching and learning will continue to occur in a 21st-century (digital) environment, and implicitly that 1:1 or something resembling it will continue. Education authorities, schools, parents and others are contemplating potential options to sustain the DER benefits.

Education authorities and schools are planning for the future in different ways. Some are providing advice and support to member schools to help them plan for the future and prepare for the refresh of devices that were initially funded under the DER. For example, the Queensland Government reported that all government schools maintain an asset register that incorporates an asset replacement schedule for updating ICT hardware and software. It had provided guidance material to assist its schools to measure, report and plan on their progress towards whole of school eLearning transformation and regeneration. While this does not deal with the issue of funding beyond the DER term, it has engendered a better understanding of the magnitude of the refresh.

The DER has increased the requirement for technical support in schools

The deployment of more than 960,000 devices across Australian secondary schools has created additional demand for technical support in schools. Many schools and education authorities indicated that the level of support required was an unanticipated consequence of the DER in terms of its scale and cost. For example, some school leaders indicated that they had quadrupled the number of devices operating in their schools, yet they are still running with a similar level of ICT support. Others indicated they had been forced to substitute teaching positions to enlist the requisite ICT support. This issue was exacerbated in some cases by difficulties finding ICT support professionals to work in school environments, particularly in regional and remote locations. The competition for ICT professionals in private industry may have increased the cost of searching for these resources and the cost of salaries to attract and retain them.

While additional funding was made available to schools through NSSCF On Cost funding to support device deployment, including costs associated with technical support, maintaining high quality ICT infrastructure remains a priority for schools.

The DER highlighted the need to more strongly engage parents in their children's education through technology

A number of teachers spoke positively about the increased communication that they were having with parents about their child's education, and the increased opportunities for parental access to online learning resources and portals. However, there was a general feeling amongst stakeholders that the opportunity to use ICT to improve parental engagement had not been fully exploited.

In particular, technology had not been adequately leveraged to improve communication between parents, school leaders and teachers on issues such as curriculum, assessment, performance and behavioural issues. Many argued that the technology now existed to allow virtual meetings between teachers and parents to improve student engagement and outcomes. Some parents indicated that they lacked detailed knowledge or understanding of how technology is actually being employed in the classroom, while others cited that it was not school policy to interact in this way. One parent noted his 'surprise' when he learnt from his child (as part of the consultations for this review) the extent to which teachers are using public resources such as YouTube to break up lessons and to engage students.

Other parents remained cynical about the use of ICT in classrooms, particularly among parents of students with access to take-home devices. A typical complaint was that take-home devices had isolated the student from the family as it was difficult to separate them from their computers and also created challenges in policing their use of social media, which was very distracting and often legitimised as being part of their homework. It was acknowledged that even if the school had not provided the device, parents may well have and the issues remained.

Other parents suggested the technology provided under the DER could have been used to assist parents to better support their child's education, including via access to resources and feedback from assessment activities.

[54] Australian Government (2011) *School Broadband Connectivity Survey 2010.*

It would be good if we could get access to the Virtual Classroom because then I could see what assignments my child needs to do rather than just getting sent an email after the due date saying that he failed to hand it in.

3 Perspectives on what is required to effectively use technology in education

Having established the achievements of the DER, this section considers whether the objectives of the DER initiative, which were set in 2007/08, need recalibrating in light of emerging trends and international practice. This section brings together evidence and judgement by drawing on a substantial body of local and international research, as well as the perspectives of stakeholders. This section examines international and local experiences with digital education and examines specific pre-requisites for the effective utilisation of ICT in education. The purpose of this section is to synthesise what works well and why. In this section we:

1. present an overview of the international landscape in integration of ICT in education and Australia's place within it
2. set out a framework for the integrated use of technology in teaching and learning, drawing upon and synthesising international and Australian experience, as well as the views of stakeholders collected through this review. For each element of this framework, the section describes:
    - its importance;
    - what works well and how Australia fares; and
    - potential future Australian policies and directions.

3.1 The international landscape and Australia's place within it

While there is widespread agreement about the need to prioritise the use of digital technologies in education, and their importance in preparing students for contemporary work, there is considerable variation in how different countries have approached policy and implementation. These policy approaches are necessarily influenced by differing political structures and philosophies. Neither the United States, nor Australia, has the kind of centralised national policy environment characteristic of Singapore or South Korea.

There is, nonetheless, an increasing body of evidence being gathered around what works in terms of the use of technology in education. Australian jurisdictions are producing materials that explicitly reflect analysis of what has worked internationally and its relevance to Australia.[55] Research and scanning of international policy and practice suggest the following conclusions.

3.1.1 The importance of digital education is broadly acknowledged

There is global recognition that digital technologies present opportunities for transformative change in teaching and learning in schools.[56] Digital education is widely recognised as providing significant economic and social benefits. Digital education is considered to improve student engagement and lead to higher retention in formal education. This in turn helps meet the labour market and productivity needs of 21st-century economies. Digital education is also considered to provide students with lifelong skills and the capabilities essential to personal success and participation in an ever-changing social environment.

3.1.2 Approaches to digital education vary across countries

While the pace and scale of investment in digital education varies from country to country, the rationale for investment is generally consistent. In Europe, the importance of the use of technology in education was identified as a priority by the European Union and has been recognised in economically diverse countries such as the United Kingdom. For example, the British Educational Communications and Technology Agency (BECTA), which was established in 1998, set its 2005 strategic objectives to 'influence

[55] Anytime Anywhere Learning Foundation, op. cit.; NSW Department of Education and Training (2009) *One to One Computing: Literature Review*.
[56] Griffin, P., McGaw, B. & Care, E. (eds) (2012) *Assessment and Teaching of 21st Century Skills*, Springer, Dordrecht.

strategic direction and development of national educational policy to best take advantage of technology' and 'to develop a national digital infrastructure and resources strategy leading to greater national coherence'.[57]

In North America, education policy is decided at the state or local level, with many jurisdictions implementing new policies to use digital technology to transform learning in their schools. For example, the Mooresville Graded School District in North Carolina developed a digital conversion campaign to close the digital divide and drive the use of technology in education. As a result, the District saw education outcomes for students that exceeded comparison jurisdictions and were recognised for their success.[58] The importance of investment is also recognised in less-developed countries, such as Venezuela, which has invested in major national programs to bring laptops to all students.

In the Asian region, prominent economies such as Singapore, Hong Kong and South Korea are seen as leaders in the field.

3.1.3 Countries considered to be leading the digital education agenda adopt a whole of system, staged approach

Some of the countries that are consistently seen to have made the most significant educational reforms include Singapore, Hong Kong and South Korea.[59] As early as the 1970s, Singapore saw the potential of ICT for their country as a whole, and subsequently developed a series of national ICT Masterplans for schools. From the late 1990s, the first of these focused on infrastructure and teacher training. The second (2003–08) focused on the integration of ICT into lessons. The third and current phase aims to 'develop better interactive environments to strengthen students' thinking'.[60] Along with this, the Government consistently invested in upgrading the ICT infrastructure of their schools. The result of this long-term strategic thinking by government can be seen in the strong performance of Singapore's students in all international comparative measures of knowledge and skills.

South Korean students have been found to be the most digitally literate in comparison to their peers from across the world[61], which can be attributed to their clear strategic national investment in ICT in schools. South Korea has now announced that all school printed materials and textbooks will be digitised by 2015. In support of this policy, the South Korean Government is planning on providing all of their schools with adequate wireless access, and students from low-income families will be provided with free tablet PCs. At the same time, this focus on technical infrastructure is accompanied by a vision of students learning with the support of varied devices, at all times of the day, inside and outside the classroom.

National innovation in digital education is not confined to the Asian 'tiger economies'. In 2005, Portugal responded to its own economic challenges with a similarly ambitious attempt to leap into the digital world. Portugal pledged to equip every student with a low-cost laptop and access to the Internet, as well as equipping all classrooms with an interactive white board and Internet access. The initiative spread to Venezuela, which began distributing the cheap laptops made in Portugal (under licences from Intel) to all school students in 2010.

In the United States, where public schooling is controlled by more than 14,000 school districts, there are no levers for system-wide innovation, despite the immense global influence of companies like Microsoft, Cisco and Intel. Many school districts are engaged in best-practice reform to improve student achievement[62], but aggregate performance data shows that overall the United States is falling behind.

The different approaches around the world largely reflect differences in the nature of educational systems, dominant ideologies and the fiscal ability of Governments to support programs, as opposed to differences in understanding about digital education. The idea that what one country has done can simply be transposed to another is unrealistic for these reasons. This does not mean, however, that there is nothing to be learned from the policy approaches and programs adopted by other countries or jurisdictions, particularly where there is evidence of significant improvement in teaching and learning as a result.[63]

3.1.4 The DER positions Australia well in terms of providing a nation-wide digital platform for learning in the 21st-century

Given international experience, and considering Australia's more complex federated system of education, the DER is significant for its scale and progress in a short timeframe. The DER has created some underpinnings for Australian education authorities and schools to capitalise on the benefits of digital education. While Australia may not have the broadband infrastructure of Singapore or Hong Kong, it is much better placed than most of the OECD countries in terms of being able to exploit the enormous potential of

[57] British Educational Communications and Technology Agency (BECTA) (2005) *Research and Development Strategy 2005–8*, available at http://www.teachfind.com/becta/bectas-research-and-development-strategy-2005-8, accessed on 8 August 2012.
[58] Greaves, T. et al., op. cit., pp 41-44
[59] Jensen, B. (2012) *Catching Up: Learning from the Best School Systems in East Asia*, Grattan Institute, Melbourne.
[60] Koh, T.S. & Lee, S.C. (eds) (2008) *Information Communication Technology in Education: Singapore's ICT Masterplans, 1997–2008*, World Scientific Publications, Singapore.
[61] OECD (2011) *PISA 2009 Results: Students Online: Digital Technologies and Performance (Volume VI)*, OECD Publishing, Paris.
[62] Many examples of this are described in Greaves, T., et al., op. cit.
[63] Jensen, B. (2012) *Catching Up: Learning from the Best School Systems in East Asia*, Grattan Institute, Melbourne.

digital education. In the recent Program for International Student Assessment (PISA) 2009 Digital Reading Literacy Assessment, Australia achieved a mean score that was significantly higher than the OECD average in terms of digital reading literacy amongst 15-year-olds. Australia was only outperformed by one other country – South Korea.[64] However, countries whose students consistently score highest in the PISA rankings of student learning outcomes do more than just invest in technology. They are also countries in which equal attention has been paid to teacher preparation and professional development, and to raising the status of the profession. In these cases teachers are being treated as the key to successful, radical change.[65]

3.2 A framework for effective technology use in education

While it is acknowledged that there is no single or easy formula for the effective use of technology in education, there was a high degree of consistency in available research and amongst stakeholders' opinions about the factors that were critical to the successful integration of computers and digital resources in education; see Figure 3-1.

On the basis of this research, and these stakeholder consultations, the following framework has been designed to specify the acknowledged success factors.

FIGURE 3-1: FRAMEWORK FOR THE EFFECTIVE USE OF TECHNOLOGY IN EDUCATION

Appropriate governance and policies in place to stimulate adoption of ICT in education at the system level	Strong school leadership and a whole of school approach	Infrastructure in place that is fit for purpose, flexible, supported and sustainable	Teacher professional preparation and development that supports integration of technology into education
Description …			

At national, system and sector level:
• Policy and direction setting
• Divisions of responsibilities
• Oversight
• Collaboration at system and sector level
	At the school level:
	• Leadership
	• Vision
	• School level implementation planning and priority setting
	• School culture and staff engagement
		At sector, system and school levels:
		• Technology infrastructure
		  • Bandwidth
		  • Devices and networks
		  • Software
		• Access and use policies
		• ICT support and maintenance
		• Sustainability measures
			At national, system and school levels:
			• ICT literacy
			• Integration of ICT into pedagogy
			• Digital resources

What works…			
• Adopting a long-term, staged approach to digital education policy • Adopting a tight approach to specifying outcomes and a `looser' approach to implementation so that those at school level have appropriate autonomy • Seeking to engender collaboration across the field– amongst teachers, schools, education authorities and national teaching bodies – and systematise innovation	• Personal and team leadership style that enthuses teachers to embrace technology • Explicitly incorporating ICT in achieving the school's educational vision and a strategic plan • Creating an operational plan that clearly identifies the key responsibilities and accountabilities • A focus on the development of a strong school culture, which seeks to engage all staff in digital education • Engaging stakeholders in the wider school community, including parents	• Ensuring that selection and design of the physical infrastructure, including broadband connectivity, devices, school-based infrastructure and software, is based on the unique requirements of learners and the school environment • Setting device access and proper-use policies at the school level • Provisioning for infrastructure support/maintenance at the outset • Considering a range of infrastructure sustainability and funding strategies	• Integrating content, pedagogy and technology • Integrating ICT into initial teacher education as opposed to being offered as a skills-based 'bolt on' • Developing on-site, context specific, regular, peer-mediated opportunities for professional learning • Developing professional networks, both within and beyond the school

Appropriate governance and policies in place to stimulate adoption of ICT in education at the system level

Appropriate governance and policies in place to stimulate adoption of ICT in education at the system level	Strong school leadership and a whole of school approach	Infrastructure in place that is fit for purpose, flexible, supported and sustainable	Teacher professional preparation and development that supports integration of technology into education

[64] Thomson, S. & De Bortoli, L., op. cit.
[65] Jensen, B. (2010) *Investing in Our Teachers, Investing in Our Economy*, Grattan Institute, Melbourne.

3.2.1 The importance of governance and policies

Governance includes setting directions, priorities, standards and expectations, as well as the establishment of supporting frameworks and policies. Arrangements should be in place to provide effective oversight of planning and implementation, and monitoring of progress. Effective governance arrangements should also support the capacity to learn from and share successful practices, as well as specifying how to improve ineffective and inappropriate practices. The considerations for what represents good governance for the design and implementation of 1:1 initiatives include the following:

- Which policy functions are best approached at the national or education authority level?
- What level of flexibility is appropriate at the school level in the implementation of system-level policies?
- What incentives and systems need to be put in place within the education field to encourage broader and more effective collaboration?
- What are the most effective measures to monitor progress and ensure continuous improvement?
- How can persistent barriers to equitable access amongst schools and students be best addressed?

The Council of Australian Governments (COAG) reform agenda and the establishment of National Partnerships have attempted to integrate education policy responses between the Australian and State and Territory governments. Stakeholders observed that effective governance mechanisms – including clear divisions of responsibility as well as areas of potential collaboration – need to be established to guide future activities and investments beyond DER.

3.2.2 What works with respect to effective governance and policies

Global practices and stakeholder perspectives suggests that good governance/policy settings around large-scale 1:1 education computing initiatives can be attributed to three critical success factors:

1. adopting a long-term, staged approach to digital education policy;
2. adopting a tight approach to specifying outcomes and a looser approach to implementation, so that those at school level have appropriate autonomy; and
3. seeking to engender collaboration across the field – amongst teachers, schools, education authorities and national teaching bodies – and systematise innovation.

1. Adopting a long-term, staged approach to digital education policy

As mentioned above, Singapore, South Korea and Hong Kong are recognised as having some of the world's most progressive approaches to the integration of ICT into education. While the timing and emphasis of investments in digital education has varied between these countries, the presence of a clear staging process is consistent. The first stage has tended to focus on school improvement and planning, the second on building teacher capability (including in regard to ICT readiness), and the third phase has tended to focus on the integration of ICT into lessons.[66]

Stakeholders in Australia observed that while digital education had been a focus for several decades, initiatives have tended to be opportunistic rather than long-term and systematic. Australia's federated education market structure, including the presence of a large number of non-government schools, was identified as a possible reason as to why system-level reform had been difficult to achieve in digital education. At a more basic level, the highly distributed nature of schools has made it difficult from an infrastructure perspective to mimic the system-wide impacts experienced in South Korea, Singapore and Hong Kong, which have simpler bureaucratic structures and fewer geographic challenges.

While there is a perception that Australia's approach to digital education had been opportunistic, stakeholders acknowledged that the scale and transformative nature of the DER has created better conditions for the longer-term planning of digital education. There is variation in the level of influence exerted at a system level due to the different governance arrangements of the government, Catholic and independent sectors. However, most stakeholders agreed that the DER had focused attention on the need for a long-term, systematic approach. It is worth noting that some education authorities intentionally delayed the deployment of devices in the early rounds of the NSSCF to ensure that the requisite strategic planning could be put in place first.

[66] The incorporation of ICT into lessons includes the digitisation of learning materials and the transfer of assessment and testing to an online form.

Providing devices at a significant scale has had a catalytic impact that alternative policies may not have had. This is one of the most important staging lessons arising from the DER. For example, the scale of device deployment demanded changes in other areas, such as school-based wireless networks, that otherwise might not have happened as quickly. While educationalists caution against the tendency to overstate the importance of the physical infrastructure such as technology[67] – and that it is a means to an end – the simple objectives of the DER and presence of clear staging had significant value. The vast majority of those interviewed suggested that the decision to implement technology at scale, and in advance of the foundation stones being in place, could be justified. They argued against waiting for the 'right' settings to be universally in place at the school level prior to deployment of devices as it was costly.

> *There is a clear choice in educational technology policy: you either wait for everything to be in place and then rollout or you do what the DER did and use it as a shock to the system. Waiting was not an option.*

Notwithstanding the rationale of decisive national action, there are clear benefits stemming from detailed planning and preparation at the school level around 1:1 access. The learnings embedded in the *21 Steps to 21st-Century Learning*[68] methodology adopted by the Victorian and Queensland governments, as well as other research, suggest that a long-term strategic approach has value at the school level as well as at the system or education authority level.

2. Adopting a tight approach to specifying outcomes and a looser approach to implementation, so that those at school level have appropriate autonomy

Tightly controlled systems, such as those in Singapore and South Korea, demonstrate that there are some significant advantages in a systemic approach to digital education. This observation is somewhat strengthened by the counter-example of the highly decentralised model of the United States, where aggregate performance is lagging. In the United States, where a high number of school districts represent the 'system' from a policy and funding perspective, good results have been achieved in some districts. However, reform and deployment have not been achieved at scale. The Australian model, with its federated structure, falls somewhere between these models. It is worth noting that differences in educational outcomes are impacted by a range of factors beyond the level of centralised control.

A spectrum of governance arrangements exists within the education authorities implementing the NSSCF, ranging from centralised to decentralised. The approaches vary significantly by sector and state. Whilst the Australian Government drove change with its large-scale investment, responsibility for the major components of education delivery at the school level resides with the state for government schools and the dioceses for Catholic schools, and it is a devolved decision for independent schools.

Notwithstanding the devolved nature of decision-making in education, it is relevant that the DER initiative operates within a broader set of national frameworks, including teacher standards, a national curriculum and national assessments. Even in highly decentralised environments, a role for the centralised governance of policies that sets tight policy frameworks exists to:

- support interoperability between schools, including technical standards;
- underpin appropriate minimum standards, including security and privacy standards; and
- provide the potential to generate significant economies of scale/cost advantages, including procurement.

Firstly, establishing technology interoperability standards represents an example of policy that is best set at higher-level schools. It is generally agreed that there is justification for interoperability standards to be set at the national level. The Systems Interoperability Framework (SIF), an initiative of the DER, is a set of industry-developed and supported technical blueprints aimed at enabling K-12 software applications to work seamlessly together. These open-source, free-to-use blueprints, referred to as 'SIF Specifications', make it possible for diverse applications to interact and share data at the school and sector levels. SIF allows for the exchange of information between all Australian school sectors, reducing the need for schools and education authorities to design customised approaches to information sharing.[69] The Tri Borders cross-jurisdictional project between the WA, SA and NT governments, which was developed under the DER, is one example where the SIF is being used in Australia. The project, which aims to create a consistent approach to the capture of data using the SIF, enables data to be collected and tracked across jurisdictions around issues such as student attendance. Some of the benefits of this project to date include a 50 per cent saving on 'business as usual' development costs and the ability of each jurisdiction to maintain control of their student information while operating in a multi-jurisdictional system.[70]

[67] Fullan, M. (2011) 'Choosing the wrong drivers for whole system reform', *Seminar series 204, April 2011,* Centre for Strategic Direction, Melbourne.
[68] Anytime Anywhere Learning Foundation, op. cit.
[69] SIF Association (2012) *What Is SIF?*, available at http://www.sifinfo.org/au/, accessed on 24 July 2012.
[70] National Schools Interoperability Program (2012) *Tri Borders: Supporting Students in SA, NT and WA*, available at http://
http://www.sifinfo.org/upload/story/8E3BFF_SIF%20Association%20AU%20Pilot%202.1%20Tri-Borders.pdf, accessed on 23 July 2012.

Secondly, there is also general agreement that for issues such as security and privacy management, it is appropriate to have a set of standards beyond the school level. The rationale for this is that these policies benefit from a consistent approach that is widely understood. A mix of state/territory and Australian Government policies exist that relate to privacy, as an example, though there is recognition that widely applicable policies are more effective and simpler to administer.

Thirdly, procurement is another area in which some form of centralisation can work effectively. The NSSCF suggested that it is possible to achieve and exploit economies of scale through effective policy settings related to procurement. One of the potential considerations in the development of centralised procurement policy is over-specification of technology, particularly devices. This has the potential to reduce both competition and the buyer's leverage. The DER is acknowledged to have achieved reasonable buying power for States and schools, leaving device and related technology decisions to education authorities in the first instance, through to schools in some of the more devolved environments.

3. Seeking to engender collaboration across the field – amongst teachers, schools, education authorities and national teaching bodies – and systematise innovation

For decisions other than standards and procurement, stakeholders argued that preserving flexibility at the local level to interpret and customise policy was critical. An effective way of encouraging innovation is to ensure that the desired outcomes of policies are clear, without mandating overly prescriptive processes.

Implementation flexibility was also considered a pre-requisite for innovation at the school level. It was also more likely to create the conditions for improved collaboration, as leaders, teachers and administrators sought to continuously seek out best practice. Greater collaboration was identified as a valuable outcome of the DER.

A significant legacy of the DER is the cooperation that it has engendered at sector, school and teacher levels. Most notably, these include effective collaboration on digital education between State government CIOs and eLearning coordinators, principals and teachers. These collaborations have led to tangible results, including the establishment of a National Digital Learning Resources Network that enables the management and distribution of the national collection of digital curriculum resources to education authorities. It comprises systems to manage content, standards, networks and distribution infrastructure. This network is managed by Education Services Australia (ESA) and contains more than 12,000 digital curriculum resources that are free for use in all Australian schools. The resources are made available to teachers through State and Territory portals and to graduate teachers through eContent.[71] The same is true of the collaborations between State government CIOs and industry, which has led to the development of interoperability standards and agreement on their application across the government sector. Stakeholders also reported that the benefits of collaboration between principals were perhaps less tangible, but vital. Opportunities for teachers from the same key learning areas to collaborate had been particularly effective. Other collaborations were cited as providing significant value, including a number of DER Advisory Groups focused on digital infrastructure and national eLearning projects.

Collaboration has also been effective in helping education authorities drive better 'value for money' outcomes. The sharing of information about procurement outcomes under the DER – rather than the more-formal centralised procurement – had been valuable in helping smaller jurisdictions, such as the ACT, improve their purchasing power.

3.2.3 Potential future Australian priorities and directions

In thinking about future priorities and directions, it is important to bear in mind that Australia is a federated system and school education is the responsibility of States and Territories. Governance arrangements at the national level need to account for a number of complexities as outlined below.

Education policy development and implementation occur in the presence of a myriad of parties, many of whom have decision making and direction setting responsibility. The Australian education field entails complex interactions between:

- Australian Government and State and Territory governments;
- Education sectors: Catholic Education Offices, Independent Schools Associations;
- Devolved administrative bodies: Block Grant Authorities for independent and Catholic schools;[72]
- National policy and practice bodies, such as AITSL and ACARA; and

[71] Education Services Australia (2012) *National Digital Learning Resources Network*, available at http://www.ndlrn.edu.au/about/about_landing_page.html, accessed on 24 July 2012.
[72] Block Grant Authorities are responsible for administering funding to both the independent and Catholic sectors in the ACT and NT.

- Devolved delivery 'arms' within sectors, such as Catholic dioceses and regional offices in some government jurisdictions.

In the government sector, the degree of centralised policy setting and implementation varies widely from jurisdiction to jurisdiction. This manifests in a tension between the desire for control by the centre and the desire for autonomy at the school level. While most jurisdictions have moved towards more devolved governance structures, tension between centralisation and decentralisation creates issues for all parties that need to be acknowledged and managed.

Given these distinctive Australian conditions, any initiative of the scale of the DER could be expected to meet a number of potential barriers as a result of the number, and diversity, of stakeholders. The priority is on ensuring that the many benefits that have come about under the DER are effectively leveraged in furthering the digital education agenda in Australia. The priorities and directions are likely to include ensuring that:

- disadvantaged schools and families are provided with equal opportunities to high-quality education;
- collaboration continues amongst and between States and Territories, and sectors; and
- progress is maintained at a national level, and where necessary accumulates in further action.

Future priorities and directions around national governance arrangements are discussed in more detail in the concluding final section of this report.

Strong school leadership and a whole of school approach

Appropriate governance and policies in place to stimulate adoption of ICT in education at the system level	**Strong school leadership and a whole of school approach**	Infrastructure in place that is fit for purpose, flexible, supported and sustainable	Teacher professional preparation and development that supports integration of technology into education

3.2.4 The importance of school leadership and a whole of school approach

Fully utilising the educational benefits of the DER requires coordinated change on a number of fronts within each school. Significant leadership capabilities must be put in place to ensure school-wide adoption of ICT, and the realisation of its transformative educational potential in the classroom and beyond.[73] Leadership is regarded as essential to mobilising the informed support of teachers, students, support staff and parents, which in turn ensures that all key contributors to the school's success are working towards the same aims, with mutually reinforcing expectations and behaviours.

Research suggests that all members of the school community need to understand the digital education vision. Stakeholder input supports the idea that sustained change cannot be achieved if it is left only to enthusiasts, or if significant stakeholders remain sceptical or unaware of the benefits of digital education. The school community must also understand how it enhances what they individually care about – be it educational outcomes, student engagement, pedagogy in particular subject areas, reliable IT systems or classroom design.

School leadership is vital given that the school tends to make important decisions about:

- how digital technology can be used to support the educational vision of schools;
- what technologies will be adopted and how they will be integrated into the classroom, as well as for the everyday business of schools;
- how all teachers will be supported to adopt contemporary approaches to teaching and learning;
- how the whole school community, including students, support staff and parents, will be informed and assisted to become active participants in the program of change; and
- how the school will allocate resources to realise their vision.

[73] Newhouse, P. (2010) 'School leadership critical to maximising the impact of ICT on learning', in D. Gronn & G. Romeo (eds) (2010) *ACEC2010: Digital Diversity*, Conference Proceedings of the Australian Computers in Education Conference 2010, 6–9 April, Carlton, Victoria, Australian Council for Computers in Education (ACEC).

3.2.5 What works from a school leadership perspective

Evaluation of 1:1 programs in Australia and overseas, together with feedback from the stakeholder consultations, identifies several critical components of effective school leadership and a whole of school approach:

1. a personal and team leadership style that enthuses teachers to embrace technology;
2. explicitly incorporating ICT in achieving the school's educational vision and a strategic plan;
3. creating an operational plan that clearly identifies the key responsibilities and accountabilities;
4. a focus on the development of a strong school culture, which seeks to engage all staff in digital education; and
5. engaging stakeholders in the wider school community, including parents.

1. A personal and team leadership style that enthuses teachers to embrace technology

Teachers acknowledge that the school leadership team's visible leadership is critical in implementing ICT for educational gains. They identify the school's leadership and culture as the biggest determinant of teacher engagement and development. Teachers want the school leaders to 'lead', not just 'support'.[74] Leadership in this context involves several distinct dimensions (see points 2–5 below), but it needs to personally manifest in visible enthusiasm for the role that technology plays in improving student learning. Evidence suggests that the best results occur when a school leader is able to demonstrate his/her belief in the importance of ICT through their own practices.[75] The demonstrated commitment of school leaders to the use of ICT in teaching and learning, was identified as one of the single biggest factors in encouraging uptake of technology by teachers. For example, the *DER-NSW Evaluation* (2012) reported a significant difference in the use of laptops by teachers who felt that their school had a strong school leader compared to those who did not.[76]

Personal leadership styles are considered most effective when they create an environment in which teachers feel comfortable to take calculated risks and innovate, and as a result, thrive. In support of the DER, funds have been made available through the ICT Innovation Fund (ICTIF) for the project *Leading ICT Learning in Technology Enabled Schools*. This is intended to enable current and aspiring school leaders, by networking online, to lead school communities in understanding the role and potential of ICT to extend and transform the school learning environment.[77]

In some Australian jurisdictions, there are examples of moves to invest in leadership capacity, such as the Queensland Government's *eLearning Leaders Framework*, which is designed to support leaders in digital education.[78] Similar approaches have been taken overseas, including in leading Asian countries where aspiring principals complete a certification in principalship (Hong Kong) or a full-time *Leaders in Education Program* (Singapore).[79]

2. Explicitly incorporating ICT in achieving the school's educational vision and a strategic plan

It is widely agreed that the school leadership team must lead the development of an explicit learning-focused vision for ICT use. This vision should clearly support the school's particular educational mission and ensure that there is a strategic/operational plan to realise it. For example, where school students come from diverse backgrounds, greater focus may be on supporting differentiated instruction to address individual needs.[80] In general, ICT is considered most effective when it is integrated into the most important school-wide curriculum projects (for example, improving literacy or numeracy).[81]

The school-based ICT/learning strategy has to be a living document that evolves in response to a continuously changing external environment in which funding is uncertain, and technologies change rapidly. Strategic plans also need to be regularly reviewed to ensure that the investment in digital education is self-sustaining on an ongoing basis (such as plans for parent co-contributions and negotiations over eTextbooks).[82]

While it has been acknowledged that the principal's individual leadership style is critical, it is equally important that school leadership be developed beyond a single individual. Research into the successful implementation of 1:1 programs in Australia

[74] Moyle, K. (2006) *Leadership and Learning with ICT: Voices from the Profession*, Australian Institute for Teaching and School Leadership; Tearle, P. (2004) *The Implementation of ICT in UK Secondary Schools, Final Report: February 2004*, University of Exeter, The Telematics Centre.
[75] Tearle, P., ibid.; Newhouse, P., op. cit.; Lee, M. & Gaffney, M. (eds) (2008) *Leading a Digital School*, ACER Press, Melbourne.
[76] Howard, S., Thurtell, E. & Gigliotti, A. (2012) *DER-NSW Evaluation: Report on the Implications of the 2011 Data Collection*, NSW Department of Education and Communities, p. 63.
[77] Palnet, available at http://www.palnet.edu.au, accessed on 1 August 2012.
[78] Queensland Government, Department of Education, Training and Employment (2012) *eLearning Leaders Framework*, available at http://education.qld.gov.au/smartclassrooms/developing-professionals/elearning-frameworks/leaders/index.html, accessed on 25 July 2012.
[79] Jensen, B., *Catching Up*, pp. 19–22.
[80] For a highly successful example of this, see Woods, K., Griffin, P. & Care, E. (2011) *Evaluation of the Ultra Mobile Personal Optimised Devices Trial in Victorian Schools: Addendum to the Final Report*, Assessment Research Centre, University of Melbourne.
[81] ibid.; Newhouse, P., op. cit.; Greaves, T. et al., op. cit.
[82] Victorian Government, Department of Education and Early Childhood Development (2012) *eLearning ICT Showcases – Galvin Park Secondary College*, available at http://epotential.education.vic.gov.au/showcase/1to1_learning/nsscf, accessed on 9 August 2012.

suggests that the existence of a school leadership position that combines curriculum and ICT experience is effective in championing the integration of ICT into teaching.[83] This should be accompanied by the creation of a clear leadership team appropriate to the school's characteristics and level of development with ICT, including all relevant departments (such as IT, staff development, curriculum and subject coordinators, teacher-librarians and students). Some teachers interviewed suggested that as a result of the DER there is now a greater focus at the leadership level on initiatives such as up-skilling senior leadership teams so they are competent ICT users, creating ICT coordinator roles within their schools with the goal of spreading ICT across the curriculum, and establishing active ICT committees. In Hong Kong, there has been a particular focus upon the strengthening of school leadership as a critical component of the implementation process.

> *Hong Kong created new leadership positions in order to put implementation leaders into every school. In secondary schools, curriculum leaders were assigned to every key learning area … They were given extensive training on curriculum and pedagogy reform, enabling them to help other teachers to implement changes in every classroom.*[84]

Similarly, in one US school district recognised for digital education good practice, the decision to institute 'coaching staff to support technology integration in curriculum and instruction for 1:1 computing' was identified as critical.[85]

3. Creating an operational plan that clearly identifies key responsibilities and accountabilities

School leadership teams have to link the ICT vision with school-wide planning so that everyone understands their role in realising the vision and is appropriately supported. In short, the vision has to be operationalised. If school ICT managers believe that the servers, administrative ICT systems and devices are more important than support for effective use of those devices, then the educational gains of leveraging ICT may be challenged. Similarly, teachers are professionals with strong views about their autonomy and their approach to pedagogy. There are likely to be major differences in attitudes between individual teachers within the same school.

The *21 Steps to 21st-Century Learning* framework provides a well-regarded example of all the operational elements involved in implementing a successful 1:1 program. The four key phases identified include:

- planning (doing research; engaging the community; developing a communication strategy and a project plan);
- preparation (investing in teacher professional development and ensuring teachers have laptops before students; preparing physical learning spaces and selecting pedagogically appropriate software; defining essential policies);
- implementation (ordering and deployment of devices; conducting parent and community sessions); and
- review.[86]

4. A focus on the development of a strong school culture, which seeks to engage all staff in digital education

Educational leadership is more than direction setting: it is enabling a culture in which innovation, collaboration, peer-learning and risk-taking thrive. Teachers report that their contribution is 'dependent on more than developing content knowledge, pedagogical practices and skills in the use of ICT':

> *It's not enough that the teacher has a vision for effective integration of ICT across the curriculum – if her [or his] school blocks or does not share this vision, this will inhibit her [or his] growth. The 'external' environment has to explicitly articulate and action policies and practices to enable the development of technological, pedagogical content knowledge.*[87]

The most powerful pressure on teachers to exploit the potential of ICT to improve teaching and learning involves their own school's 'culture' and local expectations. Teachers change their practices most quickly and effectively through various forms of peer learning, which require school-based support to be fully effective.

The principal can increase staff engagement by encouraging them to participate in the development and evolution of both the ICT vision and the school's implementation plans, for which the whole school community should feel responsible. The use of ICT in the everyday practices of schools helps their teachers to become comfortable and confident in its use. This confidence is the baseline for use in the classroom – that is teachers will not be able to effectively use ICT in teaching and learning if the basic level of skills are not present. This does not mean that 'high-quality' practices automatically come about with familiarity; however, it is a

[83] Griffin, P. et al., *Evaluation of the Ultra Mobile*; Newhouse, P., op. cit.
[84] Jensen, B., *Catching Up*., p. 19.
[85] Greaves, T. et al., op. cit., p. 28.
[86] Anytime Anywhere Learning Foundation, op. cit.
[87] Vacirca, E. (2008) 'How do teachers develop their technological pedagogical content knowledge in the context of system-wide pedagogical and curriculum reform?', Australian Association for Research in Education Conference, Brisbane, p. 15.

necessary pre-requisite. Opportunities can be engineered to increase the use of ICT amongst teachers through planning and administrative activities, such as requiring that all school written communication occur via email. Adopting a 'no opt out' approach removes the choice of staying with inefficient or unsustainable technologies. In support of this, performance management/mentoring/staff development investment should be aligned with the ICT vision and plan.

Ensuring that teachers are fully engaged in exploiting the potential of digital technologies requires leaders to provide time for regular teacher professional learning and collaboration. This was the second-most-powerful factor identified with improved student learning by *Project RED*.[88] The allocation of teachers to small teams for structured and collaborative planning, in which student achievement data is central to the ongoing evaluation of the effectiveness of teaching approaches, has been shown to be extremely effective.[89] The process of ensuring that ICT is part of day-to-day business also extends to the induction of new staff. Best practice suggests that induction formally embraces the school policy on ICT and its relationship to pedagogy. This is particularly important in schools with a high staff turnover, as well as for accommodating temporary staff. An effective induction process with an ICT focus ensures that temporary and new staff members are sufficiently helped to adopt local technologies and use them in alignment with the school's mission and plan.

5. Engaging stakeholders in the wider school community, including parents

Implementing a 1:1 computing program involves adopting a new approach to teaching and learning, which may challenge the beliefs of some education stakeholders, including parents. For example, some parents reported being strong supporters of digital education while others remained disengaged or even sceptical of its potential to enhance their children's learning outcomes. Parents are an integral component of a whole of school approach, and they need to be engaged in the learning process and supported in developing their understanding of the potential that ICT offers in enhancing student outcomes. Some parents indicated that their current lack of awareness and understanding of how ICT is used in learning could leave them feeling quite negative and dismissive of the ways in which online resources can improve student engagement and outcomes. The Australian Parents Council felt that the DER had not delivered on its potential to increase parental engagement and that the opportunity to use ICT to improve parental engagement had not been fully exploited. In addition, some parents also hold the belief that their children will use their devices for purposes that are not traditionally educational, meaning that they may become distracted from learning, and also potentially isolated from the family unit. Better communication of the potential benefits of using technology, such as gaming, in the classroom may help to address some of these concerns.

Best practice' suggests that parents should be involved at a very early stage in school-level planning, and understand the potential that it offers to enhance learning, both inside and outside of the classroom. They should also be encouraged to develop a sense of ownership and responsibility for their child's education. This requires an effective multi-strand communication strategy.[90] As part of the NSW DER rollout of netbooks across secondary schools, a Laptop User Charter was developed, requiring all parents to attend a briefing session and sign the charter prior to students receiving a netbook. This process was effective in getting parents to take responsibility and ownership for the devices, whilst also providing an opportunity for parents to communicate with principals about the use of ICT. Some parents consulted as part of this review also commented that a school's overall attitude towards technology sets the tone for how well parents perceive technology is being used in the classroom. Online reports for parents, regular email correspondence and remote access to the school's portal are interpreted by parents to indicate that technology will also be used productively in the classroom.

3.2.6 Potential future Australian priorities and directions

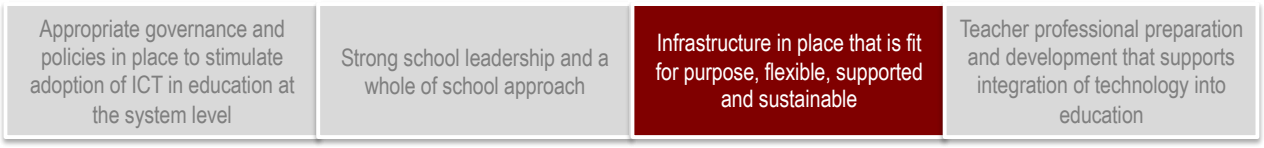
While there is general agreement about the importance of school leadership and a whole of school approach to achieve the full benefits of the DER, there is no simple or consistent formula to follow. It is inevitable that individual schools are at very different stages of development in their capacity to implement the strategies that are known to work, and will have different priorities as a result of the characteristics and needs of their student body. The pace and sequencing of the development of these capabilities and resources will vary depending on the history and scale of individual schools. Future Australian arrangements must be sensitive to this.

A minority of schools have not fully engaged with the ambitions and goals for the DER. For some of these, other strategies to improve student engagement and learning have been given priority. For others, the lack of engagement reflects a lack of confidence and knowledge, or for some small schools, a lack of resources to invest in ongoing digital devices and support. Stakeholders commented on the challenges faced by a minor proportion of small and less well-resourced schools in achieving a sustainable approach to digital teaching and learning. These challenges may continue to increase with the pace of technological change, particularly when it comes to overcoming the technical challenges associated with embracing non-approved devices at school, which some are considering.

[88] Greaves, T. et al., op. cit.
[89] Woods, K. et al., op. cit.; Jensen, B., *Catching Up*.
[90] Anytime Anywhere Learning Foundation, op. cit., p. 5.

At a time when some jurisdictions are finding it difficult to fill vacant principal positions, it is important to think about how principals can be continuously developed and supported in achieving this.

Infrastructure in place that is fit for purpose, flexible, supported and sustainable



3.2.7 The importance of good practice in infrastructure

The major funding components of the DER related to the purchase of infrastructure and peripherals: devices, school-based networking equipment and software. Physical infrastructure is a critical component of the digital education policy response, and it is clear from the DER and other major investments by States/Territories, sectors and schools that the type and quality of infrastructure deployed is crucial. The infrastructure needs to be fit for purpose, flexible, supported and sustainable. Given the sums of money involved in digital education technology – for example, it is estimated that State and Territory governments and schools from other sectors spend up to $1 billion on technology annually – poor decisions will incur significant costs, both in a financial and educational sense.

3.2.8 What works in terms of fit for purpose, flexible, supported and sustainable infrastructure

There are clear learnings from research and stakeholders in regard to good practice in infrastructure provision. These include:

1. ensuring that selection and design of the physical infrastructure, including broadband connectivity, devices, school-based infrastructure and software, is based on the unique requirements of learners and the school environment;
2. setting device access and proper-use policies at the school level;
3. providing for infrastructure support/maintenance at the outset; and
4. considering a range of infrastructure sustainability and funding strategies.

1. Ensuring that selection and design of the physical infrastructure, including broadband connectivity, devices, school-based infrastructure and software, is based on the unique requirements of learners and the school environment

Understanding context is critical in identifying what represents the 'fit for purpose' infrastructure. This is particularly true of device selection, where the characteristics and functions of various technology have a direct impact on the extent to which they can be used for educational purposes. While views differ on the merits of specific devices, there was a consistent view expressed that some devices work better in particular contexts.

The use of digital technologies in education is considered to take two forms: content use and content creation. Content use can involve interaction with content such as learning objects, while content creation allows for information to be generated or modified. It is generally agreed that a full-size keyboard and easily manipulable applications are highly desirable for content creation, and therefore often more appropriate in the middle years of schooling. More intuitive, touch-based tablets and devices with no or smaller keyboards are considered more appropriate and effective for the early years of schooling and for students with disabilities, where content creation is more limited and interaction with the device is more intuitive. Some schools argued that tablets can be highly effective as a complementary tool to a laptop during the final two years of schooling.

The consumption of digital resources continues to increase substantially, with implications for bandwidth and broadband infrastructure. South Korea's ubiquitous high-speed broadband is seen to have been an important pre-condition to its digital education investments, and best results from a connectivity perspective in Australia are ascribed to the majority of Australian government schools which now have fibre connectivity. In the Catholic sector, some dioceses have negotiated similar fibre connectivity, while the decentralised procurement in independent schools has created a patchy connectivity picture, with generally lower rates of fibre availability. In short, fibre-to-the-premise connectivity remains best practice.

Fit for purpose, school-based infrastructure to support digital education is also important, including wireless networks, storage and server infrastructure. The planning and design of wireless networks needs to reflect the current and future usage profile of the networks and how/where networks are accessed, and should be customised for the school environment. The DER facilitated significant investments in school-based infrastructure to support wireless access. As wireless is a 'contested' infrastructure, where the number of users on a network has a direct impact on the quality of the service, the capacity to scale networks to meet increasing demands is critical. Schools observed that one of the great achievements of the DER was the creation of 'enterprise grade', scalable and secure wireless networks.

The enterprise grade argument was not universally true for software applications. Like the devices, the most effective software infrastructure should also be fit for purpose. In some cases, the software procured by schools under the DER was regarded as too sophisticated for its intended purpose. For example, some applications were difficult to use and more intuitive consumer tools would have been more effective. There is also broad agreement that the most effective software and applications should support an individual's learning style, particularly for students at risk of disengaging from education.

Many stakeholders held strong views about restricting the types of devices allowed in the school environment, with a number of schools insisting that students bring an approved device. The reasons for selecting an approved device include the lower costs for schools and jurisdictions around supporting one type of device, simplification of the classroom instruction task for teachers, and equity issues. On the subject of equity, it was suggested that competition had begun to emerge in schools between students trying to outdo each other with ever more powerful, sophisticated and in-demand mobile devices. By mandating a single standard device, there was lower potential for students to be alienated from their peers because of the device they owned, an increasing likelihood given the status implications of consumer electronics.

2. Setting device access and proper-use policies at the school level

Schools are responsible for developing a range of policies that have the potential to improve or impede a student's experience with digital technology. One of the major decisions required under the DER initiative was whether schools should allow devices to be taken home by students. Schools and education authorities had mixed policies on this for the following reasons:

- cost – in a number of schools, students were not provided with a dedicated device 24 hours a day, seven days a week, though all students had access to a device when required for learning;
- risk management – by taking the device home, the risk of loss, theft and damage increases;
- fears of overuse and/or misuse – some parents and teachers expressed concerns that take-home devices prevented students from disconnecting from their devices at the expense of other forms of interaction and learning; and
- cultural factors – in some Aboriginal and Torres Strait Islander communities, taking a device home resulted in it automatically becoming a community resource, and in these circumstances this was not considered appropriate. This was counter-balanced by views that Aboriginal and Torres Strait Islander students benefited more than most from take-home devices given a proportionally lower presence of at home devices.

Most stakeholders, particularly those with experience in digital education at the school level, argued there are significant benefits associated with students taking home devices. These include helping to foster greater use and care of the devices by students. The main argument is that a large proportion of the education process takes place outside of the school, and that access to a device after-hours enables the learning to continue. For example, All Hallows' School in Queensland conducts an annual survey of its students to gain a better understanding of the usage profile of students' devices. The *2011 Blended Learning – Netbook Report*[91] found that the amount of time students spend on the DER-funded devices is increasing. In 2009, 14.5 per cent of students used their netbook at home for more than three hours per day. This increased to 22 per cent of students in 2011. While some of this time was spent on social activities (32 per cent of students indicated they were using their netbooks after-hours to access YouTube), most students (87 per cent) indicated that they were using the device primarily for homework and assignments.[92] While this survey was only of a small portion of students, these results indicate that there are noticeable education benefits to providing students with portable devices that they can take home. The results also show that usage of the netbooks at school and at home, as well as usage of related technology such as wireless printing, have increased over time.

Policies governing the type of content that can be accessed are constantly evolving. There are two basic policy approaches that can be adopted to address this issue: technical and behavioural. The technical policy response involves the use of filters to prevent malicious use and access to sites deemed inappropriate. These mechanisms can be installed at the application or network layer

91 This report is based on the 2011 survey, whereby there were 439 student respondents.

92 All Hallows' School, op. cit.

and are commonplace. The network interventions are only possible where the school controls the network environment – such as the school wireless infrastructure – leaving devices accessed via the public mobile networks more difficult to control.

The other policy approach, the behavioural response, seeks to treat malicious or inappropriate uses. In this case, schools may not physically restrict access but rely on education through digital citizenship programs to promote student responsibility. For example, the NSW DER *Digital Citizenship* program provides students, teachers and parents with information about digital citizenship and being safe, positive and responsible online. One of the advantages of this approach is that schools can avoid the cost of constant refreshing of filtering tools.

It is likely that, as some stakeholders suggested, 'pure' interventions, either technical or behavioural, would alone be insufficient and that rather a hybrid policy response deployed in light of the specific context, will have the greatest effectiveness.

3. Providing for infrastructure support/maintenance at the outset

Infrastructure investment brings with it a significant maintenance and support burden. Education authorities and schools have made large investments in technical support staff as a result of the NSSCF, with many suggesting the DER had forced them to elevate the support function from a teacher's 'extra duty' to a technician's full-time job. During the period of the NSSCF, on-cost funding was provided to schools to support the deployment of devices. If schools choose to maintain 1:1 after the DER initiative, they may face challenges in financing infrastructure support. There is strong agreement that operational expenditure needs to be budgeted years in advance. Stakeholders and experience suggests that the most important success factors in terms of support arrangements are when:

- the support budget is reserved/budgeted for years in advance and calculated reasonably precisely; and
- dedicated ICT support staff are accessible at the school site – the presence of school-based ICT support staff was considered crucial to the effective integration of digital technologies into the school environment.

4. Considering a range of infrastructure sustainability and funding strategies

Infrastructure sustainability is the subject of significant research and discussion globally. While a number of stakeholders indicated they expected ongoing contributions from government for devices and other technology, many schools have started seeking contributions from parents to cover some/all of the cost of devices and meet the ongoing cost of providing a contemporary learning environment. There are various models for collecting contributions.

- Purchasing via the school, where parents are asked to purchase the device through the school's selected provider. This approach has a number of advantages, including that the school is often able to negotiate a better price than is available at consumer retail outlets. As well as a more appropriate warranty (for example, three years rather than one year), school-procured devices often come with more favourable service-level agreements to cover replacement and repair.
- Charging of ICT levies to cover the cost of devices and other infrastructure and maintenance. This approach is considered highly effective in part because it enables schools to offset the total cost of infrastructure, not just the device. Technology levies are generally higher than the device purchase price and there were reports of parents being dissatisfied that their contribution for a student device was significantly higher than the price charged for the device at a consumer retailer.
- Requiring parents to purchase (usually approved) devices via consumer channels. This approach was used in the United Kingdom, where credits were provided to low SES parents for redemption at consumer technology retailers. The advantage of such an approach includes releasing schools from the support burden, as parents assume responsibility for breakages and servicing claims. However, it has the disadvantage of leaving students without a device for long periods of time under consumer service-level agreements.

One example of emerging practice in this area is the Broadmeadows School Regeneration Project in Victoria. The project was established to determine whether a 'redesign' of the local school system could improve the literacy and numeracy outcomes of students. The project involves 17 schools (both primary and secondary) across the northern suburbs of Melbourne who committed to 1:1 computing programs. Schools have adopted a parental co-contribution model, which has gained high levels of support from parents and a universal compliance rate, including from those schools ranked in the lowest 15 per cent of the SES band. Parental co-contributions were considered to work effectively when paid in instalments (term-based rather than up-front payments). Schools participating in the project also leveraged the existence of an Educational Maintenance Allowance, which provides funding to low SES parents and schools.

Schools not only used the allowance to cover part of their contributions, but also drew parents' attention to the existence of the scheme in convincing them to co-contribute. There was a strong belief from those involved in the program that parental co-contributions, together with access to computer devices, are a necessary cost of education in contemporary society. Parental co-contribution was considered to work equally effectively for primary and secondary school environments, although there have been some issues with parental resistance to take-home devices in primary schools. The level of contribution is an important consideration for low SES cohorts, as is the instalment plan. In Broadmeadows, the cost of their contribution was communicated to them in terms of the number of cups of coffee per week, to provide perspective on the relatively small cost of the device compared with its high value.[93]

3.2.9 Potential future Australian priorities and directions

The most frequently cited issues associated with infrastructure relate to cost and affordability. The sustainability of devices has not been universally planned for, and is a subject of concern for some schools. Schools that are determined to maintain the 1:1 computer to student ratio beyond the DER are contemplating a range of strategies, all with their own challenges. These include:

- bring your own device (BYOD) models where students are permitted to bring any technology to school to be used as a learning tool, including mobile phones, laptops, netbooks and tablets;
- approved BYOD devices; and
- parental co-contribution towards devices, including flexible payment terms – for example, leased computers and smaller, frequent instalments.

The concepts of BYOD and parental co-contribution are often used interchangeably, but there are particular differences between the two. BYOD tends to imply that any available technology can be brought to school. Strictly speaking, BYOD refers to a policy instituted in workplaces or institutions where a device is provided by the employee/student rather than the institution. Specifically, BYOD implies that:

- any Internet capable device is permitted – including laptop, netbook, tablet or smart phone; and
- the device is purchased by the user outside of any workplace/institution procurement arrangements.

There are a number of variations beyond these two basic features, including whether maintenance and support is provided by the user or the institution. In a DER context there was strong opposition, particularly from those with deep experience in 1:1, to move to a full BYOD policy as outlined above. The preference for schools was to adopt the parental co-contribution approach in which schools approved certain device/devices, and the schools procured these devices on behalf of parents. The reasons for this include:

- not all devices support legacy applications (including student management systems) that operate in K-12 environments;
- software licences can be more easily negotiated;
- security is more difficult to achieve for a range of devices; and
- there is added complexity for teachers in managing a classroom with a range of technologies.

Schools considering co-contribution beyond the DER suggested the payment schedule also needed to be carefully considered, with more frequent, smaller instalments appropriate for parents from low SES backgrounds. Some argue that co-contribution should not be mandatory, in part because it is difficult to enforce. This means that schools/sectors must consider how to provide access to devices to those who opt out of the co-contribution model, in recognition of the fact that technology is now a core learning and teaching tool. Decisions about which devices to approve or recommend are also complex. A range of considerations need to be taken into account, including the:

- intended purpose, specifically whether they are used for content creation or consumption;
- price; including both initial cost and total cost of ownership;

[93] Cisco (2010) *Genuine Transformation in K-12*, available at http://www.cisco.com/web/strategy/docs/education/broadmeadow_cs.pdf, accessed on 2 August 2012.

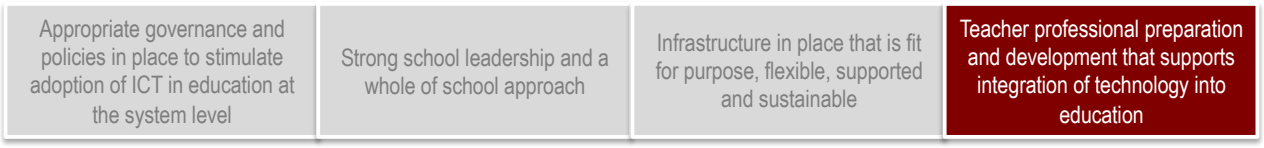
- robustness of the device, including the warranty arrangements in place; and
- compatibility with legacy applications such as existing student management systems, which need to be accessible.

The sustainability of school-based technology infrastructure – including the enterprise-grade networks at the school level – is generally considered to be a potentially greater challenge than device sustainability. This is due both to the quantum of investment required for major wireless upgrades and the fact that it is more difficult to secure co-contributions from parents for network infrastructure than devices. It is believed that this is at least in part because a parent feels that this device is a tangible thing, meaning that they are able to clearly see the 'fruits' of their investment. Continued education around the importance of devices, as well as the required supporting infrastructure is a way of potentially addressing this issue.

The pace of technology change, and increasingly rich content, is placing significant demand on school networks from a scalability perspective and brings with it significant costs. Though government departments retain control of school-based infrastructure in the public sector, there is still a risk that this will not keep pace with the changing usage. This risk is particularly notable in the current fiscal environment. The challenge is acute in primary schools, which have not benefited directly from the major funding injection provided under the NSSCF, but where technology is increasingly being relied upon for educational purposes. The same is true of broadband connectivity, which continues to impede some schools' ability to extract the benefits from investments in devices, school infrastructure, policies, content and teacher capability.

The ongoing funding of school-based support and maintenance requirements was also an issue for some, particularly where government does not provide these resources. NSW schools that participated in the DER reported the dual challenges of an increase in the demand for dedicated ICT support coupled with a shortage of willing, qualified and affordable ICT support staff.

Teacher professional preparation and development that supports integration of technology into education



3.2.10 The importance of teacher preparation and professional development

Designing educational experiences that take advantage of the potential of digital technologies hinges on the professional skills, knowledge and confidence of teachers. Many observers of the DER have commented that digital technologies are leading to radical changes in the role of the teacher, including the fact that they are 'grappling with new professional identities'.[94]

According to research, the most significant single factor affecting student outcomes is not class size, nor financial resources or technology itself; it is teacher capability and its long-term development.[95] There are over 250,000 secondary school teachers in Australia, with the average age of secondary teachers being 45.[96] Presumably, many of these teachers would have been initially trained in the 1980s, when contemporary technologies, such as computers, were in their early developmental stages. A large-scale survey of NSW teachers found that, at the beginning of the DER in NSW, *'teachers generally indicated that they did not feel confident using the laptops and they might need focused time simply gaining a "feel" for technology integration, pedagogical knowledge and related teaching strategies*'.[97] The DER has increased teacher knowledge of and confidence in the use of digital technologies, but a significant proportion of teachers work in schools where their principals believe 'a lack of pedagogical preparation … hinders instruction in their school "a lot" or "to some extent"'.[98] The OECD survey *Creating Effective Teaching and Learning Environments: First Results from TALIS* reveals 'that teacher evaluation and development in Australia is poor and amongst the worst in the developed world'.[99] Improving the quality of teachers and teaching should therefore be a central goal of educational policy.

The changes in what teachers need to be able to do are significant and complex. This is because of changes in the way learning can occur, and also because of the kinds of capabilities students need to develop to succeed in the knowledge economy of the 21st-century.

[94] Vacirca, E., op. cit., p. 17.
[95] Jensen, B., *Investing in our teachers.*
[96] McKenzie, P. (2012) 'Painting a picture of the teaching workforce', *Research Developments, Vol. 27 (2012)*, pp. 2–5, available at http://research.acer.edu.au/cgi/viewcontent.cgi?article=1099&context=resdev, accessed on 3 August 2012.
[97] Howard, S. & Carceller, C. (2010) *DER-NSW Evaluation: Phase 1 – Before the Laptop Rollout*, NSW Department of Education and Training, p. 91.
[98] Jensen, B. (2010) *What Teachers Want: Better Teacher Management*, Grattan Institute, Melbourne, p. 21.
[99] ibid., p. 3.

Stakeholders suggested that teachers need to ensure that they are confident users of educational technologies and familiar with the constantly evolving digital resources available to them and their students. Properly prepared teachers will understand how and where the use of digital technologies can radically improve learning. Not only can they then take advantage of the unique characteristics of these technologies to teach content, but also the opportunity created for students to develop key 21st-century capabilities. These include the ability to work collaboratively and solve problems – capabilities that involve both cognitive and collaborative skills[100], and which allow students to become successful learners, confident and creative individuals, and active and informed citizens.[101] At the same time, the potential for teachers to focus on individual student development and a more personalised approach to learning is greatly enhanced. This includes working in ways which support student learning 'anywhere, anytime', not just in the classroom during school hours.

> *Laptop programs provide opportunities to promote student autonomy, enabling students to work quickly and independently … Students can work at their own pace and devise their own search strategies. The 1:1 laptop program can change the practice of teachers, changing the way they organise classroom activities. Teachers rely less on textbooks and many say they are better able to meet the needs of students that are struggling and those that are gifted.*[102]

Teachers who do not feel confident about these changes will be unable to exploit the full benefits of digital technologies, and at best may use them to support traditional practices such as getting students to take notes on their computers rather than relying on handwriting. These changes bring with them other widely acknowledged variations to the role of the teacher in the contemporary classroom. The potential shift in the balance of power or control in the classroom empowers students to become more autonomous and self-directed in their learning, with research reporting that this can lead to enhanced student outcomes. In this kind of environment, the role of the teacher also shifts from one of transmitter of information to more of a 'facilitator' of learning.

While many teachers welcome this transformation and the enhancements it can bring to the learning environment, other teachers are more sensitive to change. Some principals consulted as part of this review felt that teachers see ICT as a threat, or that they fear losing control of their classroom. This concern may be about the impact of technology in education in general, as opposed to the DER, however it has certainly been influenced by the DER and 1:1 access to devices. A number of students reported that some of their teachers lacked the understanding and skills to use ICT, which resulted in those teachers developing mistrust for the devices.

> *If teachers don't know it [technology] then they don't trust it because they don't understand it.*

Given the significant changes that technological advancements and the DER are bringing to the work that teachers do in schools, it is not surprising that this review found widespread agreement that a strong focus on teacher development represents best practice. This is supported by evidence from those countries/cities whose students show the highest ability to apply academic skills in real-world situations. Teacher training and ongoing professional development in Finland, Singapore and Shanghai, for example, is extremely rigorous and demanding.[103] In Singapore, the National Institute of Education is responsible for all teacher education, with a strong focus on discipline knowledge combined with an equally strong focus on practical teaching skills. Teachers are recruited and paid as civil servants during their initial teacher education. Potential leaders are identified through extensive interviews and reviews to assess their leadership capabilities before they are admitted to a six-month, full-time *Leaders in Education* program. Potential leaders and principals are rotated to different positions and schools to build experience and maximise impact. In Shanghai, teaching is seen as a research-oriented profession, and teachers are expected to publish research papers on pedagogy.[104] In Finland, teaching is a Masters level qualification.

In Australia, a major national survey of attitudes to professional development found that only 57.4 per cent of secondary teachers gave a very high priority to professional development in their work (compared to almost 70 per cent of primary teachers).[105] Teaching in Australia needs to be able to attract high-quality students who will go on to see themselves as engaged in lifelong individual and collaborative research on their practices and how they increase learning.

3.2.11 What works in effectively preparing and developing teachers to support ICT integration into education

Creating the opportunities and incentives to ensure that all teachers, including participants in initial teacher education, are equipped to exploit the full benefits of digital technology in Australian schools is a large and complex undertaking. It involves the

[100] Griffin, P., McGaw, B. & Care, E. (eds) (2012) *Assessment and Teaching of 21st Century Skills*, Springer, Dordrecht.
[101] Ministerial Council on Education, Employment, Training and Youth Affairs (2008), op. cit.
[102] NSW Department of Education and Training (2009) *One to One Computing: Literature Review*, p. 6.
[103] Jensen, B., *Catching Up*.
[104] ibid.
[105] Doecke, B., Parr, G. & North, S. (2008) *Report of the National Mapping of Teacher Professional Learning in Australia Project*, DEEWR, Canberra.

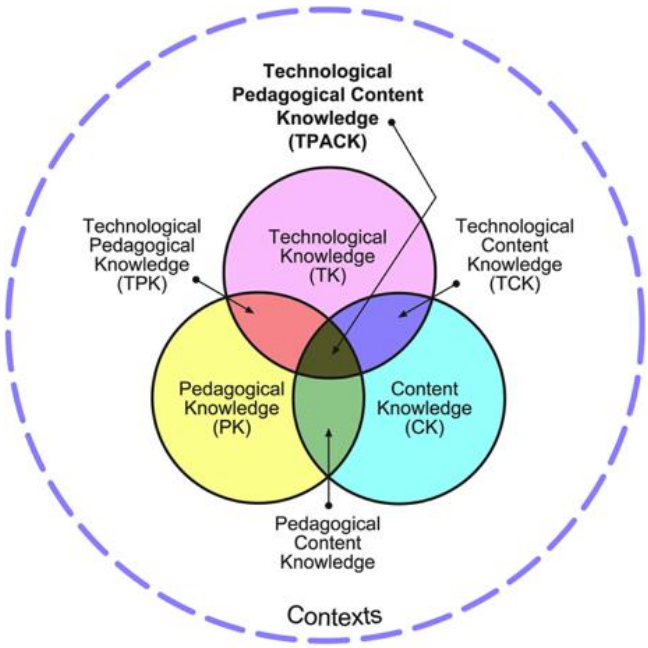
development of a widely shared view of what teachers need to know, particularly regarding what constitutes excellent teaching practice in a digital world. It also involves developing a range of strategies to ensure that teachers at different levels, in different jurisdictions, teaching different subjects, are all exposed to professional learning which persuades them that they should change their collective practice in ways which will improve educational outcomes for their students. The following critical success factors are supported by the research and stakeholder views:

1. integrating content, pedagogy and technology;
2. integrating ICT into initial teacher education as opposed to being offered as a skills-based 'bolt-on';
3. developing on-site, context-specific, regular, peer-mediated opportunities for professional learning; and
4. developing professional networks, both within and beyond the school.

1. Integrating content, pedagogy and technology

There are several ways in which Australian teachers learn the practice of their profession and continue to develop their knowledge and skills during their career. This necessarily includes deep knowledge of their subject matter, but also pedagogical content knowledge (PCK) – knowledge of the pedagogy that is necessary for that subject to be successfully taught (in contrast to general pedagogical knowledge).[106] Mishra and Koehler (2006) added technology to the elements of professional knowledge needed for teachers, designing a model they call 'technological pedagogical content knowledge' (TPACK).[107] The framework (see Figure 3-2) describes the relationship of the three key components: content, pedagogy and technology. It draws attention not only to the separate kinds of knowledge needed, but equally importantly, to the areas of intersection – and in particular to the way all three come together. In other words, 21st-century teachers need to engage in lifelong learning in all three domains and their intersections in order to 'take advantage of the unique features of technology to teach content in ways they otherwise could not'.[108]

FIGURE 3-2: TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE (TPACK)



Source: Mishra & Koehler (2006)

Given the existing wide variety in experience, school culture and subject areas, professional learning needs to occur on many different levels. It was suggested that teachers commonly start by adapting traditional teaching strategies rather than embracing student-centred, project-based learning environments, and that often teachers progress through stages in integrating technology into teaching and learning, resulting in teachers being at many different points of development.[109]

[106] Schulman, L. (1987) 'Knowledge and teaching: foundations of the new reform', *Harvard Educational Review*, 57 (1), pp. 1–22.
[107] Mishra, P. & Koehler, M.J. (2006) 'Technological pedagogical content knowledge: a framework for teacher knowledge', *Teachers College Record*, 108 (6), pp. 1017–54.
[108] Vacirca, E., op. cit., p. 3.
[109] NSW Department of Education and Training, *One to one computing*, p. 17.

2. Integrating ICT into initial teacher education as opposed to being offered as a skills-based 'bolt-on'

Many stakeholders commented on the need for initial teacher preparation to focus on systematically integrating ICT into teaching and learning. Some concern was expressed that this ICT competency in teaching can operate in isolation from pedagogy, or as a 'bolt on'. To be effective, it needs to be integrated into all aspects of learning, 'acknowledging that pedagogy is transformed by technology'.[110]

In particular, the potential for digital technology to support personalised learning requires teachers to have technical skills in educational measurement to underpin the effective use of assessment.

> *Teachers need the data to make decisions about appropriate intervention, and they need the skills to interpret the implications of the data if they are to assist students to develop expertise in twenty-first century skills.*[111]

The recently completed *Teaching Teachers for the Future* project represents a unique collaboration between all faculties/schools of education in Australia to embed ICT capabilities in the National Professional Standards for Graduate Teachers. This project included the development of a suite of high-quality resources to support the adoption of these standards, developed by the Australia Council for Computers in Education (ACEC) and ESA.[112] Evaluations of teacher professional development for schools reveal that effective partnerships with education faculties and schools is critical so that graduates can move easily into schools and continue to practise their digital skills.

3. Developing on-site, context-specific, regular, peer-mediated opportunities for professional learning

While initial teacher education is a vital cornerstone of the future, new teachers make up only a relatively small proportion of the total profession. In addition, graduating teachers gain employment in particular schools that have their own culture and way of doing things. This can be a more powerful influence on the practices of new teachers than their formal training.

Stakeholder feedback and research on effective professional learning to support the integration of ICT into teaching and learning is consistent about what works at both the individual and school level. It suggests that one-off sessions or curriculum days led by external experts are relatively ineffective. Sustained professional learning was recommended as best practice, with the objective that '*teachers should come to believe in continuously monitoring their teaching in collegiate settings, learning from their work (situated learning), and using data effectively to look at student learning*'.[113]

It is the support and training that is offered in the teacher's classroom that has been found to be the most effective, with this approach needing to ensure that it is relatively short and frequent, using peers and experts.[114] A major review of Australian teacher professional learning concluded:

> *There is growing recognition at the level of policy, systems, and school practices, of the value of on-site professional learning mediated by critical friends rather than knowledge or expertise 'acquired' from outsiders, and of sustained (ongoing or continual) professional learning as opposed to one-off professional development sessions or events.*[115]

Another major research project on effective ICT implementation concluded that leaders should provide time for teacher professional learning and collaboration at least monthly.[116] They can also identify and encourage champions who will promote ICT integration into teaching and learning, and support the development of their colleagues' skills and confidence.

Professional learning opportunities need to be tailored to the individual teacher's knowledge and are considered most effective when embedded in particular subject areas. Key Learning Areas (KLAs) are a strong indicator of the use of technology. It has been stated that in 'secondary school, the curriculum and teaching strategies of KLAs have a significant impact on the use of technology', with teachers in different KLAs having 'different beliefs about technology and their teaching', and research also suggests that 'teachers maintain consistent pedagogical views about their subject area, regardless of changes in ICT'.[117] Peer learning within, and between schools, using teacher 'buddy' or mentoring systems, has been found to have the potential to be very effective. A major literature review undertaken by the NSW Department of Education and Training concluded:

> *Ongoing, hands-on professional learning where teachers learn applications in the context of an actual project is very effective – teachers also need a problem-based, authentic task of real-world significance to aid their learning.*[118]

[110] Vacirca, E., op. cit., p.17.
[111] Griffin, P. et al., *Assessment and teaching*, p. 10.
[112] Education Services Australia (2012) *Teaching Teachers for the Future*, available at http://www.ttf.edu.au, accessed on 24 July 2012.
[113] Woods, K. et al., op. cit.
[114] Howard, S., Thurtell, E. & Gigliotti, A. (2012) *DER-NSW Evaluation: Report on the Implications of the 2011 Data Collection*, NSW Department of Education and Communities.
[115] Doecke, B. et al., op. cit.
[116] This is the second most important factor in successful ICT implementation according to *Project RED*; Greaves, T. et al., op. cit.
[117] Howard, S., Thurtell, E. & Gigliotti, A. (2012) *DER-NSW Evaluation: Report on the Implications of the 2011 Data Collection*, NSW Department of Education and Communities.
[118] NSW Department of Education and Training (2009) *One to One Computing: Literature Review*, p. 18.

These conclusions are borne out in the case-study research into the impact of the DER in NSW. At 'Coastal High School', teachers felt very strongly supported by the school leadership in the laptop program. By 2011, the teachers at the school 'were starting to want more from their professional development opportunities. They wanted to focus on learning pedagogy and creating resources, instead of being at introductory levels of learning how to use a program'.

> *I find there's lots of different things you can be trained on how to do with the laptops, that if anything's lacking for me, I felt that it's been the embedded time to go and make resources from that. So you've taught me this tool in an hour and I can see great possibilities for it but I feel like I need another six hours to really become a bit competent and develop some resources that might be useful in my class.*[119]

4. Developing professional networks within and beyond the school

Participation in professional networks and communities of practice, including social networking, is an effective form of professional development for teachers. A number of stakeholders spoke highly of the *TeachMeets* initiative – 'meeting/un-conferences where teachers share good practice, practical ideas and personal insights into teaching with technology'.[120] Stakeholders also noted that learning communities were operating at the national and grass-roots levels.

Individual States in Australia have invested in developing the digital skills of their teacher workforces in ways that are highly regarded, and have created committees of passionate teachers who can advise on curriculum and ICT policy and practice at the Educational Authority level. One example of this type of approach is the Queensland Government's ICT Learning Innovation Centre. As part of the DER, ESA has been funded through the ICTIF to develop the ICT in *Everyday Learning: Teacher Online Toolkit*.[121] This initiative will assist teachers to access online professional learning with local support to analyse, plan and implement changes to their teaching approaches and to access quality online resources. Similarly, ICTIF has funded the development of *PLANE – Pathways for Learning Anywhere Anytime: a Network for Educators* for both graduate and in-service teachers in which they can develop their skills, connect with others, and take part in formal structured learning or informal learning.[122] It is also agreed that teachers are more likely to take advantage of these professional learning opportunities when there is pressure from peers and students as well as local leadership.

3.2.12 Potential future Australian priorities and directions

The sheer number of schools and their different histories, profiles and leadership capacities mean that system-wide engagement and commitment to good practice in teacher professional development is difficult to achieve. Maintaining momentum across the country when relying primarily on distributed leadership models of enthusiasts, mentors, subject area specialists, one-on-one tailored support and so on is far from easy. Yet, perhaps counter-intuitively, teachers suggest that a lack of formality and reliance on peers and self-direction could be an even more effective way of learning how to leverage ICT in education.

Many stakeholders interviewed as part of this review expressed concern about the quality of initial teacher education in Australia and its capacity to prepare graduates for the digital world of teaching and learning. There has been much media commentary about the relatively low Australian Tertiary Admission Rank (ATAR) scores required for entry into many university teacher training programs. In 2012, more than 20 per cent of entrants to undergraduate programs in NSW had ATAR scores below 60, and education was the least popular course for students with ATARs above 90.[123] A recently released discussion paper commissioned by the NSW Minister for Education articulates many of the concerns that exist about the quality of teacher preparation in Australia generally. It acknowledges the significance of OECD research that ranks Australia comparatively lower than other jurisdictions in terms of teacher preparation[124], and goes on to pose a number of provocative questions about how teacher quality might be improved. These include restricting the over-supply of teachers, raising the entry requirements for initial teacher education, regulating the quality of practicum supervision in schools, the removal of poorly performing teachers, and increasing financial rewards for the highest level of accreditation for teachers.

While the discussion paper acknowledges recent policy developments designed to improve teacher quality, including the new Australian Teacher Performance Development Framework to be introduced from 2013, it suggests the need for a more radical review of teacher initial education. In Victoria, a discussion paper with similar propositions, *New Directions for School Leadership and the Teaching Profession*, has recently been released.[125]

[119] Howard, S., Thurtell, E. & Gigliotti, A. (2012) *DER-NSW Evaluation: Report on the Implications of the 2011 Data Collection*, NSW Department of Education and Communities, p. 97.
[120] TeachMeet Australia (2012) available at http://www.teachmeet.net, accessed on 26 July 2012.
[121] Education Services Australia (2012) *ICT in Everyday Learning – Teacher Online Toolkit*, available at http://www.esa.edu.au/projects/ict-everyday-learning-teacher-online-toolkit, accessed on 26 July 2012.
[122] Pathways for Learning, Anywhere, Anytime – a Network for Educators, available at http://www.plane.edu.au, accessed on 26 July 2012.
[123] NSW Department of Education and Communities (2012) *Great Teaching, Inspired Learning – Discussion Paper*, available at http://www.schools.nsw.edu.au/media/downloads/news/greatteaching/gtil.pdf, accessed on 1 August 2012.
[124] OECD (2011) *Teachers Matter: Attracting, Developing and Retaining Effective Teachers – Pointers for Policy Development*, OECD Publishing, Paris.
[125] Department of Education and Early Childhood Development (2012) *New Directions for School Leadership and the Teaching Profession: Discussion Paper, June 2012*, available at http://www.eduweb.vic.gov.au/edulibrary/public/commrel/about/teachingprofession.pdf, accessed on 3 August 2012.

While there is considerable agreement about the characteristics of effective in-service professional learning, many believe that this is seriously compromised by inadequate approaches to performance evaluation, together with the absence of rewards for high performance or penalties for low performance. In 2008, Australian teachers in the OECD *Teaching and Learning International Survey* (TALIS) reported that many do not receive regular feedback on their classroom practice. Further, of those that do, nearly half report that it is largely an administrative exercise with little impact on their practice.

Nonetheless, whatever national or wider levers for change exist, their value will ultimately depend on the local context, defined by school leadership and school culture. Measures to increase the quality and effectiveness of individual professional development cannot be separated from measures to develop school leadership capacity.

It is not difficult to articulate the significance of the digital revolution for school education, both in preparing students for the 21st-century and in transforming how they learn the capabilities they will need. But at the school level there are many competing priorities, shaped by local and particular needs and pressures. For example, in many schools the primary focus is on managing behaviour, attendance and retention. Stakeholders interviewed for this review noted that other testing pressures may work to lift teacher engagement with digital technologies and collaborative capabilities. For example, it is planned that PISA will include on-line testing of collaborative problem solving in science in 2015. Similarly, the International Education Association is looking at measuring individual skills in ICT literacy for 2013.

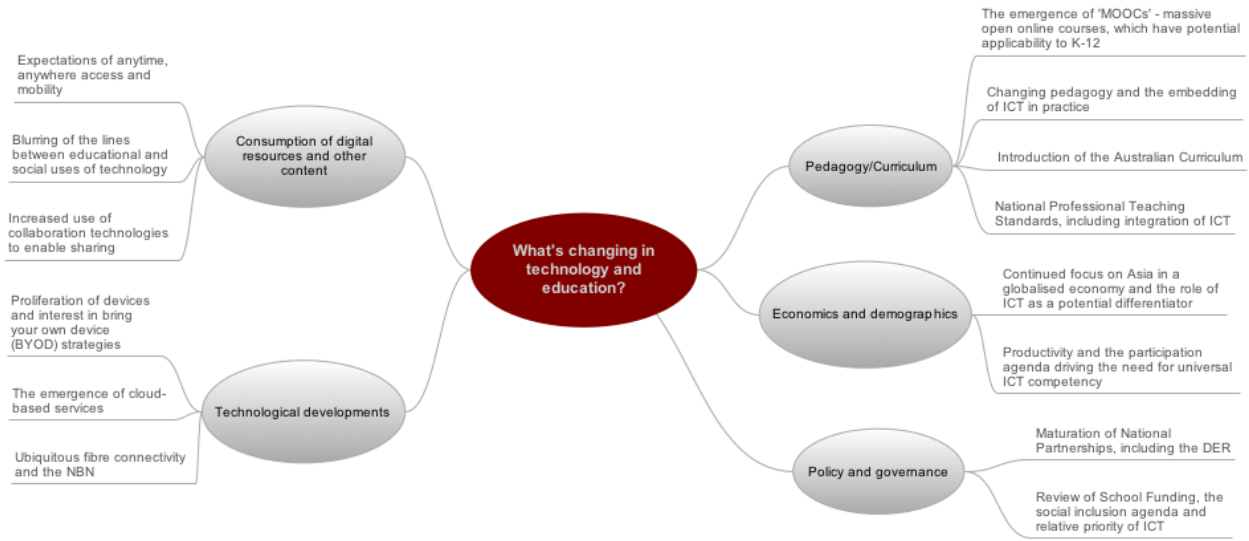
4 Changes in the technology and education landscape

The evolution of technology means that future investments and approaches will need to be flexible and adaptive. In the period since the DER was announced, a number of fundamental changes have occurred that have had implications for the implementation of the DER and future directions for digital education.

Looming changes to education and technology are also profound and will challenge governments, sectors, school leaders and teachers. Whether governments stimulate this or not, according to stakeholders, an education revolution is taking place. The question is whether schools are sufficiently equipped to respond to existing and emerging challenges. If recent developments in technology and technology consumption demonstrate anything, it is that change will remain a constant rather than something that needs to be conquered once. Stakeholders have consistently cautioned that not everything can be anticipated and planned for. The emergence of new technologies such as the proliferation of tablets such as iPads – a device not even conceived when the DER was announced – and changes to the way that digital content is consumed are examples. To provide effective, timely responses to these issues capability must be built into all levels of the education sector.

The purpose of this section is to identify what is changing and why. Woven throughout the discussion are implications for schools related to digital education that will be considered in the concluding section of this report. The issues raised are not intended to be exhaustive but to provide a snapshot of the myriad of considerations for future policy design and implementation. Figure 4-1 depicts the major changes impacting on digital education, as described in research and by stakeholders.

FIGURE 4-1: WHAT'S CHANGING IN TECHNOLOGY AND EDUCATION?



It is important to recognise that these changes are not discrete: many of them converge to create new challenges and opportunities. As an example, changes in technology have the potential to influence new pedagogical approaches, not just provide a vehicle to deliver evolving pedagogy in different ways. The conclusion of this chapter articulates the growing interdependence of trends as they relate to digital education. To illustrate:

- Device proliferation, particularly among learners, is increasing expectations that learners will be mobile (anywhere, anytime learning). This includes the prospect of moving beyond support for 1:1 access to one-to-many access to devices.
- Students' demand for anywhere, anytime learning is driving investment in a range of technologies, including compression technology, 'thin client' applications such as virtual desktops, and cloud-based services.

- Advances in compression technology and cloud-based services are creating the potential for improved and accessible media-rich content such as captured video to be effectively collected and delivered as part of the education process.
- Demand for captured video is putting new strain on school-based infrastructure such as networks, video applications, data storage and access to educational content on demand.
- As a whole, these are all leading to greater personalisation of learning, opportunities to exploit real-time formative assessment and feedback, new mechanisms and channels to deliver blended learning, and opportunities to deliver new pedagogical approaches including concepts such as the flipped classroom.
- As a result of all of these changes, there is a growing interest in BYOD by the administrators of systems, sectors and schools, who want to ensure that devices can be refreshed regularly and in an economically sustainable manner.

In reading this section, it is important to reflect not only on the changes identified but also on the upstream and downstream impacts on other trends.

4.1 Changes in how digital resources and other content are being consumed

4.1.1 Expectations of anytime, anywhere access and mobility

The device choices of schools under the DER initiative demonstrate the value placed on anywhere, anytime access. Of the almost one million devices procured under the initiative, the number of desktops is estimated to be less than 5 per cent. Principals interviewed confirmed that there were two underpinning reasons for the movement away from desktops. The first of these is the lack of physical space to house dedicated computer labs and, secondly, the need for learning to be mobile. Forecasts relating to the growth of mobile devices support the views of principals. In May 2012, a report was released that forecast estimated growth in mobile access globally and in Australia for the period from 2011–16. Highlights from the updated research included projections that by 2016:

- There will be nearly 19 billion global network connections (fixed and mobile), the equivalent of 2.5 connections for every person on Earth.
- There will be about 3.4 billion Internet users, which is more than 45 per cent of the world's projected population.
- Wi-Fi will account for nearly half of all Internet Protocol (IP) traffic.[126]

The forecast[127] for Australia is equally compelling, with mobile data traffic expected to grow 14-fold between 2011 and 2016, a compound annual growth rate of 68 per cent. Australian mobile data traffic will grow two times faster than Australian fixed IP traffic from 2011 to 2016, and mobile data traffic will account for 16 per cent of Australian fixed and mobile data traffic in 2016, up from 7 per cent in 2011.

The potential impacts these growth rates have on education are quite significant. This includes on the selection of devices for schools, the ongoing investment required in school-based network infrastructure and the demands for pedagogical practices to adapt to a more mobile learning environment. One specific impact is on security, particularly where school-issued educational devices can also be used for social purposes. This complexity is also acknowledged in commerce:

> *Mobile computing has broken down the barriers between work and personal life. The always-on employee has few options for maintaining segregation between these two worlds. While some opt to carry multiple devices, others use work devices for personal use, or perform work activities on personal devices. Whether accessing public or private networks, using social media applications, or even 'checking in' via location-based services, the explosion of these devices has created a myriad of security problems.*[128]

4.1.2 Blurring of the lines between educational and social uses of technology

Technology has long been regarded as an educational and professional tool, but the explosion in Web 2.0 technologies and the growth of social media has challenged the concept of the school-provided device as exclusively educational. Additionally, the evolving nature of social media and the role it plays in people lives is also blurring concepts of education. Students interviewed as part of the review indicated they were more likely to visit YouTube for educational tasks than they were to visit

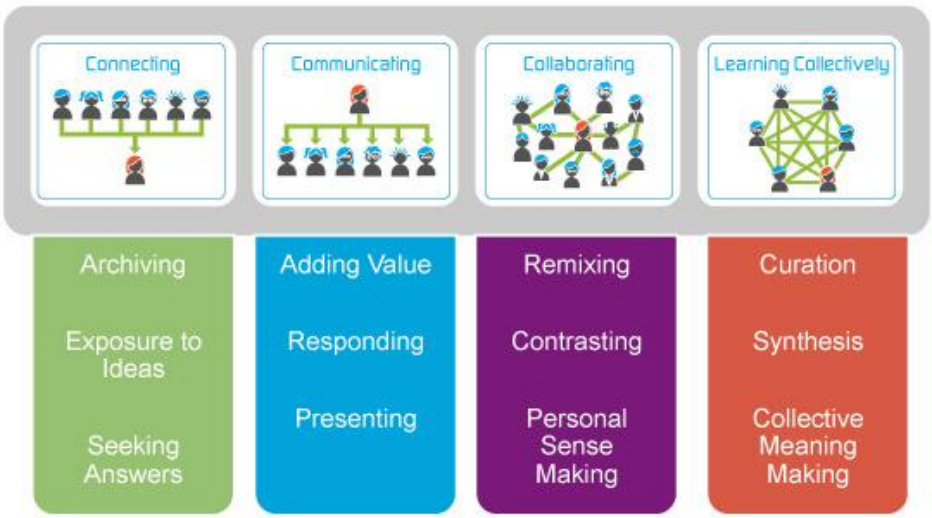
[126] Cisco (2011) *Visual Networking Index (VNI): Global Mobile Data Traffic Forecast Update, 2011–2016*, available at http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-520862.pdf, accessed on 3 August 2012.
[127] Cisco (2011) *VNI Mobile Forecast Highlights, 2011–2016*, available at http://www.cisco.com/web/solutions/sp/vni/vni_mobile_forecast_highlights/index.html, accessed on 3 August 2012.
[128] *Ubiquitous Computing, Pervasive Risk: Coping with the Proliferation of Mobile Devices* (2011) online conference, available at https://isc2.brighttalk.com/node/902, accessed on 3 August 2012.

accredited/sanctioned educational sites. The rise of social media is illustrated through statistics such as there being 2.4 billion social networking accounts worldwide, including nearly 800-plus million on a single platform of Facebook.[129]

Education authorities, schools and education publishers are recognising the potential value of leveraging these social media tools to simultaneously increase the relevance of applications/content and reduce their cost. The education publisher Pearson and search engine Google are blending traditional learning management systems and social networking platforms. Their platform, *OpenClass*, allows teachers to import material from a vast range of online sources, and features a Facebook-style newsfeed stream of comments and activities to encourage socialisation together with learning.[130]

Pedagogy is also reflecting the blurring of social media and traditional education content. The evolution of blended learning acknowledges that informal information gathering tends to happen outside the classroom using digital resources, while more formal application or construction of this knowledge is the focus inside the classroom. The *Collective Knowledge Construction* research paper identifies a range of strategies by which knowledge is gathered and disseminated in online learning. It breaks down the different possibilities of communicating when teaching and learning in technology-rich environments. These range from relatively simple connections between students and teachers through to dynamic exchanges that are less predictable but potentially more valuable.[131] As indicated in Figure 4-2, the paper identifies four types of 'knowledge construction' that exist in contemporary pedagogy and which are driven by both digital education technology generally and the power of Web 2.0 technologies specifically. Stakeholders indicated that teachers have established networks on social media (e.g., on Facebook) to share resources and experience relating to ICT, digital resources and their application.

FIGURE 4-2: FRAMEWORK FOR KNOWLEDGE CONSTRUCTION MODELS



Source: ideasLAB

4.1.3 Increased use of collaboration technologies to enable sharing

The rise in demand for and creation of video content is significant; particularly considering the fact that 48 hours of video is uploaded onto YouTube every minute. It is estimated that 201 billion videos were viewed on the Internet in the month of October 2011 alone, and more than 88 billion of those were as a result of Google and its affiliates (such as YouTube). The use of video in education is increasing exponentially, via both dedicated education channels and open-access channels such as YouTube. The rise of video is significant from a learning perspective on a number of fronts:

1. It challenges long-standing school access policies that attempt to restrict admission to open-access channels in particular and video in general (particularly in schools where bandwidth is limited and expensive).
2. It places significant additional demands on school-based infrastructure – including networks, storage and devices – to keep pace with the volume of traffic, quality of service requirements (particularly if the video is two-way and synchronous) and requirements for additional security.

[129] Royal Pingdom , op. cit.
[130] Fischman, J. (2011) 'Pearson and Google jump into learning management with a new, free system', *The Chronicle of Higher Education*, available at http://chronicle.com/blogs/wiredcampus/pearson-and-google-jump-into-learning-management-systems/33636, accessed on 3 August 2012.
[131] Developed by the Victorian Government's ideasLAB, which is funded in partnership with Cisco, Intel and Microsoft.

3. It increases the demand for safe, accessible and accredited education sites, including sites that enable uploading of video as part of ePortfolios, and challenges education authorities to connect rich media content repositories to the core curriculum.

While the DER has created significant additional online learning resources, teachers often generate their own or access publicly available content. Content is accessed from a range of sources including corporate sites, dedicated sites (such as that operated by the US Center for Interactive Learning and Collaboration[132] to facilitate videoconferencing and school exchanges), community-based sites such as the Powerhouse Museum in NSW[133], commercial providers such as education publisher Pearson, and proprietary school repositories operated by major technology vendors. In this way, it is suggested that the availability of content is not an issue, but significant work is required to help teachers and students navigate and ascertain the quality of available resources, and to gain easy access to them.

4.2 Technological developments

4.2.1 Proliferation of devices and interest in bring your own device (BYOD) strategies

The value of technology in the classroom to enrich the student experience and drive better engagement has piqued interest in sustaining ICT investment beyond the funded period of the DER. In considering how to sustain 1:1 computing ratios in schools beyond the DER, education authorities and schools are considering opportunities to have students bring their own devices/ technology. At the same time as this is being contemplated, the number and range of device types and platforms is proliferating. Incorporating a range of device types into the school learning environment brings both technical and pedagogical challenges. From a technical perspective, different device types/platforms have varying functionality and security provisions. Even more significantly, this creates challenges in ensuring that legacy applications such as student and learning management systems can be supported across a range of platforms.

Teachers that participated in this review identified significant challenges arising from a 'multi-device' environment. Firstly, the standard of teacher competency in the effective use of ICT required of the teacher is significantly higher, including a working knowledge of potentially dozens of different devices. Secondly, the complexity of lesson planning is increased given that instruction needs to be geared towards the lowest common technology denominator (i.e., aligned to the most basic device in the classroom rather than the most advanced).

Another challenge associated with BYOD is acknowledged as the preservation of equity, particularly in a proliferating device environment. Stakeholders expressed significant reservations about a move to unrestricted BYOD due to the fact that it could reinforce the marginalisation of students from low SES backgrounds who could not 'keep up' with other students.

A number of organisations – from schools through to corporations – have recognised that many of these challenges can be overcome by restricting the range of devices supported. While technically still BYOD, schools are recognising that parental co-contribution or purchase of an approved device is potentially the optimum outcome. In a single-device environment, parental purchase of the device shouldn't create any additional technology challenges but provides all the benefits of transferring the ownership burden away from the school.

4.2.2 The emergence of cloud-based services

Technological change is prevalent across the technology value chain, from devices to applications, networks and data centres. Cloud-based services, which include the provision of IT services such as storage or software over the Internet on a pay-per-use basis[134], offer a number of potential opportunities for education authorities and schools, including the ability to:

- scale up and down quickly and cost-effectively; and
- manage applications remotely, reducing the need for dedicated on-site ICT resources at schools.

The cloud is also considered to be `democratising' information technology by making it easier for consumers and providers of content to reach their intended audience and access their own tools. An example of a cloud-based service that is emerging, though still not at critical mass in education, is the concept of the virtual desktop. In a typical virtual desktop environment the device simply hosts rather than saves content and applications that are provided from the cloud or data centre via the internet. These applications and content are accessed via a log-in and in some cases no content or applications physically sit on the device. The virtual desktop has a number of advantages, including the fact that changes to applications can be made without IT technicians

[132] Center for Interactive Learning and Collaboration, available at http://www.cilc.org, accessed on 3 August 2012.
[133] Powerhouse Museum NSW, available at http://www.powerhousemuseum.com, accessed on 3 August 2012.
[134] Office of Information Technology, University of Colorado Boulder (2012) *What Are Cloud-Based Services?*, available at http://oit.colorado.edu/node/7532, accessed on 30 July 2012.

having to physically access a device, and that when a device is stolen, it contains no content. This latter feature is particularly attractive in an education environment where the theft of take-home devices is a consideration for school students.

Some CIOs indicated that for cloud-based services to work effectively, education authorities need to significantly bolster 'back end' systems such as student administration and learning management systems to support digital education in cloud environments. Stakeholders expressed interest in cloud-based technologies for some applications and content, though they were concerned about the economics of such a move given it can lead to higher data-storage costs and requirements for higher standards of connectivity and therefore greater investment. Another complicating factor for some education authorities was privacy legislation restrictions relating to the residency of data. For example, the ACT Government reported that its educational data cannot be stored more than 25 kilometres from school locations, making it difficult to access cloud-based services where a provider does not have a local data centre.

4.2.3 Ubiquitous fibre connectivity and the NBN

The National Broadband Network (NBN) represents a $42 billion infrastructure investment, connecting 100 per cent of Australian residences to high-speed broadband (almost 80 per cent of those via fibre-to-the-premise technology). The NBN is designed to mitigate one of the most significant impediments to the ubiquitous uptake of the Internet by Australian citizens (and, in turn, schools): the high cost (relative to speed) of bandwidth. This is particularly true of, but not restricted to, regional and remote areas, which have historically experienced lower service levels and higher prices due to their higher cost to serve. The NBN's impact is not confined to consumers in their homes.

A number of NBN trial sites are underway in the education realm. For example, a NBN-enabled tele-education project has commenced in Armidale (NSW) to trial virtual interactive training rooms, laboratories and community learning capability. The partnership between the New England Institute (TAFE NSW) and University of New England focuses on trialling the impact of high-definition, Internet-protocol-delivered television, video on demand and three-dimensional trade skilling packages, open-access courseware and cloud-based technology, and a range of other applications. The One Community Project in Cleveland, Ohio, demonstrated significant benefits from connecting mostly low SES households to high-speed broadband. These included 65 per cent of parents using their home broadband connection to communicate with their child's school and teachers, and 75 per cent increasing the frequency of their engagement with teachers and administrators as a result of having home broadband access.[135] The results are instructive about the value of connectivity at the home, not just the school.

While trials are still underway, the NBN has transformative potential in education, providing the underlying infrastructure to enable high-resolution video and other forms of data necessary to provide a truly interactive experience. While a number of government departments have ubiquitous or high levels of fibre connectivity to schools, some States/Territories and sectors – particularly the Catholic and independent sectors – do not. The transformative potential of the NBN is perhaps most significant, therefore, for schools that have to date found it difficult to fully exploit the DER on the basis of poor connectivity. In education, the NBN also has the potential to improve home Internet connectivity, though it is feasible that some of the 28 per cent of households that do not have home Internet access[136] are in this position due to cost rather than purely infrastructure considerations.

While it is generally accepted that the NBN has promise, stakeholders expressed some concerns. One of the concerns was the timing of the NBN – still many years away in some States – and fears that the NBN will be delivered at 'residential grade' to many schools due to their location. Some of these views were particularly prevalent in WA, where there were doubts about the NBN's capacity to provide high-speed, affordable broadband given the remoteness of many schools.

[135] OneCommunity (2012) *Connect Your Community: K-12 Parents Digital Literacy Survey*.
[136] Australian Bureau of Statistics (2011) *Australian Social Trends June 2011 – Online @ home*, Catalogue No. 4201.0, available at http://www.ausstats.abs.gov.au/ausstats/subscriber.nsf/LookupAttach/4102.0Publication29.06.116/$File/41020_Online_Jun2011.pdf, accessed on 30 July 2012.

4.3 Changes in pedagogy and curriculum

4.3.1 The emergence of `MOOCs' – massive open online courses, which have potential applicability to K-12

A new model for the delivery of digital content has emerged in the higher education sector, and has potentially significant implications for K-12 learning. `MOOCs' – massive open online courses – represent a potential glimpse into the ways in which new curriculum might be incorporated from unlikely sources. Some of the highest profile MOOCs are developed on open source standards, purely for consumption online, are provided free of charge to users and provide online assessment. Though the high profile MOOCs have been launched in higher education at this stage, it is easy to imagine the model being extended to primary and secondary schools. The main difference between a MOOC and traditional learning resources is that the MOOC provides an end to end course experience, including assessment, rather than providing artefacts that can be used in the classroom. It is therefore conceivable that a MOOC designed in Europe, Asia or the United States could be accessed by students to augment curriculum that is offered under the Australian Curriculum. This would have the effect of rapidly expanding the choice and quality of learning options for students and teachers in the future.

While only launched in 2011, a collaborative MOOC between Harvard and MIT universities entitled EdX has made a significant impact. The model is potentially extendable to a K-12 environment, and has the ability to redefine the definition of learning resources by incorporating assessment as well as learning objects. The model is potentially attractive as it enables learning to occur in students' own time/place, is low-cost and requires only an Internet connection and device to access and engage with the course content.

4.3.2 Changing pedagogy and the embedding of ICT in practice

Employers and public interest groups have been calling for many years for students to be given more opportunities to develop their skills in the critical capabilities for the future, particularly the ability to work collaboratively to solve complex problems and create and share new ideas. Many experts agree that the changes occurring represent a dramatic break with past practice – a 'second-order change'[137] – requiring a 'transformation' in the role of the teacher. There is widespread agreement about some of the elements that characterise the pedagogy of the 21st-century. These include a focus on the new skills and capabilities to be developed in students as opposed to test scores; personalised learning and teaching, 'with curriculum and assessment responsive and tailored to the individual student and data analysed and available to assist teachers, schools, education authorities and governments'.[138] This pedagogy also encompasses collaborative and team-based learning for students and teachers; inquiry-based or problem-solving curriculum; pedagogies that enable the learner and prepare for lifelong learning; and virtual learning and virtual classrooms.

These changes in pedagogy will require teachers to reorganise their classrooms and manipulate the learning environment to meet the needs of individual students. The demands should not be underestimated and will require constant reflection and redesign. ICT creates radically new possibilities, but the fundamental shifts involve what needs to be taught and the process for teaching this.

4.3.3 Introduction of the Australian Curriculum

The Australian Curriculum sets out the core knowledge, understanding, skills and general capabilities that are important for all Australian students.[139] The online delivery of the Australian Curriculum was identified by a number of stakeholders as creating a focal point for embedding ICT into teaching. The Australian Curriculum is a dynamic resource that has inserted links to online resources, and which allows for greater collaboration and information sharing between schools and education authorities. Stakeholders reported that unless the major assessment instruments had ICT embedded in them, some teachers would not see a need to change.

One of the challenges for the Australian Curriculum and related assessment tools, as noted by several stakeholders, is ensuring that assessment reflects what is expected of contemporary teaching practice. This extends to the adoption of formative testing to ensure that the technology is intrinsically connected to the act of teaching and learning.

> *One of the challenges is that we are telling teachers that they must be creative, and teach in different ways, but the assessment has not caught up. We need to create assessments that recognise teachers for being more innovative in the use of ICT. At the moment the 'test' is disconnected from the vision for teacher practice.*

[137] The distinction between first- and second-order change is elaborated in Greaves, T. et al., op. cit., chapter 1.
[138] Griffin, P., McGaw, B. & Care, E. (eds) (2012) *Assessment and Teaching of 21st Century Skills*, Springer, Dordrecht.
[139] The Australian Curriculum, Assessment and Reporting Authority (ACARA) is responsible for developing the Australian Curriculum, which is being drafted progressively from Foundation to Year 12 and being guided by the *Melbourne Declaration on Educational Goals for Young Australians* and the policy document *Shape of the Australian Curriculum*.

4.3.4 National Professional Teaching Standards, including integration of ICT

The recently released *National Professional Standards for Teachers* is intended to have a significant impact on the professionalisation of teaching. The standards are organised into four career stages (graduate, proficient, highly accomplished and lead), with descriptors that represent an analysis of effective, contemporary practice in Australia.[140] The *Teaching Teachers for the Future* project[141] was undertaken with the specific aim of building the ICT capacity of graduate teachers in Australian universities. Led by ESA, this project brought together the Australian Council of Deans of Education, with this initiative being the first time the 39 Australian higher education institutions with initial teacher education programs had worked together on a significant national project.[142] This project has developed ICT statements for the graduate career stage of the National Standards, together with elaborations and exemplars to support initial teacher education.

While the development of standards will have an impact on the ICT skills and knowledge of graduating teachers, they will have less impact on more senior teachers (highly accomplished/lead) for whom professional learning is all about self-development, not accreditation requirements. Standards will certainly focus the attention of all schools on professional development. What will be critical is the way individual schools develop professional learning opportunities for their staff to ensure they reflect what is known to be good practice at all stages of career development.

4.4 Changes in economics and demographics

4.4.1 Continued focus on Asia in a globalised economy and the role of ICT as a potential differentiator

The Australian Government's recent white paper *Australia in the Asian Century*[143] provides a rationale for increased focus on economic, social and educational ties with Asia. This is supported by calls for increased focus on Asian languages in the education system as well as greater focus on cultural literacy[144] and Asian language skills in education. This is already beginning to happen in schools, with examples such as the University of New England's *Australia–Korea Connexion* program that digitally connects NSW schools with those in Korea to expand cross-cultural and language programs.[145] These types of approaches acknowledge that formal and informal exchanges provide significant value at an educational level.

As much as Asia represents a significant trade and cultural partner, in an increasingly globalised world, Asia also represents a source of competition. This is recognised in international education, where Australia now competes with many of our traditional source markets for provision. There are opportunities for Australia to exploit its proficiency in ICT as a competitive advantage, but there are also risks should the education systems of Asian countries outpace Australia in this area.

4.4.2 Productivity and the participation agenda driving the need for universal ICT competency

Productivity is a critical element of the success and prosperity of Australia. Improving productivity levels is a key focus of the Australian Government following a drop in the growth of average annual labour productivity, from 2.1 per cent in the 1990s to around 1.4 per cent in the 2000s.[146] A number of empirical studies suggest that developing higher levels of human capital, which can be achieved through reforming education and training, can produce higher levels of productivity and workforce participation.[147]

Improving productivity in Australia will involve improving the participation of some of the most disadvantaged members of the community. Increasingly, ICT skills (or their absence) are seen as a major impediment to effective participation in society and the workforce. ICT skills have quickly evolved from a value-added competency to something more fundamental. In addition, digital education provides an important opportunity to personalise learning and engage students by appealing to their interests and learning preferences. Therefore, digital education can be a foundation for improved attainment levels and better school-to-work transition outcomes.

[140] The Australian Institute for Teaching and School Leadership (AITSL) (2012) *National Professional Standards for Teachers*, available at http://www.teacherstandards.aitsl.edu.au, accessed on 26 July 2012.
[141] The project was funded by ICTIF.
[142] With Australian universities increasingly required to compete against each other, this provides a telling contrast to the strategic approaches to teacher education possible in a country like Singapore.
[143] Australian Government (2011) *Australia in the Asian Century, Issues Paper December 2011*, available at http://asiancentury.dpmc.gov.au/issues-paper, accessed on 1 August 2012.
[144] Submissions strongly supported the notion that Asian literacy was broader than language skills and that a greater focus should be given to the study of Asian countries in a cross-disciplinary manner.
[145] University of New England (2011) *Australia–Korea Connexion*, available at http://www.une.edu.au/austkoreaconnexion, accessed on 1 August 2012.
[146] Hon. Wayne Swan MP (2010) *Government's Productivity Agenda to Tackle Future Changes*, 1 February, available at http://ministers.treasury.gov.au/DisplayDocs.aspx?doc=pressreleases/2010/007.htm&pageID=003&min=wms&Year=2010&doctype=0, accessed on 26 July 2012.
[147] Banks, G. (2010) *Advancing Australia's 'Human Capital Agenda'*, Ian Little Lecture, Melbourne, 13 April.

4.5 Changes in policy and governance

4.5.1 Maturation of National Partnerships, including the DER

The governance arrangements in place to support the delivery of education in Australia have undergone significant changes in recent years. The formation of COAG and the creation of National Partnerships relating to education are prominent examples. Many of those agreements are coming to an end, and policy priorities have evolved. This represents a significant shift in both governance and policy, with implications far broader than the DER. Questions remain about the extent to which collaboration and sharing will continue beyond the agreements currently in place, including on issues identified as part of this review.

4.5.2 Review of school funding, the social inclusion agenda and relative priority of ICT

The Review of Funding for Schooling was initiated in 2010 to develop an alternative funding system for Australian schooling.[148] In December 2011, the panel overseeing the review, led by David Gonski AM, concluded that Australian schools needed to lift the performance of students across all levels of achievement, particularly those who are the worst performers. The review recommended a need for governments to move away from funding targeted programs and focus on ensuring that the States and Territories and non-government sectors are publicly accountable for achieving student educational outcomes. Under this construct, it will be necessary to evaluate how the prominence of ICT is likely to be affected, and the extent to which funding will be dedicated to digital education objectives. It is likely that for some schools, where ICT is a top priority, the impact may be minimal or positive. However, the impact on schools that are not committed to long-term ICT integration is less certain. The school funding review's focus on low SES cohorts also has potential implications for schools considering parental co-contribution models for the provision of ICT.

[148] Australian Government (2011) *Review of Funding for Schooling: Final Report*, available at http://www.deewr.gov.au/Schooling/ReviewofFunding/Documents/Review-of-Funding-for-Schooling-Final-Report-Dec-2011.pdf, accessed on 22 June 2012.

Conclusion

Implications of review findings for the role of technology in education

Recent developments in technology and technology consumption suggest that change will remain a constant, rather than something that needs to be conquered once. Looming changes to educational technology are profound, and will challenge governments, sectors, school leaders and teachers. The question is, how well equipped are schools to respond to, and keep pace with, the rate of change forecast?

The DER was a mostly programmatic response to the need for improved infrastructure and capability in education. It succeeded in establishing equity through ubiquitous access to 1:1 computing, and through that, it had a catalytic impact on digital education in schools. However, to truly create and sustain a digital education revolution, a focus on future investments will need to leverage the major shifts in technology and education that are occurring now.

Stakeholders have consistently cautioned that not everything can be anticipated and planned for. The emergence of new technologies, such as tablets, and changes to the way that digital content is produced and consumed are examples. Providing effective, timely responses to these issues requires capability to be built into all levels of the education field, most notably at the level of the school. The focus therefore needs to be on encouraging and equipping school leaders, teachers, parents and students to make sound decisions about all aspects of digital education.

Implications for schools

These implications and challenges align with the framework set out in section 3 of this report.

At a school level, governance arrangements, including appropriate usage policies, will need to evolve. As a result of both device proliferation and social media, much learning will occur outside the classroom and non-educational activities will occur within schools: the education system will need to keep pace with such changing practices and ensure that social media and device-usage policies are responsive.

Research and stakeholder views provide a clear sense of what works effectively to achieve school-level reform and results. The importance of leadership is significant, including principals' personal leadership style and their capacity to demonstrate the behaviours they are seeking to promote within the school. Their capacity to create a culture that encourages teachers to innovate and respond to their own context is critical.

Mobility, collaborative technologies and the increasing uptake of software as a service model, such as cloud-based computing, are increasing the emphasis on security management and network sophistication at an infrastructure level. In the short term, additional demands on school-based infrastructure arising from the need for back-end upgrades and greater data storage capacity requirements, as well as adequate connectivity within and to the school, mean that increased technology and support costs are likely. In some cases, legislation related to remote storage may need to be examined.

From a teacher capability perspective, the lessons are equally profound, and consistently promoted. These include the need for teachers to evolve their pedagogical practices in response to major technology changes, and to adapt their roles to become a facilitator of learning rather than purely a transmitter of information. Embedding ICT in practice and providing students with skills for the 21st-century (e.g. through online curricula and assessment) will require schools to reorganise lessons, classrooms and teaching practices. As an example, should the range of devices in schools proliferate as expected, the complexity of lesson planning will need to be geared to the most basic device in the classroom. Teachers are being challenged to fully exploit digital technologies that enable formative, regular assessment and personalised learning that research acknowledges as producing positive results. Keeping pace with the latest best practice is a significant challenge for teachers in a time-pressured environment, increasing the role for, and reliance on, peer-to-peer professional development and collaboration. The required standards of teacher competency in the effective use of ICT will continue to rise.

Perhaps the most significant decision for schools when the NSSCF funding concludes will be how to provide students with access to devices in a financially sustainable way. Most of the stakeholders interviewed supported some form of parental co-contribution to technology, including in low-SES areas. Some schools suggested they were planning for parents to cover the entire cost of purchase, while others expected costs to be shared by the school and parents. It is important for schools to recognise that there are significant technical and pedagogical challenges associated with a 'free reign' BYOD policy. No matter what model is adopted

for the future, schools will need to exercise caution in making decisions about the financial and technical model for provision of devices.

Implications at a national level

The Australian Government's investment in digital education, by way of the DER, has been successful in catalysing action at a school and sector level that in many cases would have taken much longer to achieve in the absence of a program of such a scale. However, it is unlikely that such one-off capital investments of this magnitude will be repeated in the foreseeable future. From a national perspective, how should the gains of the DER be maintained and expanded?

Section 3.2 of this report highlighted the range of approaches that is known to work most effectively from a governance and policy perspective, including:

- investing in the development of a long-term strategy with clear milestones;
- collaborative national approaches to critical issues such as standards development, interoperability and strategic procurement; and
- providing implementation flexibility to devolved members of systems to facilitate innovation at the edge and greater responsiveness to emerging issues.

Given that Australia is a federated system, with school education being the primary concern of States and Territories, there can be no neat transposition of what has worked elsewhere to an Australian context. The priority is to ensure that the momentum of the DER is maintained and fully leveraged.

Three areas stand out as worthy of further work at the national level, with the overall objective of sustaining the momentum of the DER:

1. monitor momentum and specifically assess the impact on low SES schools and families on the expiry of the DER National Partnership;
2. facilitate ongoing collaboration and support for activities that would benefit from national collaboration and which would unlikely be achieved without it; and
3. provide targeted support for transitioning to sustainability and maintaining momentum at the level of the school.

Monitor momentum and specifically assess the impacts on low SES schools and families on the expiry of the DER National Partnership

One of the major benefits of the DER has been to provide a better understanding of digital infrastructure in schools, as well as of what works in terms of governance and policies, school leadership and teacher capability. There is a danger that this relatively independent, national-level perspective will be lost with the expiry of the current arrangements, and hence the ability to identify areas of lagging performance at an earlier stage than might otherwise occur.

Different approaches could be considered to capture this information:

- Schools, via systems and sectors, could be required to provide information along specified dimensions – the disadvantage being the additional reporting burden on schools.
- An evaluation and assessment exercise along the lines of this report in reduced form could be undertaken – the advantage of this is that quantitative and qualitative information could be synthesised (assuming a certain level of data capture at the school level), likely leading to richer policy insights.
- An annual survey of school teachers and principals related to issues raised in this report.
- A more straightforward audit could be undertaken – this could be reasonably rapid but would lack richness of information and insight.

The results could be considered by a relevant national body, such as the Standing Council on School Education and Early Childhood (SCSEEC), with a resolve to act in response to the data.

Amongst all schools, low SES schools and families merit particular attention.

Families and devices

The most vulnerable sectors of society and the lowest performing in terms of educational achievement are those from low SES communities. These communities and schools are amongst those that have the most to gain from initiatives such as the DER and therefore might have the most to lose from the absence of such support. How will these schools fare in the future without the support of a DER-style program of assistance?

Before automatically assuming that new, specific funding programs are required, other potential sources of funding should be investigated as they may be available to be leveraged for such communities. Potential sources might include the Department of Families, Housing, Community Services and Indigenous Affairs (FaHCSIA), which organises grants for schools with a high proportion of Aboriginal and Torres Strait Islander students; regional and rural programs, where a proportion of low SES schools are located; and potentially weighted funds for low SES recipients from any revised school funding arrangements. There are also potential programs operating within States, including the Education Maintenance Allowance in Victoria, which provides assistance to low income families by helping with the costs associated with the education of their children. Finally, there are also opportunities for families to offset costs associated with devices via the Education Tax Refund.[149] The financial burden on families may also be potentially offset by the substitution or reduction in textbook costs. As publishing moves towards e-Books there is potential for production costs to be reduced.

It is worth noting that evidence from the study and from overseas experience is that low SES schools do not equate to an unwillingness or an incapacity to purchase devices, particularly when payments can be made periodically.

Schools

The impact on low SES cohorts may be greater at the level of the school, where the associated infrastructure and non-infrastructure costs arising from a growing number of devices is being and will be felt. Whilst this is primarily a state, sector or an individual school issue, a national assessment of which schools are most likely to fall behind would enable planning to help ensure that the equity improvements achieved through the DER are not lost. There is potential for this issue to be considered in the larger context of the Review of School Funding.

Facilitate ongoing collaboration

One of the most remarked upon unanticipated benefits of the DER initiative was its fostering of collaboration between:

- Jurisdictions;
- individual schools and teachers within Australia and overseas;
- school leaders, teachers, administrators and students; and
- teachers and industry representatives (providing product training).

A mechanism for continuing some level of collaboration, either through an existing forum or through an event such as an annual workshop, perhaps combining demonstrations of good practice with working sessions, would be a relatively straightforward event to organise. A simple online resources centre and other tools to stimulate distributed communities of practice could supplement the face-to-face forum. An online resource and collaboration space could potentially be an adjunct to an existing resource, and serve as a repository of practical examples and contact details of those teachers and administrators willing to be contacted.

Provide targeted support for transitioning to sustainability and maintaining momentum at the level of the school

In the event of the NSSCF program ceasing after the current financial year, there may be a case for specific limited interventions by the Australian Government to help maintain momentum. For example:

- **research and policy:** on the principle of 'provide once and use many times', the Australian Government could undertake research, policy or costing work that could be made available to all schools. As an example, one such piece of work could establish the comparative costs for purchasing digital content on devices, as distinct from purchasing physical textbooks, hence making clear the real impost on parents and schools of purchasing devices.
- **industry negotiation:** there are cases where national-level action can achieve greater benefits than any one jurisdiction or authority acting on its own. The Australian Government could negotiate with education publishers to stimulate the development of digital content to substitute for textbooks.
- **advocacy**: there is clearly a central digital component to the work of national bodies such as ESA, ACARA and AITSL, and through them to a range of other relevant bodies including standards bodies - for example initial teacher education

[149] Eligible families can currently claim up to $397 per primary and $794 per secondary school student per financial year for educational expenses associated with the purchase, repair and maintenance of devices, which could be factored in to considerations about the level of parental co-contribution

and teacher standards. Any national work and monitoring of progress should involve engagement with these bodies to embed and encourage the uptake of good practices in digital education, particularly with regard to the two critical levers of:

- teacher capability; and
- assessment tools – online diagnostic tools to enable formative assessment in the classroom.

There is a role for national advocacy and national-level initiatives; for example, moving NAPLAN online to drive uptake and skills around digital literacy and education; monitoring improvements in digital learning in initial teacher education. Another example where momentum needs to be sustained is in the area of technical interoperability, and the work around SIF that has matured under the DER. This work is critical if Australia is to reap full benefits from its investments in digital technology, and is most appropriately done collaboratively.

The purpose of these initiatives is to ensure that the undoubted gains of the DER are maintained and built upon in the future.

Attachment 1: DER Mid-Program Review Evaluation Framework

Infrastructure

What is being measured	Description of aspirations	Summary of indicators	Data Sources
Have access targets been achieved?	Schools are now providing 1:1 access to computers for all year 9-12 students across the country The DER has helped to address issues associated with inequity and disadvantage – providing access and benefits for students who are Aboriginal or Torres Strait Islander, living in remote locations, from low SES backgrounds or have a disability.	Reported year 9-12 computer access ratio – in total and across States and Territories Perceptions of stakeholders regarding the impact of the DER in addressing equity of access and disadvantaged cohorts – including case studies where possible	SEMIS data tables to be provided by DEEWR (validated by proposed Audit) Interviews/Focus Groups with Authorities, Principals, Teachers, DEEWR
Have schools established the network infrastructure needed to support the use of computers/devices in the classroom?	Most schools have established broadband connections to the Internet – or have plans in place to achieve that. Most schools have established broadband networks – within the school - to support classroom activities	Schools support broadband LANs within the school that are used for teaching and learning (e.g. wireless networks) Schools support a fibre (broadband) connection Stakeholder experience in establishing desired network infrastructure	NSSCF progress reports Schools Broadband Connectivity survey Interviews/Workshops with Authorities, Principals
Has the DER been a catalyst for broader utilisation of ICT in the classroom?	Most schools are integrating the use of other devices/hardware in the classroom	Schools use non-computer hardware	NSSCF progress reports
Are computers and networks reliable and well supported?	Established environments seen as generally reliable Most schools provide teachers and students with access to technical support – however, the strategies adopted vary across schools	Schools provide teachers with access technical support (e.g. a helpdesk) Perceptions of stakeholders regarding adequacy and reliability of infrastructure and support	NSSCF progress reports Interviews/Workshops/Focus Groups with Principals, Teachers, Students, Authorities
Are schools actively planning beyond the DER?	State governments expecting Australian Government to refresh Most schools have established a dedicated technology budget The DER has stimulated additional investment from other parties – authorities, schools, industry, parents, other… Most schools have a planned approach to ICT refresh	Schools have a dedicated technology budget Schools have a planned and budgeted approach to ICT refresh	NSSCF progress reports Implementation plans Interviews/Workshops with Authorities, Principals, DEEWR

Leadership

What is being measured	Description of aspirations	Summary of indicators	Data Sources
How have authorities changed the way they work with ICT – and each other?	DER has been a catalyst for greater collaboration across jurisdictions and sectors Authorities and schools are adopting a variety of strategies to share knowledge about the use of ICT in the classroom	Schools / jurisdictions disseminate sound practice with other schools / jurisdictions about the use of ICT for teaching and learning How sound practice is disseminated – evidence that systems/sectors disseminate knowledge and sound practice and facilitate collaboration within and beyond their jurisdictions Perception of effectiveness of knowledge sharing and collaboration activities	NSSCF progress reports Interviews/Workshops with Authorities, DEEWR, Principals, Teachers
How are the authorities leading and supporting schools in their use of ICT in classrooms?	All jurisdictions have established an ICT vision for the classroom – DER has been a catalyst for this to happen Authorities are supporting schools in a variety of ways – policies, standards, PD, support for ICT planning, procurement, installation, support…	Evidence of support provided to schools by the authorities	NSSCF progress reports Interviews/Workshops with Authorities, Principals, DEEWR
Are school leaders committed to greater use of ICT for teaching and learning?	Most Principals self-identify as driving ICT integration in their school ICT is now seen as a core responsibility for school leadership – e.g.: significant portion of school budget, core function for Principals, specific roles established in many schools… Principals are increasingly engaged in PD about the use and management of ICT Principals see that increased use of ICT is benefiting teachers, students and parents	Principals self-identify as driving ICT integration (need to confirm confirm SiAS collects this data) Examples of how school leadership is driving ICT integration Participation by school leaders in PD about the use of ICT School leaders' perception of the importance of ICT on teaching and learning – including benefits for teachers, students and parents School leaders' perception of how ICT has changed roles, responsibilities and practice	Staff in Australia's Schools (SiAS) survey Literature review Interviews/Workshops with Authorities, Principals, DEEWR
How are school leaders planning and supporting the use of ICT in classrooms?	Most schools have an ICT Strategy or Plan in place Most Principals have an ICT deployment plan in place Authorities and schools have developed policies for ICT use in the classroom – e.g.: ethical use; equity of access; student misuse; intellectual property; staff ICT PD; technology risk management; good digital citizenship; elearning	Schools have an ICT Plan / Strategy Principals have an ICT deployment plan for the provision of infrastructure, learning resources and teacher capability (confirm SiAS collects this data) Stakeholder views on adequacy of policies for ICT use in the classroom	NSSCF Progress reports SiAS survey Implementation plans Interviews/Workshops with Authorities, Principals, Teachers

Teacher capability

What is being measured	Description of aspirations	Summary of indicators	Data Sources
Are teachers committed to greater use of ICT in the classroom?	Teachers are using ICT more since the DER was introduced Teachers see students using ICT more since the DER was introduced – e.g.: to research, prepare for and complete class tests and assignments, communication with teachers, group work/collaboration with other students Teachers cite benefits of ICT – e.g.: improved motivation; innovation in teaching practice; capacity to access information; capacity to individualise curriculum to student needs; capacity for collaboration with other teachers/experts; improve student engagement; capacity to conduct assessments more effectively; and capacity to engage more effectively with parents…	Perception of benefits associated with teachers' use of ICT hardware and digital resources/tools Perception of benefits associated with students' use of ICT hardware and digital resources/tools Perception of how ICT is transforming teaching and learning in schools – including increased use by teachers and students	Literature review NSSCF progress reports and case studies Interviews/Workshops/Focus Groups with Authorities, DEEWR, Principals, Teachers, Students, Parents
Do teachers feel adequately skilled and prepared to use ICT and online tools/resources in the classroom?	Confidence and competence levels of teachers in using ICT in the classroom varies substantially Improving ICT skills was identified by teachers as an area of high need Teachers perceive the quality and extent of current initial teacher ICT training as … Teachers are increasingly engaged in ICT PD activities	Teachers provided with PD about the use of ICT for teaching and learning (confirm SiAS collects this data) Identified importance/need for PD in ICT (confirm SiAS collects this data) # years since undertaking PD about the use of ICT for teaching and learning (confirm SiAS collects this data) Perspectives on teacher confidence and competence in using ICT and online learning resources in the classroom Inclusion of ICT in initial teacher education courses Teacher perspectives on the effectiveness of ICT in initial teacher education courses	SiAS survey Literature review Interviews/Workshops/Focus Groups
Do teachers feel adequately supported to use ICT and online tools/resources in the classroom?	Many schools are facilitating teachers' access to coaching about the use of ICT for teaching and learning Many schools are facilitating online collaboration and peer networking around the use of ICT in the classroom Teachers are looking for improved ICT capabilities and resources to support them in their role – in particular…	Schools facilitate teachers' online collaboration or peer networking How teachers' online collaboration or peer networking is facilitated Schools facilitate teachers' coaching about the use of ICT for teaching and learning How teachers' coaching about the use of ICT is facilitated Perception of ICT capability in the school and jurisdiction Perceptions of the impact ICT is having on teacher motivation and capacity for collaboration and engagement beyond the school	NSSCF Progress Reports Interviews/Workshops/Focus Groups with Teachers, Principals, Authorities

Learning resources

What is being measured	Description of aspirations	Summary of indicators	Data Sources
Are schools providing access to online learning resources?	Most schools and authorities provide teachers with access to digital learning resources Many schools and authorities are starting to develop and share digital resources with other schools and jurisdictions	Schools provide teachers with or allow access to digital learning resources Schools / jurisdictions create or develop digital learning resources Schools / jurisdictions facilitate sharing of digital learning resources with teachers outside of their school / jurisdiction How digital learning resources are delivered / shared Perception of accessibility to digital learning resources	NSSCF progress reports Interviews/Workshops with Authorities, Principals, Teachers
Are teachers increasing their use of online resources?	Teachers are starting to become engaged in development and sharing of teaching and learning resources with their peers Resources and delivery mechanisms seen as most valuable by interviewed teachers included….	Teacher confidence in using digital learning resources Extent of teachers' use of learning resources	Interviews/Workshops with Authorities, Principals, Teachers
Are online resources supporting personalised learning?	Teachers are adapting resources to addressing specific learning needs and cohorts Teachers are looking for support to help understand, access and adapt available resources Online resources are helping to improve student engagement – particularly for those who might otherwise disengage	Perspectives on the quality and impact of available digital learning resources – including barriers to increased uptake	NSSCF progress reports and case studies Interviews/Workshops/Focus Groups with Authorities, Principals, Teachers, Students, Parents

Attachment 2: Stakeholder engagement list

Throughout the review, dandolopartners gained invaluable insights into the DER program through engagement with a large number and broad range of stakeholders, including DEEWR; education authorities (government, Catholic and independent), including Block Grant Authorities; members of the Digital Education Advisory Group (DEAG); national agencies; leading education practitioners and industry representatives; principals, teachers, students and parents. Education and Block Grant Authorities were responsible for arranging consultations with principals, teachers, students and parents in their jurisdiction.[150] We are appreciative of their efforts and of all those who participated in interviews, workshops and focus groups.

Table A3-1 presents the approximate number of stakeholders engaged from each stakeholder group and the method of engagement.

TABLE A3-1: STAKEHOLDER ENGAGEMENT LIST

Stakeholder group	Engagement method	Approx. number of stakeholders
DEEWR	One-on-one interviews	2
Education authorities, including CIOs	One-on-one and group interviews	62
DEAG representatives	One-on-one and group interviews	7
National agencies	One-on-one and group interviews	12
Leading education practitioners and industry representatives	One-on-one and group interviews	15
Principals	Workshops	34
Teachers	Workshops and one-on-one interviews	30
Students	Focus groups	40
Parents	Focus group and one-on-one interviews	7
Total		**209**

[150] A limited number of workshops and focus groups were identified for principals, teachers, students and parents. The allocation of these sessions was determined at random, with a mix of government and non-government stakeholders chosen to participate.

Attachment 3: Reference list

All Hallows' School (2011) *Blended Learning – Netbook Report 2011*.

Anytime Anywhere Learning Foundation (2009) *21 Steps to 21st-Century Learning*, available at http://www.aalf.org/cms/?page=AALF%20-%2021%20Steps%20to%2021st%20Century%20Learning, accessed on 28 July 2012.

Apple Computer Inc. (2005) *Research: What It Says about 1 to 1 Learning*.

Australian Bureau of Statistics (2011) *Australian Social Trends June 2011 – Online @ home,* Catalogue No. 4201.0, available at http://www.ausstats.abs.gov.au/ausstats/subscriber.nsf/LookupAttach/4102.0Publication29.06.116/$File/41020_Online_Jun2011.pdf, accessed on 30 July 2012.

Australian Government (2008) *Success through Partnership: Achieving a National Vision for ICT in Schools – Strategic Plan to Guide the Implementation of the Digital Education Revolution Initiative and Related Initiatives*.

Australian Government (2011) *Australia in the Asian Century*, *Issues Paper December 2011,* available at http://asiancentury.dpmc.gov.au/issues-paper, accessed on 1 August 2012.

Australian Government (2011) *Digital Education Revolution Evaluation Strategy, April 2011*, Department of Education, Employment and Workplace Relations, Canberra.

Australian Government (2011) *Review of Funding for Schooling: Final Report*, available at http://www.deewr.gov.au/Schooling/ReviewofFunding/Documents/Review-of-Funding-for-Schooling-Final-Report-Dec-2011.pdf, accessed on 22 June 2012.

Australian Institute for Teaching and School Leadership (AITSL) (2012) *National Professional Standards for Teachers*, available at http://www.teacherstandards.aitsl.edu.au, accessed on 26 July 2012.

Australian Institute for Teaching and School Leadership (AITSL) (2012) *Professional Learning – Leading Curriculum Change*, available at http://www.aitsl.edu.au/leading-curriculum-change.html, accessed on 27 July 2012.

Australian Institute for Teaching and School Leadership (AITSL) (2012) *Teacher Feature*, available at http://teacherfeature.aitsl.edu.au, accessed on 24 July 2012.

Banks, G. (2010) *Advancing Australia's 'Human Capital Agenda'*, Ian Little Lecture, Melbourne, 13 April.

British Educational Communications and Technology Agency (BECTA) (2005) *Research and Development Strategy 2005–8*, available at http://www.teachfind.com/becta/bectas-research-and-development-strategy-2005-8, accessed on 8 August 2012.

Catholic Education Office Sydney (2011) *Secondary Teacher Engagement in Digital Learning*.

Center for Interactive Learning and Collaboration, available at http://www.cilc.org, accessed on 3 August 2012.

Cisco (2010) *Genuine Transformation in K-12*, available at http://www.cisco.com/web/strategy/docs/education/broadmeadow_cs.pdf, accessed on 2 August 2012.

Cisco (2011) *Visual Networking Index (VNI): Global Mobile Data Traffic Forecast Update, 2011–2016*, available at http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-520862.pdf, accessed on 3 August 2012.

Cisco (2011) *VNI Mobile Forecast Highlights, 2011–2016*, available at http://www.cisco.com/web/solutions/sp/vni/vni_mobile_forecast_highlights/index.html, accessed on 3 August 2012.

Australia Government (2011) *School Broadband Connectivity Survey 2010*.

Council of Australian Governments (2009) *National Education Agreement*.

Department of Education and Early Childhood Development (2012) *New Directions for School Leadership and the Teaching Profession: Discussion Paper, June 2012*, available at http://www.eduweb.vic.gov.au/edulibrary/public/commrel/about/teachingprofession.pdf, accessed on 3 August 2012.

Doecke, B., Parr, G. & North, S. (2008) *Report of the National Mapping of Teacher Professional Learning in Australia Project*, DEEWR, Canberra.

Education Services Australia (2012) *ICT in Everyday Learning – Teacher Online Toolkit*, available at http://www.esa.edu.au/projects/ict-everyday-learning-teacher-online-toolkit, accessed on 26 July 2012.

Education Services Australia (2012) *National Digital Learning Resources Network*, available at http://www.ndlrn.edu.au/about/about_landing_page.html, accessed on 24 July 2012.

Education Services Australia (2012) *Teaching Teachers for the Future*, available at http://www.ttf.edu.au, accessed on 24 July 2012.

Fischman, J. (2011) 'Pearson and Google jump into learning management with a new, free system', *The Chronicle of Higher Education*, available at http://chronicle.com/blogs/wiredcampus/pearson-and-google-jump-into-learning-management-systems/33636, accessed on 3 August 2012.

Fox, C., Waters, J., Fletcher, G. & Levin, D. (2012) *The Broadband Imperative: Recommendations to Address K-12 Education Infrastructure Needs*, State Educational Technology Directors Association (SETDA), Washington DC.

Fullan, M. (2011) 'Choosing the wrong drivers for whole system reform'*, Seminar series 204, April 2011,* Centre for Strategic Direction, Melbourne.

Greaves, T., Hayes, J., Wilson, L., Gielniak, M. & Peterson, E. (2012) *Revolutionizing Education through Technology: the Project RED Roadmap for Transformation*, International Society for Technology in Education, Washington DC.

Griffin, P., Care, E., Tsurutani, H. & Woods, K. (2010) *Evaluation of the Ultra Mobile Personal Optimised Devices Trial in Victorian Schools (the Netbook Trial Evaluation), Phase Three and Four Report*, Assessment Research Centre, University of Melbourne.

Griffin, P., McGaw, B. & Care, E. (eds) (2012) *Assessment and Teaching of 21st-Century Skills*, Springer, Dordrecht.

Gulek, J.C. & Demirtas, H. (2005) 'Learning with technology: the impact of laptop use on student achievement', *Journal of Technology, Learning and Assessment*, 3 (2), pp. 1–39.

Hon. Wayne Swan MP (2010) *Government's Productivity Agenda to Tackle Future Changes*, 1 February, available at http://ministers.treasury.gov.au/DisplayDocs.aspx?doc=pressreleases/2010/007.htm&pageID=003&min=wms&Year=2010&doctype=0, accessed on 26 July 2012.

Howard, S. & Carceller, C. (2010) *DER-NSW Evaluation: Phase 1 – Before the Laptop Rollout*, NSW Department of Education and Training, p. 91.

Howard, S., Thurtell, E. & Gigliotti, A. (2012) *DER-NSW Evaluation: Report on the Implications of the 2011 Data Collection*, NSW Department of Education and Communities.

Intergovernmental Agreement on Federal Financial Relations, *Schedule C: Public Accountability and Performance Reporting*, available at http://www.federalfinancialrelations.gov.au/content/inter_agreement_and_schedules/current/schedule_c.pdf, accessed on 20 July 2012.

Jensen, B. (2010) *Investing in Our Teachers, Investing in Our Economy*, Grattan Institute, Melbourne.

Jensen, B. (2010) *What Teachers Want: Better Teacher Management*, Grattan Institute, Melbourne.

Jensen, B. (2012) *Catching Up: Learning from the Best School Systems in East Asia*, Grattan Institute, Melbourne.

Koh, T.S. & Lee, S.C. (eds) (2008) *Information Communication Technology in Education: Singapore's ICT Masterplans, 1997–2008*, World Scientific Publications, Singapore.

Lee, M. & Gaffney, M. (eds) (2008) *Leading a Digital School*, ACER Press, Melbourne.

Lippett, T. (2011) *Thumbs Up for C2C Ahead of Australian Curriculum*, Queensland Department of Education, Training and Employment.

McKenzie, P. (2012) 'Painting a picture of the teaching workforce', *Research Developments, Vol. 27 (2012)*, available at http://research.acer.edu.au/cgi/viewcontent.cgi?article=1099&context=resdev, accessed on 3 August 2012.

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

Mishra, P. & Koehler, M.J. (2006) 'Technological pedagogical content knowledge: a framework for teacher knowledge', *Teachers College Record*, 108 (6), pp. 1017–54.

Moyle, K. (2006) *Leadership and Learning with ICT: Voices from the Profession*, Australian Institute for Teaching and School Leadership.

National Schools Interoperability Program (2012) *About NSIP*, available at http://www.nsip.edu.au, accessed on 24 July 2012.

National Schools Interoperability Program (2012) *Tri Borders: Supporting Students in SA, NT and WA*, available at http:// http://www.sifinfo.org/upload/story/8E3BFF_SIF%20Association%20AU%20Pilot%202.1%20Tri-Borders.pdf, accessed on 23 July 2012.

Newhouse, P. (2010) 'School leadership critical to maximising the impact of ICT on learning', in D. Gronn & G. Romeo (eds) (2010) *ACEC2010: Digital Diversity*, Conference Proceedings of the Australian Computers in Education Conference 2010, 6–9 April, Carlton, Victoria, Australian Council for Computers in Education (ACEC).

NSW Department of Education and Communities (2012) *Great Teaching, Inspired Learning – Discussion Paper*, available at http://www.schools.nsw.edu.au/media/downloads/news/greatteaching/gtil.pdf, accessed on 1 August 2012.

NSW Department of Education and Training (2009) *One to One Computing: Literature Review*.

NSW Department of Education and Training (2010) *DERNSW Professional Learning Principals' Survey*.

NSW Department of Education and Training (2012) *CLIC DER-NSW report, September 2009 to 30 June 2012.*

OECD (2011) *PISA 2009 Results: Students Online: Digital Technologies and Performance (Volume VI)*, OECD Publishing, Paris.

OECD (2011) *Teachers Matter: Attracting, Developing and Retaining Effective Teachers – Pointers for Policy Development*, OECD Publishing, Paris.

Office of Information Technology, University of Colorado Boulder (2012) *What Are Cloud-Based Services?,* available at http://oit.colorado.edu/node/7532, accessed on 30 July 2012.

OneCommunity (2012) *Connect Your Community: K-12 Parents Digital Literacy Survey*.

Palnet, available at http://www.palnet.edu.au, accessed on 1 August 2012.

Pathways for Learning, Anywhere, Anytime – a Network for Educators, available at http://www.plane.edu.au, accessed on 26 July 2012.

Powerhouse Museum NSW, available at http://www.powerhousemuseum.com, accessed on 3 August 2012.

Queensland Government, Department of Education, Training and Employment (2012) *eLearning Leaders Framework*, available at http://education.qld.gov.au/smartclassrooms/developing-professionals/elearning-frameworks/leaders/index.html, accessed on 25 July 2012.

Royal Pingdom (2012) *Internet 2011 in Numbers*, available at http://royal.pingdom.com/2012/01/17/internet-2011-in-numbers, accessed on 1 August 2012.

Schulman, L. (1987) 'Knowledge and teaching: foundations of the new reform', *Harvard Educational Review*, 57 (1), pp. 1–22.

SIF Association (2012) *What Is SIF?,* available at http://www.sifinfo.org/au/, accessed on 24 July 2012.

TeachMeet Australia (2012) available at http://www.teachmeet.net, accessed on 26 July 2012.

Tearle, P. (2004) *The Implementation of ICT in UK Secondary Schools, Final Report*: *February 2004*, University of Exeter, The Telematics Centre.

The Auditor-General (2011) *Digital Education Revolution Program – National Secondary Schools Computer Fund*, Audit Report No. 30 2010–11 Performance Audit, Australian National Audit Office, Canberra.

Thomson, S. & De Bortoli, L. (2012) *Preparing Australian Students for the Digital World: Results from the PISA 2009 Digital Reading Literacy Assessment*, ACER Press, Camberwell, Vic.

Ubiquitous Computing, Pervasive Risk: Coping with the Proliferation of Mobile Devices (2011) online conference, available at https://isc2.brighttalk.com/node/902, accessed on 3 August 2012.

University of New England (2011) *Australia–Korea Connexion*, available at http://www.une.edu.au/austkoreaconnexion, accessed on 1 August 2012.

Vacirca, E. (2008) 'How do teachers develop their technological pedagogical content knowledge in the context of system-wide pedagogical and curriculum reform?', Australian Association for Research in Education Conference, Brisbane.

Victorian Government, Department of Education and Early Childhood Development (2012) *eLearning ICT Showcases – Galvin Park Secondary College*, available at http://epotential.education.vic.gov.au/showcase/1to1_learning/nsscf, accessed on 9 August 2012.

Woods, K., Griffin, P. & Care, E. (2011) *Evaluation of the Ultra Mobile Personal Optimised Devices Trial in Victorian Schools: Addendum to the Final Report*, Assessment Research Centre, University of Melbourne.