NSW GOVERNMENT Education & Communities

Bring Your Own Device (BYOD) in Schools

2013 Literature Review

Technology for Learning Program – Information Technology Directorate

BYOD in Schools Literature Review 2013

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About this review

There is an extensive body of literature available on Bring Your Own Device (BYOD). This review represents a reasonable and representative scan of the available literature. It should be noted that this reviewer was unable to locate any peer reviewed studies of BYOD in action, though the review does include published observations of the benefits and otherwise of BYOD programs. The literature can be divided into opinion pieces, discussions, school policies, reports, lessons learnt and guides to instituting BYOD programs.

Given that all NSW public secondary school teachers and students have Wi-Fi access to filtered internet through centrally managed wireless access points in every learning space and library and that primary schools can purchase a similar solution, this review does not consider problems of wireless access and provision of bandwidth to any great depth.

Background

In 2008 the Commonwealth Government instituted its Digital Education Revolution (DER), designed to bring about a 1:1 computer to student ratio for years 9 to 12 in schools by 2012. The DER Program in NSW (DERNSW) consisted of five distinct, parallel, major projects: provision of a wireless enabled laptop with educational and productivity software to every NSW public school secondary student from years 9 to 12; professional learning and curriculum support for school leaders and teachers ; revised policies and procedures; centrally managed wireless access points – one in every learning space and library in every public high and central school in NSW; and on-site technical support services in all targeted schools including over 400 full time school Technology Support Officers. The 1:1 ratio was achieved by the beginning of 2012 with a further roll-out of laptops to students in Year 9 2013.

With the demise of funding of the DER program by the Australian Government, schools and systems are examining ways of continuing the 1:1 computer to student ratio. "The solution being given increasing attention is Bring Your Own Device (BYOD). BYOD has been popular in the business world for several years as activities ranging from email and calendar management to word processing and graphic design has migrated to hardware owned by employees" (Cohen, 2013, p. 1). BYOD is coming under serious consideration globally for schools, but not only because of the lack of funding.

One-to-one programs and student learning

There is much published research on the impact of one-to-one computer programs in school. The DERNSW One-to-One computers in school literature review of 2010 reported on this (Stavert, 2010), citing evidence in studies of improvements in standardised test results

and particularly in literacy and writing. Since the time of that review, more data has become available. A summary of the research across six states in the USA (Argueta, Huff, Tingen, & Jenifer O. Corn, 2011) found many positive effects. They found that students in these programs had become more self-directed learners and were more engaged and motivated while teachers were shifting to more student centred practices. In some, but not all, of the studies they found that laptop use was associated with increased performance in several curriculum areas. The final evaluation report of the Emerge one-to-one initiative in Alberta contains evidence that "the cross-sectional sample of elementary-level (Grades 3-5) students displayed major increases in their intrinsically engaged scores, shifting from 43% intrinsically engaged in Fall 2007 to 68% intrinsically engaged in Spring 2010.

Perhaps of similar importance has been the development of 21st century skills:

> "Evaluators also report that laptops have facilitated the development of 21st century skills e.g. digital literacy, creativity and innovation skills, critical thinking and problem solving skills, communication and collaboration, and self-directed learning) among students" (Argueta, Huff, Tingen, & Jenifer O. Corn, 2011, p. 15)

> "Emerge teachers reported significant gains in attainment of 21stCentury Skills" (The Metiri Group; University of Calgary, 2010)

Research by Howard (2013) in the phase two case studies conducted in 2012 on the DERNSW initiative revealed changes to teacher pedagogy due to the 1:1 laptop program.

Little wonder then that there is enthusiasm to continue with a 1:1 ratio of devices to students.

What is BYOD

"Bring your own device (BYOD) refers to technology models where students bring a personally owned device to school for the purpose of learning. A personally owned device is any technology device brought into the school and owned by a student (or the student's family), staff or guests" (Alberta Education, 2012). Put simply, BYOD is a solution where students quite literally bring their own device to school in order to access the internet and/or school network by 3G or Wi-Fi, be it a smartphone, tablet, laptop or other device. There are various models for BYOD which are discussed later in this review.

Why BYOD?

Financial pressures

There is no doubt that financial pressure is a major driver of the move to BYOD, though it is by no means the only driver. The Horizon Project 2013 identifies BYOD for adoption in one

year or less (Horizon Project, 2013), driven mainly by the challenge of lack of funds to continue one-to-one laptop programs. Others agree. For example, Lee (2012) points to governments' "increasing inability to fund state of the art personal technology for all students" (p. 1).

Pressure from students

As well as financial constraints, there is pressure from students and staff to use their own devices, a trend also seen in industry (Rowsell-Jones & Jones, Checklist for Determining Enterprise Readiness, 2012) (Cosgrove, 2012) (Clifford, 2012) (Good Technology, 2011). Sweeney (2012) in a report on BYOD in education for Australia and New Zealand, noted that "over the last year there has been a dramatic rise in the prevalence of students bringing personal computing devices (tablets, smartphones and laptops with greater or more personalised capabilities than those issued by the schools) into the classroom" (p. 6). Sweeney also noted that "there is a great deal of interest in utilising these consumer devices – especially tablets devices – into classroom activities" (p. 6) and that some feel that "BYOD is inevitable. We are going to face a tsunami of devices coming into the school. Students have an expectation that they can have a device to access the information they need" (p. 9). Perhaps more tellingly, DeWitt (2013) notes that "A laptop or tablet has replaced the notebook and pen over the past few years since our present technological explosion" (p.1).

Others also point out the ubiquity of these devices, their importance to students and the power many students have at their fingertips:

> "We live in a world where these devices are a huge part of our student's lives. Schools should position themselves to not only take advantage of this resource as budgets are tight, but also teach students about the powerful tool they possess" (Sheninger E. , 2011, p. 1).

> "The reality is that web-based tools and resources have changed the landscape of learning. Students now have at their fingertips unlimited access to digital content, resources, experts, databases and communities of interest. By effectively leveraging such resources, school authorities not only have the opportunity to deepen student learning, but they can also develop digital literacy, fluency and citizenship in students that will prepare them for the high tech world in which they will live, learn and work" (Alberta Education, 2012, p. 4).

One source notes that our students have never known a world without these devices:

> "To put technological change into the perspective of our current Year 6s and Year 7s it is worth examining how old these students were when certain technologies were launched.
>
> 1998 Google
> 2000 Our Year 6s were born Age 0
> 2001 Wikipedia Age 1
> 2001 iPod Age 1
> 2003 MySpace Age 3

2003 3G mobile phones Age 3
2004 Facebook Age 4
2005 YouTube Age 5
Our students have only ever known a world with Google, Wikipedia, Myspace/Facebook, and mobile phones with high speed Internet." (Swan Christian College, 2012, p. 4)

Digital device ownership and use

"Over the last few years, laptops and handheld mobile devices have become affordable and provide users with 24/7 access to ideas, resources, people and communities" (Alberta Education, 2012, p. 4). This has led to a large increase in ownership. Statistics for Australia show that adult ownership of smartphones increased from 25% in June 2011 to 49% in May 2012. A staggering 9.2 million Australians accessed the internet from their mobile phones in the six months to May 2012 and a further 4.4 million accessed the internet using a tablet (ACMA, 2013). There has been a steady increase of users downloading mobile apps in Australia from 2.408 million in June 2011 to 4.454 million in June 2012 (ACMA, 2013).

The Speak Up surveys (Project Tomorrow, 2012) reveal similar increases in the use of smartphones in the USA. More recent research in the US has revealed that "one in four teens are "cell-mostly" internet users, who say they mostly go online using their phone and not using some other device such as a desktop or laptop computer" (Madden, Lenhart, Duggan, Cortesi, & Gasser, 2013, p. 2). Further, the same researchers found:

- "78% of teens now have a cell phone, and almost half (47%) of those own smartphones. That translates into 37% of all teens who have smartphones, up from just 23% in 2011.
- "One in four teens (23%) have a tablet computer, a level comparable to the general adult population.
- "Nine in ten (93%) teens have a computer or have access to one at home. This ever increasing ownership of smart devices means that many students, but not all, possess themselves or have access to a device that can be used as a powerful learning tool" (Madden, Lenhart, Duggan, Cortesi, & Gasser, 2013, p. 2).

Interestingly, they also found that "those who fall into lower socioeconomic groups are just as likely and in some cases more likely than those living in higher income and more highly educated households to use their cell phone as a primary point of access" (Madden, Lenhart, Duggan, Cortesi, & Gasser, 2013, p. 2)

Compelling reasons from the literature

Much of the reasoning behind the use of BYOD in the literature, other than the financial imperative, revolves around the following arguments.

The devices are a significant part of students' lives

Many authors point out that these devices are a very significant part of students' lives (Clifford, 2012, p. 1) (Sheninger E. , 2011) (Lee, BYOT, 2012) (Sweeney, 2012) (Walling, 2012). Some of these authors argue that as these devices are integral to the world in which these students live they should be integral to their learning lives and their use will make learning part of their lives. In many schools the use of such devices is banned. DeWitt (2013) argues that "Just like in the workplace, schools ban the devices that make them uncomfortable. Instead, we should teach students how to use it properly" (DeWitt, 2013, p. 1) and that "banning devices only makes the school system seem further behind society than it really is" (DeWitt, 2013, p. 1). BYOD also "allows students access to the same devices at school and at home, it can extend learning opportunities to times and places outside of the classroom" (Horizon Project, 2013) and "allow students to work with technology with which they are already comfortable and familiar" (Horizon Project, 2013).

For this reason it is seen as important that the device is not a locked down solution. "The more locked down a system, the less likely students are to see the device as of personal value to them. Conversely, the more personal activities the students can perform on the device, the more care they take" (Sweeney, 2012).

21st century skills

21st century skills are cited by many authors as a justification for the BYOD. "We have come to a time when we need to accept the fact that the concept of 21st century skills is no longer a progressive phase to latch onto but a reality that we need to instil into our school systems" (DeWitt, 2013, p. 1). These authors see that mobile devices are part of 21st century living and integral to learning 21st century skills. Furthermore they are so useful that " a growing number of schools, such as New Jersey's New Milford High School (NMHS), let students use their phones, recognising that even the simplest such gadget can be a tool for communication, calculation, photography, videography, and calculations" (Watters, 2012). "Learning becomes easier to achieve, as it is more collaborative. Students can integrate the device into their daily lives" (Clifford, 2012, p. 2).

More personalised student centred learning

More personalised, student centred learning is often cited as a reason for BYOD (Alberta Education, 2012) (Argueta, Huff, Tingen, & Jenifer O. Corn, 2011). "Bring your own device puts students in a position of power over their learning. Many educational researchers argue that giving students the authority over their own learning is best: the teacher becomes a manager of learning, rather than a direct source of information" (Clifford, 2012, p. 2). "Such devices, in the hands of every student, afford seamless learning opportunities that bridge the formal learning in schools with the informal, outside of classrooms and schools" (Alberta

Education, 2012, p. 5). Many argue that this and the ability to use their own device, leads to increased motivation and engagement

The cloud

The cloud "is ideal for core apps which are free or inexpensive such as Google and Zoho" (Livingston, 2012, p. 1). The cloud enables any student with a device able to browse the web to store and share information and access applications. "With browser-based apps, we don't need to find and update resources and applications that are compatible with a wide range of devices and operating systems" (Williams, Managing BYOD Effectively, 2012, p. 84).

Increasing parental support

The Speak Up surveys in the US (Project Tomorrow, 2012) found that "87% of parents say that the effective implementation of technology within instruction is important to their child's success (50% label it as "extremely important") (p 1). Perhaps because of this "Parents are realising that a digital device is necessary for learning" (Livingston, 2012, p. 1). An informal survey run by the Sydney Morning Herald following an article on BYOD found that 68% of respondents thought that students should be able to bring their own smartphones and tablets to school (Topsfield, 2012).

Concerns about BYOD

The major concerns expressed in the literature (other than wireless, broadband capacity, web filtering and network security which are not be discussed in this review due to the NSW solution) were equity of provision, whether BYOD provided students with the right tool for the task, theft and distraction from learning. It is important to note that these were perceptions and not based on any studies that revealed these problems in any implemented BYOD programs.

Equity

This is seen as a problem by many authors. Sager (2011) believes BYOD enshrines inequity. He further believes that "The only way to guarantee equitable educational experiences is for each student to have access to the same materials and learning opportunities. BYOD leaves this to chance with more affluent students continuing to have an unfair advantage over their classmates. This is particularly problematic in a society with growing economic disparity" (Sager, 2011). However, Barsegihian (2012) quotes Tim Clark, district instructional technology specialist with Forsyth County Schools (GA), explaining that in his experience, 'Students who do not have personal technology devices have greater access to school-owned technology tools when students who bring their own devices to school are no longer competing for that access'" (Barseghian, 2012). Furthermore research quoted above on

mobile access to the internet (Madden, Lenhart, Duggan, Cortesi, & Gasser, 2013) shows little difference in access between socioeconomic groups.

Clearly inequity will need to be addressed in any BYOD implementation. "In practice, it has proven important to provide funds to support families in financial need" (Horizon Project, 2013).

The best tool for the task?

Some argue that BYOD is a poor solution and won't provide the best tool for the task. "BYOD diminishes the otherwise enormous potential of educational computing to the weakest device in the room" (Lamaster & Stager, 2012, p. 7). Dixon and Tierney (2012) argue that a BYOD model that enables students' choice of device "does not seem to be about either self-directed learning or personalising instruction, since its focus is not to provide each student with the best tool for a specific task, but rather whatever their families can provide" (Dixon & Tierney, 2012, p. 4). They argue that this has implications for pedagogy as the teacher will need to cater for the least powerful device in the classroom and students won't all have the same programs and applications. However, many BYOD programs specify the capability of devices that can be brought by students to overcome this problem. For example, Cheshire Public Schools (2013) specifies a choice of three tablets, two laptops and Wi-Fi enabled devices such as iPods and smartphones. Others argue that the use of web-based resources such as Google Apps overcomes this problem to some extent. "With browser-based apps, we don't need to find and update resources and applications that are compatible with a wide range of devices and operating systems" (Williams, Managing BYOD Effectively, 2012, p. 84).

Distraction and theft

As part of Project Tomorrow (2012), school principals identified key issues that they said would prevent them from implementing BYOD. These included concerns about theft of the devices and who would be responsible in cases of theft, and the potential for the devices to be a distraction from the core learning process. Others share the same concerns (Walsh, 2012). However, a report on a study of the implementation of BYOD in three schools, (Ray, 2013) found that "Despite a fear of the unknown by many, there were no significant disciplinary, media, or educational cataclysms" (p. 10). Nevertheless most school policies cover these points.

Models for BYOD

There are various models for BYOD, both proposed and in use. At one end are the highly "locked down" models where the device to be used is dictated by the school. At the other end of the spectrum is the "bring your own whatever connects to the internet" model, where

the school does not prescribe any device at all. Sweeney (2012), Dixon and Tierney (2012) and the Alberta Guide (2012) have described different models of BYOD implementation.

Sweeney (2012) describes several models for BYOD. Those relevant to this discussion are:

1. *Bring Your Own Standard Device*, "where the students have to procure a device from a limited selection of standardised devices dictated by the school. Fully funded and owned by the student, but managed by the school" (Sweeney, 2012, p. 23)
2. *Bring Your Own Device*, where "the student procures and owns a device of their own choosing. The school does not manage the device, but may provide a managed educational environment using VDI (virtual desktop infrastructure) or remote access, or provide a web-based learning management system. In many cases the school demands a specific operating system or software solution to be installed on the device (eg. Windows 7 and the Microsoft Office suite)" (Sweeney, 2012, p. 23).
3. *Bring Your Own Stuff* , where "the student procures and owns not only their own device, but also has complete control over the software and services they use within the educational environment. While this approach may appear similar to BYOD, it does away with any attempt by the school to provide a baseline education environment. The school's only activities are to provide network connectivity, content through a standard (web-based) Learning Management Environment, and administrative services" (Sweeney, 2012, p. 23).
4. *Education as a Service*. "At this point, the school is acting purely as an Internet based resource for learning. The student selects and owns their device(s), makes a decision on the software they will use, and also provides their own network infrastructure (using 3G or 4G wireless networking)" (Sweeney, 2012, p. 23).

Dixon and Tierney (2012) put forward five models for BYOD and include discussion of each:

1. *School-defined single platform laptop*. In this model the school defines the required minimum specifications for student laptops. The benefits of this model include: student computers all have the same capabilities, so no student is working with an inferior tool and teachers can plan learning activities around these capabilities; the specification of a single model and brand offers the best volume buying power, simplifies servicing arrangements significantly, and lowers costs accordingly; and the devices are fully functional laptops, which can be used for the full range of learning activities (Dixon & Tierney, 2012, p. 7). This is similar to Sweeney's *Bring your own standard device* model .
2. *School-defined single platform laptop, plus another device*. This is the same as the above plus students are allowed to use smartphones etc. It can be used to 'legalise' smartphones in schools and allow for school policy to more effectively guide appropriate use. When used as supplementary devices, this format allows for flexibility and personal choice, while ensuring there is a common standard across a class. Considerations include: smartphones, as with 3G or 4G enabled modem sticks,

are unfiltered; additional devices can be seen as distracting; and maintenance of any additional device is entirely the responsibility of families. (Dixon & Tierney, 2012, p. 8).

3. *School-defined multi-platform laptops*. Similar to Model One, but, while the laptop must adhere to minimum specifications it several platforms or manufacturers are acceptable. Benefits: Parents or students who prefer one platform or manufacturer over another have a choice. Considerations: more work for the network manager to manage a variety of laptops; buying power and bulk discount purchasing options are diminished, for both hardware and service accountability; teachers and tech support staff need to be familiar with several platforms; and some programs are either not available across platforms or exhibit some differences (Dixon & Tierney, 2012, p. 8).
4. *Student-choice of laptop or tablet*. The students can bring a laptop (no matter what form, including netbook) with full PC functionality, or a Tablet. 100% -parent funded. Benefits: parents and students who prefer one platform or device over another have a choice. Considerations: student devices do not all have the same capabilities; some devices aren't suitable for consumption and production/ creative tasks or cannot even input full sentences easily; teachers and tech support staff need to be familiar with several platforms and many devices; buying power and bulk discount purchasing and licensing options are diminished; most programs/applications are not available across all platforms and devices or function very differently across various devices (Dixon & Tierney, 2012, p. 9).
5. *Bring your own whatever connects to the Internet*. When people speak broadly of BYOD, this is the option they are usually referring to. This model allows students to bring any device that connects to the Internet – smartphone, e-book or 5-year-old laptop from their parents. There are no minimum specifications for screen size, keyboard, storage, ports and so on. 100 % parent funded. Considerations – same as for model 4 plus the" wide variety of devices and device functionality engenders considerable complexity in the classroom" (Dixon & Tierney, 2012, p. 9).

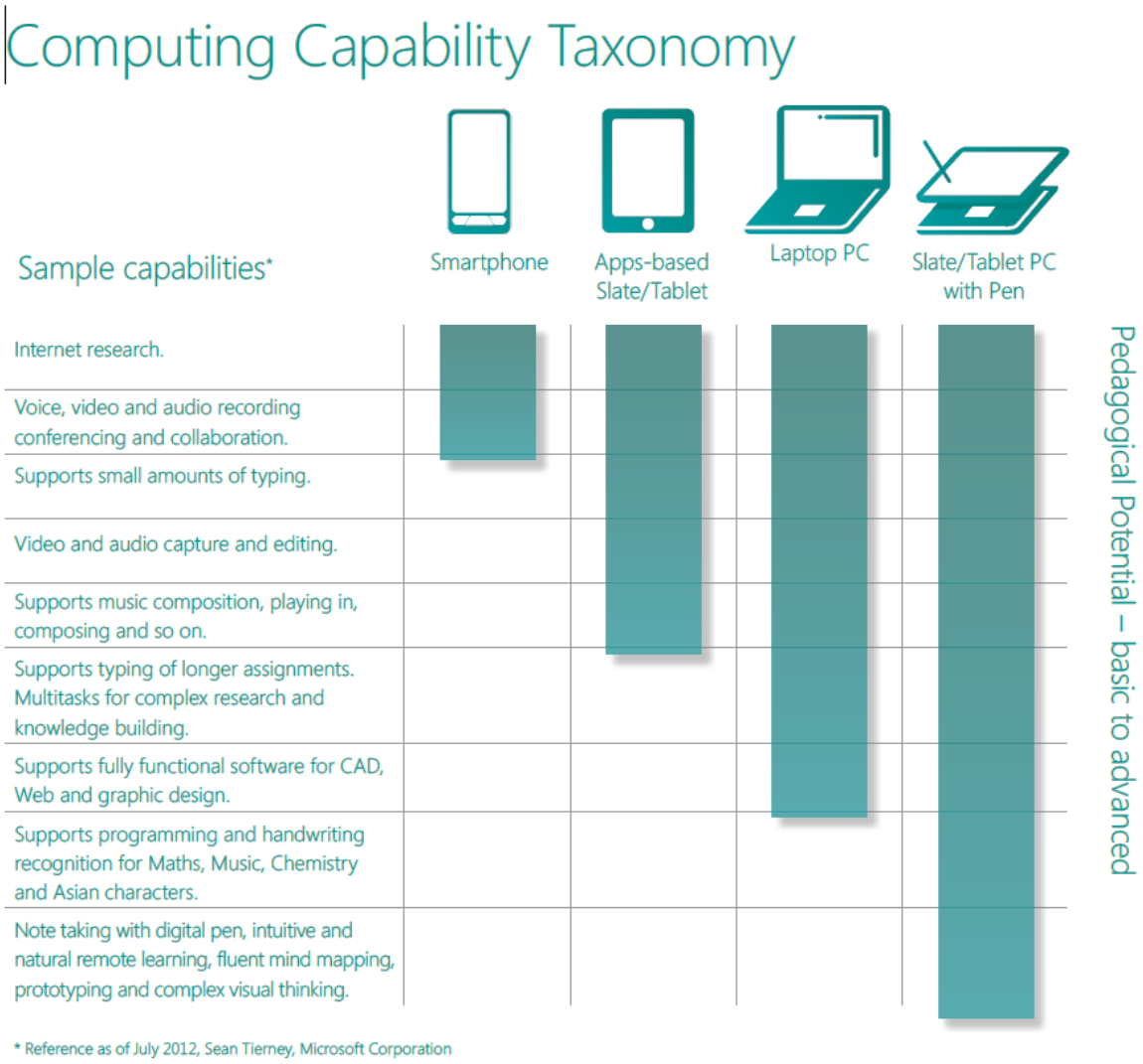
The Alberta guide for schools (Alberta Education, 2012) cites five models as follows:

> "1. Limiting personally owned devices to a specific brand/model of device.
>
> 2. Limiting personally owned devices to those that meet specific technical specifications (e.g., specific versions of operating systems, minimum amount of storage space, Internet ready, etc.).
>
> 3. Limiting personally owned devices to those with specific functionality (e.g., compatibility with software, compatibility with online testing requirements, etc.).
>
> 4. Accepting all personally owned devices provided they are Internet-ready.
>
> 5. Hybrids or combinations of the four models listed above." (Alberta Education, 2012, p. 11)

Clearly the model decided upon is extremely important. "One of the key strategic steps each school authority should take, prior to making this decision, is to clearly articulate its goal(s) for opening up schools and classrooms to personally owned devices" (Alberta Education, 2012, p. 11). The goals of the program will determine the model to be used and must be carefully considered. Selection of a model will be discussed below.

Device capabilities

Dixon and Tierney (2012) examine the abilities of devices and propose the "pedagogical potential" of each. Figure 1 represents their findings. As can be seen, according to these authors the devices with the greatest pedagogical potential are the laptop PC and the



Slate/tablet PC with pen. Schools will have to consider carefully the purposes to which the devices are to be put to when developing their own BYOD policies.

Figure 1: Computing Capability Taxonomy (Dixon & Tierney, 2012, p. 5)

Implementing BYOD – lessons from the literature

There are many lessons that can be learnt from those who have implemented BYOD programs. "A year ago, the BYOD wave swept over education as schools reversed previous policies and allowed students to bring in their own devices and use them in the classroom. While many districts agreed to the new rules as an experiment, or pilot, it was quickly discovered that this decision was the easy one to make. What comes after allowing devices into schools — from beefing up networks and wireless access to keeping your network safe from viruses to training teachers to handle the influx — is where the real work starts" (Butterman, 2012, p. 55).The overall advice from the literature will come as no surprise to educational leaders: plan collaboratively, consult and communicate, keep teaching and learning at the centre of everything, provide professional learning for teachers, have good policies in place, address equity and include a focus on digital citizenship.

DeWitt (2013), Dixon and Tierney (2012), Livingston (2012) and Sweeny (2012) propose a series of questions that schools must consider before embarking on a BYOD program. These cover the major considerations schools need to address and are discussed below.

Planning collaboratively

As with all initiatives, clarification of goals and careful and collaborative planning are essential. There are several guides to planning available and this literature review will not go into the process in great detail. Butterman (2012) gives a month by month guide to planning. Alberta Education (2012) provides a very comprehensive guide. Many other sources provide guidance in the form of setting out the issues that must be discussed. It is also important to be clear on the reasoning behind and the goals for the program (Alberta Education, 2012, p. 11). Corrimal East Public School (2012, p.3) set out their goals very concisely.

The first steps recommended in planning incorporate answering the questions below in order to establish a school BYOD policy (see next section).

What model of BYOD is appropriated for your school?

Three sets of models were discussed above. The pros and cons of each model are discussed at length, particularly in the Alberta guide to schools (Alberta Education, 2012) and by Dixon and Tierney (2012) and Sweeney (2012). In making a decision, it is useful to consider the three broad categories.

Tightly controlled models

In these models all students have the same laptops with the same capabilities and software decided in advance by teachers. This assists teachers with their planning, makes for easier

trouble shooting and management and allows volume buying thus saving money. However, this completely limits options for families which may decrease compliance. Lee (2012) points out that it is important there be choice if there is to be compliance: models of BYOD "where there is minimal collaboration where the school or authority largely unilaterally informs the parents what they are obliged to do with their personal technology but the signs are the likelihood of that approach realising the 100 per cent uptake and many of the desired outcomes are small" (Lee, 2012, p. 45). As well as this, students may not feel any personal ownership of such a device, especially if it is centrally managed by the school and limits any personal usage.

Limiting the device to those that meet specific requirements

An example of such a program would be one where the school specifies that the device must run specific software or apps, have a minimum size RAM and hard drive etc. be it a laptop or tablet device or even a smartphone. This model gives more choice to families while still allowing teachers to know the capabilities of the student devices when planning lessons. This model may cause more technical management problems, particularly in the classroom, and eliminates any advantages in bulk buying, but may encourage more compliance than the single device model. Dixon and Tierney (2012) point out that most applications and functions are not available across all devices so, if this is important to a school, careful thought must be given to the range of models acceptable. Despite these considerations, this model is proving popular in many schools.

Accepting any personally owned device provided it is internet ready

This model offers families maximum flexibility which will produce greater compliance (Lee, 2012) and allows students to bring their personal devices such as smartphones. Students' personal connection with their own devices, the fact that these are part of their lives and many authors believe should be part of their learning life has been covered above. Some authors predict that this model will cause more technical management problems, particularly in the classroom. However, Williams (2012, p.84) studied the implementation of such a BYOD model in several schools and found that "BYOD is much easier on the IT department because students troubleshoot and manage their own devices". This model does eliminate any advantages in bulk buying but as students will, in the main, be bringing devices they already possess this is of little consequence. Dixon and Tierney (2012) also point out the difficulty this would create for teachers - there could such a variety of devices from 5 year old laptops to smartphones that teachers could not be certain what will work on each person's device. However, some see this as a lever to change pedagogy: " With the variety of devices in any classroom, the teacher cannot know every device, thus he will be required to focus on the learning and leave the technical challenges to the student, who knows (or must learn to know) his own device" (Alberta Education, 2012).

Let the pedagogy decide

According to Sweeney (2012) the answer to the question of which model to use depends mainly upon pedagogy. He proposes further questions to help schools focus their discussion of pedagogy. These include: "What is the purpose of education in our institution: to assist students to be workforce ready; produce outstanding results on standardised test; provide equity and equal opportunities, etc? Are the students best served by demonstrative or experiential learning? How does pedagogy impact the types of devices and software required? What teacher professional development is required to cause a shift in pedagogy?" (Sweeney, 2012, p. 18). He also points out that "Teacher control is closely related to the pedagogy conversation (above) but is worthwhile being debated independently, since it has so much bearing on BYOD decisions. A key element for BYOD decision making is how much control of content and software the teachers need in the classroom. Questions to ask**:** Is the teacher the font of knowledge or a guide? How much control of content and classroom activities does the teacher need? Is the teaching related to skills or theory? Where does learning take place? Is the intention to have 'flip classrooms'?" (Sweeney, 2012, p. 19).

Sweeney (2012) maintains that where the teaching environment is tightly controlled, the BYOD model needs to focus on students having the same software and desktop experience. This does not necessarily mean a single standard device managed by the school (the first model in each of the sets of models described above) but it would limit the range of devices that students and their parents could choose from. Where the control of learning is mainly in the hands of the students themselves, Sweeney (2012) maintains that far less standardisation and control is required.

How will parents be informed and consulted?

"The communication with the school community (i.e. students, parents, community groups and other stakeholders) is tremendously important if the plan is to have strong community support and sustainability. The community needs to be involved every step of the way" (Alberta Education, 2012, p. 58). In this way there will be greater ownership of the decisions and greater compliance. The Alberta guide (2012) suggests data needs to be collected including: the types of technology devices students have access to at home; home internet access; parents' hopes and fears regarding personally owned devices; the cost that is reasonable for parents; and the support, information and training needed by parents. Connecting with the community can also successfully achieved by community forums:

> "One key strategy was hosting a series of community engagement meetings. The meetings provided a forum for teachers and administrators to speak with and answer questions from parents and students. The theme of these conversations centered on understanding the why behind the initiative. Staff reflected that parents were extremely supportive upon recognizing the enthusiasm and conviction of the staff members and as they came to understand that the initiative was centered on improving student learning. The summary of these conversations can be read here: http://springhs.rockyview.ab.ca/our-school/one-to-one/important-documents/Q-A.pdf/view " (Alberta Education, 2012, p. 60)

Once data from parents has been analysed, the device or range of devices and BYOD model decided upon and all policies put into place, communication about the program is again very important. "Parents need to know what their children are doing with the expensive devices they bring to school" (DeWitt, 2013, p. 1). This can be achieved in many ways, including community forums and, almost universally, by the school web site.

How will you address equity?

"What about the students who cannot afford the devices? If schools require or encourage devices, they need a plan for those students who cannot afford them" (DeWitt, 2013, p. 1)

As discussed earlier, equity is seen as a major issue in any discussion of BYOD. Even though Forsyth County Schools found that students bringing their own devices freed up school devices for students who could not afford them (Barseghian, 2012), "in practice, it has proven important to provide funds to support families in financial need" (Horizon Project, 2013).

Schools will need to plan and budget for this. The Alberta guide (Alberta Education, 2012, p. 20) suggests two strategies: a pool of school-owned devices for loan to students whose families cannot afford a personally owned device; and a scheme whereby families' lease-to-own devices to that make payment easier for parents. The first of these ideas is repeated throughout the literature. "Be sure to budget for more spares than you think you will need" (Inman, 2012, p. 1)

What professional development do teachers require for BYOD? Keep the emphasis on teaching and learning.

Planning for professional leaning for teachers is also seen as essential by many authors. "Not all staff understand how it works. Many teachers want to allow students to bring their own devices but they do not always understand how they handle the concept" (DeWitt, 2013). In NSW, secondary school teachers in the public school system are entering their fifth year of experience of a one-to-one program and, according to Howard (2013) there is evidence of pedagogical change. However, many teachers in NSW primary schools have not had this experience and secondary school teachers have experience of students using laptops, not other devices nor a mixture of devices.

The literature is clear that the focus of professional learning should be on pedagogy, not the technology. Inman (2012) studied the implementation of BYOD programs and concluded that "BYOD programs that focus too heavily on the technology at the expense of teaching and learning goals fail to really get off the ground" (Inman, 2012, p. 1). The report on a trial of the use of iPads in three NSW schools noted that tablets "have the potential to afford new opportunities for learning if accompanied by student-centred pedagogies and authentic learning experiences" (NSW Department of Education and Communities, 2012, p. 9). The report also noted that "the deployment of mobile devices in the classroom demands the overt teaching of 21st century skills, as presently advocated by the National Curriculum" and

that "professional learning should also encourage teachers to consider the pedagogical approaches that best optimise the iPad's use in the classroom" (NSW Department of Education and Communities, 2012, p. 10). A report on BYOD implementation in three US districts found that "If the teachers and the instruction are not ready for BYOD, then it will not be successful. It is about creating student-centred instruction that allows students to use technology to its fullest. When students are actively involved with the lesson by gathering information, collaborating, and sharing their findings, technology will have the type of impact for which we have been striving" (Stutsman, 2013, p. 36).

Teachers will need to know about the tools and apps available to students using their devices, including the use of the cloud based apps and storage, but the emphasis must be on the pedagogy – how can students most effectively use them in their learning?

Have you prepared your students to be good digital citizens?

"Today's digital devices and social media provide opportunities for students to be part of the participatory digital culture that connects people both locally and globally. To participate fully, ethically and safely, students must step up and exercise their rights and responsibilities as digital citizens" (Alberta Education, 2012, p. 24). However, there are many pitfalls awaiting our students entering this online world and there is a growing consensus that they need guidance and help to learn not only to keep themselves safe, but also to behave ethically. "Educators have realised the need for a set of common understandings about what is expected of students and others in using technology. There is an emerging worldwide movement to address and characterise digital citizenship which makes it imperative that this is addressed in all schools" (O'Brien & Stavert, 2011, p. 115).

Digital citizenship education goes further than an attempt to control behaviour, it "takes a more comprehensive approach by recognising the important role of education in preparing digital citizens" (Alberta Education, 2012, p. 1). There are various frameworks for digital citizenship, including the framework adopted by DEC NSW which has six domains: digital conduct, digital footprint, digital relationships, digital health and wellbeing, digital law and digital financial literacy. There are also two interwoven themes: cyber safety and cyberbullying (O'Brien & Stavert, 2011, p. 116). After the adoption of this framework, the NSW DEC created "an online resource for teachers to assist them to both understand and teach digital citizenship along with parent education materials have been developed to explain the issues and introduce teachers and parents to the online resource materials that will be used in class" (O'Brien & Stavert, 2011, p. 116). This comprehensive resource is available at: http://www.digitalcitizenship.nsw.edu.au/ and targets primary and secondary school students. A limited trial of the resources in 2012 revealed that the "digital citizenship education lessons were remarkably successful and indicate the value of educating young people in safe and responsible behaviours when using social networking services and other new technologies" (O'Brien & Stavert, 2011, p. 118).

Schools need to plan for the implementation of digital citizenship lessons in their teaching programs.

Practical considerations

Will your wireless network cope?

Many authors pose this question. For example, Robinson (2012) advises schools to "make sure your hardware and software is prepared to handle things like the sudden increase of IP addresses with all the new devices logged on to your network. Also, how will the sudden increase in devices affect bandwidth? Taking stock of your network to see if BYOD is going to enhance access not degrade access is important" (p. 1).

The Alberta guide (2012) poses these key questions:

> *"• What are the projected requirements per student/staff?*
>
> *• What is the current wireless capacity and configuration? What is the number of supported users per access point? Can you manage the network centrally?*
>
> *• What is the gap in bandwidth? Wired network capacity? Wireless coverage? Network configuration? How will you close the gap in the short-term?*
>
> *• What will the network look like in the long-term?*
>
> *• What will be your projected adoption rate, i.e., growth rate among students with personally owned devices and subsequent upgrading of your infrastructure?"* (Alberta Education, 2012, p. 49)

NSW public secondary schools have the DERNSW solution in place. All NSW public schools will soon have the opportunity to migrate to the Enhanced Technology for Learning (eT4L) solution, consisting of a server and services. This will provide all schools with an easily managed solution that they can adapt and build on. Secondary schools are already equipped with wireless access points in all learning spaces courtesy of the DER. Primary schools will need to plan for the purchase and installation of access points to support their BYOD programs. These can be purchased through the DEC.

What is the policy if a device is lost or stolen?

This is raised several times in the literature and is an important concern. There are guidelines covering this in two NSW Department of Education and Communities Legal Issues Bulletins. These both make it clear that

- students bring their own property to the school at their own risk
- schools will not accept any responsibility for loss or damage
- students and parents should be constantly reminded of this

- once property is confiscated from a student and is then lost or destroyed the school may be liable to compensate the student.

These are relevant excerpts from Legal Issues Bulletin 35:

> "If a student's mobile phone is damaged or lost after being confiscated, is the school or institute liable to pay any compensation?
>
> > "Students and parents should be reminded on a regular basis that students bring mobile phones to the school or institute at their own risk – schools and institutes will not accept any responsibility for loss or damage to mobile phones.
> >
> > "Once confiscated however, responsibility for the security and safe keeping of the mobile phone does rest with the school or institute. If a confiscated mobile phone is lost or destroyed while not having been properly secured by staff, the school or institute may be liable to compensate the student" (NSW DEC Legal Services Directorate, 2012, p. 3).

These are relevant excerpts from Legal Issues Bulletin 8:

> "Will students, parents or community members be covered for loss of personal property in schools and institutes?
>
> > "Principals and institute managers should ensure persons who have cause to bring property onto the school or institute site are advised they do so at their own risk. As a general rule no responsibility should be accepted for loss or damage to private property brought to the school or institute." (NSW DEC Legal Services Directorate, 2012, p. 2)
>
> "If the personal property of a student, parent or community member is confiscated or otherwise lent to the school or institute, what steps should be taken in relation to its security?
>
> > "The Department is obliged to take reasonable steps to ensure the security of items entrusted to it by others. It is not a duty to ensure safety – merely one to ensure reasonable steps are taken. If the personal property of students or other people is retained by school or institute staff, action must be taken to securely store the property until it is returned to the owner. Under no circumstances should personal property be left in unlocked desk drawers, teachers tables, cupboards, staffrooms and the like. The property must as a minimum be locked away. Failure to do so will render the school or institute liable in the event of loss" (NSW DEC Legal Services Directorate, 2012, p. 2) .

The lesson is clear – schools need to plan to inform and remind students and parents that schools will not accept any responsibility for loss or damage and be very cautious when taking a device from a student.

How will students charge their devices during the day?

This question is also raised many times in the literature with no clear answers. The Alberta guide (2012) states that "As personally owned devices are increasingly integrated into teaching and learning, limitations due to battery life of the devices becomes evident. School authorities are finding it necessary to establish procedures that require students to bring their personally owned devices fully charged" p. 54. This is also the solution adopted by DERNSW also as the DER laptops have a charge capacity that will last a full school day. However, many devices will not have this capacity. Because of this, "provisions must be in place to enable students to recharge their devices during the school day" (Alberta Education, 2012, p. 55). The Calgary Board of Education recommends "the creation of simple charging stations for laptops and other devices through access to power bars" (Anon, 2012, p. 55) while noting that students will still be responsible for the security of their devices while they are charging. All schools will need to consider this question and plan solutions.

School Policies

There are many examples of policies available on school web sites. These generally outline the BYOD model chosen for the school and address many or all of the issues outlined at some length above, including consequences of non-compliance.

Many schools allow students to "Bring your own whatever connects to the Internet" (Dixon & Tierney, 2012, p. 9). Typical of these policies is that from the Cheshire Public Schools district of Connecticut USA. The Cheshire Public Schools website contains a BYOD resources centre (Cheshire Public Schools, 2013) that commences by emphasising digital citizenship and includes sections for parents and students containing digital citizenship and safety information and links. The "Bring your own whatever connects to the Internet" nature of their implementation model can be seen in Its "Frequently asked questions" section:

> "What type of electronic device would you recommend for my child to bring to school?
>
> Our Wi-Fi network is "device-neutral" and students can bring in and connect to our Wi-Fi network with any device of their choice. A list of some suggested devices is provided below:
> Tablets
>
> - iPad 2 (16GB Wi-Fi model)
> - iPad Mini (16GB Wi-Fi model)
> - Android-based Tablets (Large selection available, such as the 7" 16GB Wi-Fi Kindle Fire HD)
>
> Laptops

- Samsung Chromebook, the 11.6" Wi-Fi model is a highly recommended student favorite
- Other Mac or Windows based laptops (numerous models available)

Other Wi-Fi enabled devices

- iPod Touch
- Smartphones

Book Readers (Note - these are permitted but may have limited browser features)

- Kindles, Nooks, etc." (Cheshire Public Schools, 2013)

The policy also covers access to the district wireless network including passwords, loan devices for those who cannot bring their own device, and a clear district and school disclaimer for any responsibility when a device is lost or stolen. It also includes information on setting up and using a Google Apps account as students will be connect through their devices to "a wireless network that is designed to give you Internet access only. It is not the same as the network you would normally access from a district owned computer. You will not see your student network drive, so you will need to save your work in your Google Apps account. You can access that account from anywhere you have connectivity—at home, school, Starbucks, McDonalds, etc." (Cheshire Public Schools, 2013). It also outlines the use of the Google Apps domain the district has purchased for student and teacher use.

The Cheshire Public Schools policy contains, as well as their acceptable use policy, a BYOD agreement. This asks each parent to acknowledge among other things that the school is not responsible for the student's device, that technology support of the device will not be available (which is typical of this sort of model), that loaned devices will not be taken off the school premises and that the devices will not be used for personal , commercial or illegal purposes.

Swan Christian College in WA has implemented a tighter model, limiting the device to those that meet specific requirements. The college has arranged for a single supplier, presumably to cut costs for parents, while allowing choice of the type of device within a defined range:

" BYOD Device Specific Recommendations

Acer TM3830 - Entry Level 13" Windows Laptop

Acer S3 / Dell XPS 13 - Higher End 13" Windows Ultrabook

Macbook Air 11" - Lower End Mac

Macbook Pro 13" - Higher End Mac

Apple iPad2 16GB edu model - lower end iPad

> Apple iPad Series 3 16GB edu model - higher end iPad" (Swan Christian College, 2012, p. 1)

As these are recommendations only, the college also supplies minimum specifications for other laptops and tablets. The policy sets out the apps required for tablets and the software required for laptops. There is information on available support, initially from the teacher and then from the IT support team. The discussion of models earlier predicted a greater need for support in this type of implementation.

The BYOD information to parents and students supplied by the Swan Christian College also emphasises student safety and the parental role in this and outlines a comprehensive code of conduct (Swan Christian College, 2012, p. 8). It outlines a policy for loan devices that only covers loans where a student device is in for repair. The school states that it will provide lockers for senior students and that those devices belonging to student in the junior school will be locked in the classroom at recess and lunch for juniors. The discussion of breakage does not mention the school liability but instead advises that help to arrange insurance is available.

The policy at Illawarra Grammar School in NSW is even more tightly controlled. The students are allowed the choice of a Windows (Vista or higher) laptop or an Apple Mac (OSX 10.4 or higher) with minimum requirements for RAM, hard drive capacity, screen resolution and wireless connectivity and specific hardware requirement. They are also told what pieces of software are required. (Illawarra Grammar School, 2012). Negotiations with suppliers have taken place to reduce costs for parents as is possible under this model. There is a specific process for technology support. The school acceptable use policy, social media policy, and technology use guidelines were yet to be published on their website at the time of writing.

Corrimal East Public School in NSW is an example of the implementation of an even more tightly controlled program where the only device in use is an iPad (Corrimal East Public School, 2012). Their policy clearly sets out the goals of the program and why iPads were chosen. While routines for the safe keeping of iPads before school, at recess and lunch are outlined, the policy makes it clear that the responsibility for the device is with the owner. They give parents the choice of purchase of an iPad through their own online store, the use of a school iPad (which must remain at school) and the choice to opt out of using the technology. They also specify the iPad apps to be installed on all iPads. All students participating and their parents must sign BYOD policy clearly setting out responsibilities.

As can be seen from these four policies, the models being introduced by schools vary considerably but the policies have common elements. These are summarised in the conclusions and key implication section of this review.

Technical Support

The model that is introduced in the school will largely determine the amount of technical support required. The tightly controlled model where the school insists on the one laptop will have similar technical support needs to the current DERNSW program. The more relaxed model where parents can choose from a range of laptops or other devices may cause greater technical support problems, particularly in the classroom where "teachers and tech support staff need to be familiar with several platforms and many devices" (Dixon & Tierney, 2012, p. 9). However, the model wherein students bring in any device that connects to the internet has proven to need the least technical support in practice. Williams (2012, p.84) studied the implementation of such a BYOD model in several schools and found that "BYOD is much easier on the IT department because students troubleshoot and manage their own devices". Others have found that "after moving to BYOD, students provide high levels of peer-to-peer support" (Sweeney, November 2012, p. 22). Inman (2012) quotes Jim Gerry suggesting shifting the technology support burden to students as a solution. Gerry "recommends having students help each other when their personal devices have technical issues (rather than making it the responsibility of school IT staff). This is especially important for schools that welcome an array of devices that carry unique support requirements" (Inman, 2012, p. 1).

Studies of BYOD in action

This literature review has used lessons learned from the study of BYOD programs throughout. There appear to be no peer reviewed studies of the impact of BYOD on learning as yet. As Babic (2012) stated when reporting on a BYOD implementation in Katy, Texas "it's too soon to know the impact on test scores" (Babic, 2012, p. 43). However, there is much anecdotal information on increases in homework completion, participation, engagement and motivation throughout the literature and, as BYOD is just another form of one-to-one computing, there is no reason why the impact will be any less.

Conclusions and key implications

1. BYOD is coming under serious consideration globally by schools for many reasons, including:
    a. Lack of funding to continue or implement one-to-one laptop programs.
    b. The ubiquity of wireless internet enabled devices.
    c. The integral nature of these devices to the students' own world.
    d. Pressure from students to use their own devices in class.
    e. Leveraging students' attachment to their own devices to deepen learning and make learning more personalised and student centred.
    f. Furthering the development of 21st century skills.
    g. The availability of cloud based storage and applications.
    h. Increasing parental support for such a move.
2. Concerns about the introduction of BYOD programs include:
    a. Equity issues, though the evidence is that these can be ameliorated.
    b. A BYOD program which allows a wide variety of devices may not supply the best tool for the task, though some argue that this is overcome by browser based apps.
    c. Distraction and theft, though the little evidence available has not found these to be major problems.
3. There are various models for BYOD implementation, both proposed and in use.
    a. At one end of the spectrum are the "locked down" models where the device and software to be used are dictated and controlled by the school. These can bring purchase costs down and assist teachers in their planning as they know the device capabilities. However they limit options for families and result in decreased compliance.
    b. In the middle are programs that limit the device to those that meet specific requirements (e.g. must run specific software or apps, have a minimum size RAM and hard drive etc.). These allow families greater choice and increase compliance. Technology support can be more problematic with so many devices but once more teachers are aware of the device capabilities for their planning.
    c. At the other end are programs where schools accept any personally owned device provided it is internet ready. This reduces costs for parents and increases compliance further. As the teacher cannot know the capability of every device, he or she must concentrate on the learning and leave the technical challenges to the students. Others argue that browser based apps help to overcome these problems. Technology support by the school can only be minimal in such an implementation and must be left mainly to the students themselves

d. The pedagogy to be used in conjunction with the devices should largely determine the model used:
    i. In a teacher centred learning environment, the BYOD model needs to focus on students having the same software and desktop experience, with either a single standard device managed by the school or a controlled range of devices.
    ii. In the student centred learning environment, far less standardisation and control is required.
e. Some devices (e.g. laptops) are able to carry out more tasks than others. The potential for their use in pedagogy needs to be carefully assessed before decisions are made.

4. Implementing a BYOD programs requires:
    a. Defining goals
    b. Planning collaboratively
    c. Consulting and communicating
    d. Keeping teaching and learning at the centre of everything
    e. Providing professional learning for teachers that focusses on pedagogy
    f. Having good policies in place
    g. Addressing equity
    h. Including a focus on digital citizenship
    i. Planning for your network to cope
    j. Planning for students recharging their devices during the day
5. School policies should:
    a. Set out the goals of the program
    b. Address digital citizenship and students' rights and responsibilities, including acceptable use policies and BYOD agreements and consequences of not abiding by the agreements.
    c. Clearly specify the model of BYOD to be used, including minimum specification of devices if applicable.
    d. Include information on access to the school's wireless network.
    e. Inform parents and students that students bring their own property to the school at their own risk and that schools will not accept any responsibility for loss or damage. Furthermore, students and parents should be constantly reminded of this.
    f. Include information on any technical support available from the school.
    g. Include information on provision of loan or lease-to-buy machines for those families that cannot afford devices.
    h. Where the school finds it applicable (e.g. in a primary school) cover storage of devices before school, at recess and lunchtime.
    i. Insist that students bring their devices fully charged to school and outline any provision for charging during the day if supplied.

6. The technical support

   The technical support required will depend upon the model chosen. The model where schools accept any personally owned device provided it is internet ready has in practice proven to need the least technical support.

Due to the ubiquity of wireless internet enabled personal devices, "the reality is that web-based tools and resources have changed the landscape of learning. Students now have at their fingertips unlimited access to digital content, resources, experts, databases and communities of interest. By effectively leveraging such resources, school authorities not only have the opportunity to deepen student learning, but they can also develop digital literacy, fluency and citizenship in students that will prepare them for the high tech world in which they will live, learn and work" (Alberta Education, 2012, p. 4).

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