



Education

The practice of digital writing: Benefits, challenges and choice

Associate Professor Sarah K. Howard



UNIVERSITY
OF WOLLONGONG
AUSTRALIA

Acknowledgements:

Dr Melinda Plumb (UOW) for her contributions to development of this report.

Cover image courtesy Microsoft Australia

The practice of digital writing: Benefits, challenges and choice

Prepared for the NSW Department of Education

By Associate Professor Sarah K. Howard

University of Wollongong

July 2018

Forward

Reading, physically writing and effectively communicating are unarguably important literacy skills that students need to possess when they leave school. While writing with a pen and paper still has a role in society, it is significantly diminished as a result time spent communicating through digital devices. Different ways of writing made available through digital technologies have expanded how and what people write. A person is able to communicate through a range of media and in different genres, such as writing a cover letter for a job application or ‘tweeting’ about a job opportunity through social media. Further, the tools people use to write have changed. A person may type using a keyboard, they may tap out a message on their phone with their thumbs, or they may write on a digital surface using a finger or stylus. Each tool has different affordances and is appropriate for different kinds of tasks. Therefore, it is important as educators to consider the role and possible benefit of digital writing and communicating in learning, to ensure students experience the full range of skills and understandings they will need to fully participate in society, work and lifelong learning.

The following literature review explores ‘what is digital writing?’, different ways of writing with digital technologies and writing in different digital platforms, what these new practices mean for learning and what we might be looking towards in the future. We also address some of the challenges of integrating digital writing into learning. We do this in an effort to provide some strategies and support for teachers who may be interested in broadening their use of digital writing or may be thinking about changing their own practice. Ultimately, the aim of this document is to provide a research foundation for teachers and school leaders to support thinking about and experimenting with digital writing in learning. The following work is also intended to support caregivers, to better understand digital writing and to be able to support their students with digital writing in school.

The presentation of this information is modelled after the New Media Consortium Horizon Reports (NMC, 2017). The NMC Horizon Reports provided annual reporting on digital disruptors across a number of educational contexts, one of which was schools. In each year the report considered in impact of different digital technologies as they related to the core business of schools. The [2017 Schools Horizon report](#) identified a new trend, ‘Advancing Cultures of Innovation’ (NMC, 2017).

The current discussion has embraced the concept of ‘innovation’ to frame digital writing. Writing is part of the core business of learning and schools. New technologies, e.g. 2-in-1 devices (combined tablet and laptop devices), use of a stylus, online writing platforms and ways of thinking about writing, e.g. collaboratively, formatively, etc., are changing how students write in school. The topics selected to organize the current discussion are designed to take teachers, school leaders and caregivers through a process of thinking about digital writing as an innovation.

Advancing Cultures of Innovation

Long-Term Trend: Driving technology adoption in K–12 education for five or more years

Innovation in schools has sparked a trend toward learner-centered paradigms in which students build critical thinking skills in environments that mimic the real world. Entrepreneurship, collaboration, project-based learning, and creativity are hallmarks of this transformational movement, which often falls under the umbrella of STEAM education... education leaders find ways to engage learners in authentic experiences that are relevant to their future, while businesses seek pipelines for highly skilled, global citizens. This trend acknowledges that every big idea has to start somewhere, and both students and teachers should be equipped with the mindsets and tools needed to spark real progress.

To do this, research will be presented and discussed and followed by practical approaches or considerations for teaching and learning. Digital writing will be explored from early primary school, up to secondary school (e.g. HSC). Throughout the document, resources have also been linked in relevant areas to provide contextual links, examples of best practice and professional learning resources.

Exec summary

What is digital writing and why is it important? Digital writing is physically writing with new digital technologies, and it is writing in new digital formats. However, while the digital technologies used in digital writing are important, the following review takes a look at digital writing in teaching and learning, and why these practices are necessary in today's school. This is explored through an Introduction to digital writing and then a close study of five different sub-topics, that are presenting innovations in how writing may be understood and executed in the classroom:

1. **Handwriting** - People are writing more than ever before, but they are writing in a range of new and different ways. However, people are writing by hand less and less. It is important to understand when students should handwrite, keyboard and/or write using a stylus and tablet.
2. **Assessments** - Assessments drive learning and technology use. How standardized assessments are being delivered across Australia and NSW is changing, which will impact digital writing in the classroom.
3. **Note-taking** - Note-taking is an important part of learning, to support encoding. Different forms of digital writing and methods note-taking have different implications for learning, depending on what is being learned.
4. **Collaborative writing** - In today's society, it is necessary that students can effectively negotiate collaborative work and using digital technologies to communicate. Sharing, audience and the form of this communication are important.
5. **New digital writing genres** - Students are writing in a wider variety of forms and genres today, some informal and some formal. Teachers need to consider how these various approaches to digital writing can be brought into the classroom.

However, these changes in how students write and their digital writing are not without challenges. The issues of digital reading, digital writing and digital literacy are explored. Specifically:

- Physical concerns related to reading and writing on a device
- Questions about distractions, multi-tasking and being off-task
- Informal writing as an issue in formal academic writing
- Students' understanding of multimodal writing
- Students' digital literacy and capacity to write digitally

Practical discussions and approaches to these issues are explored. This is followed by a discussion about choosing the right device, for the right task. This section addresses the hardware of digital writing, some affordances and some limitations. Finally, the take-home messages for the discussion are:

1. Digital technologies should be used for writing, but they are not necessary for everything.
2. Be alert to how students are negotiating a digital device when writing and be aware if support is needed.
3. Be sure you and your students understand the affordances of different devices for digital writing. Not all devices are equal.
4. Be aware of the different ways students are writing informally and formally, and how these can be used together to engage students in the writing process.
5. Involve students in thinking about digital writing, such as multimodal writing and developing their digital literacy, to encourage ownership of the process.

Three future directions are identified: Artificial Intelligence, Virtual Reality and Augmented Reality, as technologies that may influence digital writing in the future. All three would serve to enrich the writing process, but artificial intelligence has the potential to actually assist students' writing.

1. Introduction: What is ‘digital writing’?

Key section points:

- Digital writing is how we physically write using digital technologies
- New technologies for writing have specific affordances and should not be used homogeneously in learning
- Digital writing is also new ways of communicating afforded by new technology platforms and tools.
- New genres of writing have emerged as a result of new digital technologies, which affect how students learn to write.

What is digital writing? It’s a good question. Roughly, the following discussion divides digital writing into two areas. The first is the physical act of writing. This can mean writing with a pen on a tablet, using a stylus with a touch-screen 2-in-1 laptop, keyboarding, tapping with your thumbs on a smartphone, etc. For the purposes of this discussion, we include all practices of writing using a technology of some form. Now, this does not mean that these practices are homogenous and interchangeable. They each have different affordances - things they do well - in a learning environment. For example, quick responses to a text or posting an in-situ response to an experience can be quickly captured on a phone, by tapping it into a text message with thumbs. However, the phone is not a good tool for writing extended essays or a report. This might require a keyboard and laptop. It is necessary to gain a deeper understanding of these affordances to innovate in this space, and bring these various modes of writing to the classroom.

The second part of digital writing is ‘communicating’ and the different digital media used to communicate. In this discussion, this also includes how we communicate. People are writing more frequently and in a variety of ways. There is a widening range of writing genres emerging from digital media and social platforms, such as a blog, a post or a tweet. This can take two forms as well. The first includes the well-accepted practice of word processing, the drafting and editing of digital documents. This now includes online writing, such as Google Documents and Microsoft’s Office365. These new tools support traditional word processing, with the capacity to share and access anywhere, but also the ability to create texts collaboratively. The other side of communicating includes newer forms of written communication. This includes blogs, posting in social media, writing online reviews, email and instant messaging. In all of these various forms, writing is also often multimodal. It may be a combination of communicating through text and images, with emoji, or even digitally drawing on an image and adding stickers. It could be a video or simply an audio stream. The aim is to gain a better understanding of the different digital technologies for writing, and how they best support the various written genre we need students to be experiencing. In doing this, we try to get the most out of the various digital technologies to support innovative learning.

2. Thinking about ‘digital writing’

Key section points:

- Writing and communication practices are changing as a result of digital technology affordances and experiences
- Digital writing practices have different cognitive implications and effect on learning
- Opportunities afforded by digital writing can engage students in writing and expand their understanding of writing
- Students need to be supported to fully take advantage of digital writing opportunities and to be successful

In the following section, we will first address why students need to be able to write digitally. Primarily, screen-based communication has become an integral aspect of our personal and professional lives. Young people are living a life where digital technologies are inextricable from their lives (Lai & Hong, 2015) and reading and writing via digital tools such as smartphones, tablets, laptops and computers is common. As educators, this leads us to consider how we account for this change when teaching writing, different genres students need to grasp and how students communicate. Although traditional writing with pen and paper still has a role to play, use of it to communicate is significantly reduced because of increased technology use. Therefore, we ask: “What are advantages and the affordances of digital writing that make it important?”

We will explore this from the two ‘parts’ of digital writing (*how* we write and *what* we write) and draw them together.

To start, a Pew Research Center survey of 2,462 writing teachers in the United States reported that digital writing had “tangible, beneficial impacts on students’ writing” (K. Purcell, Buchanan, & Friedrich, 2013, p. 2). Specifically, of surveyed teachers:

- 96% agreed (including 52% who strongly agreed) that digital technologies “allow students to share their work with a wider and more varied audience”
- 79% agreed (23% strongly agreed) that these tools “encourage greater collaboration among students”
- 78% agreed (26% strongly agreed) that digital technologies “encourage student creativity and personal expression”

While this research was conducted in the United States, teachers’ beliefs about the benefits of digital writing reflect many of the same curriculum priorities and skills expected in NSW schools. Across the curriculum learning outcomes and content points include these same ideas, such as the English K-10 syllabus Stage 2, Objective C where students are expected to think “imaginatively, creatively and interpretively about information, ideas and texts when responding to and composing texts” (EN2-10C; NES, 2018). In the most recent K-6 Science and Technology syllabus, collaboration is identified as a skill across the stages. For example, in the Stage 3 description, students are expected to “engage in the skills of Working Scientifically, and Design and Production independently and collaboratively” (p. 21). These are only two of many examples in the syllabi that relate to some of the strengths of digital writing.

However, we cannot assume that students also possess sophisticated technological knowledge and skills as result of constant access (Bennett & Maton, 2010). It is necessary to teach students how to use digital technologies in sophisticated ways. “Hands on is not the same as heads on” (Considine, Horton, & Moorman, 2009, p. 472). There is a disconnect between literacy skills that are developed by students in their out-of-school lives and the literacy environment within schools (Oh & Reeves, 2014). There is a need for curriculum that is relevant to today’s students and acknowledges the environment that students navigate outside of school, but selection of new practices needs to be driven by potential effectiveness in pedagogy. This means identifying *which* digital writing practices are good for *what* learning. In the following sections, several key areas of digital writing are addressed. These topics have been drawn from the literature, based on their relation to major changes happening in education in response to digital technologies.

Handwriting

The first topic is ‘handwriting’. There are a few very important social and educational trends that have resulted in changes related to how we thinking about writing and how we actually write. In

primary schools around the world, students still learn to write with 'pen and paper'. However, the role of traditional pen and paper communication in the classroom is being challenged as society increasingly writes digitally. In fact, in educational technology research one of the enduring concerns about integrating digital technologies has been the loss of handwriting. While handwriting has traditionally been considered an essential skill for life, work and learning, this has come into question over the past 10 years. There has been considerable investigation into whether students need to continue to learn handwriting, if this will affect the quality of students' writing and if keyboarding is 'as good'. Further, are there other ways to 'write'?

Handwriting: Is it still relevant?

- **Download audio**

With digital technology, typing has become as important as handwriting. So should we be placing as much emphasis on the teaching of handwriting?

An [ABC Podcast discussion](#), 4 December, 2014

From the sensorimotor point of view, handwriting and typing are clearly two distinct ways of writing, and they involve distinctly different processes (Longcamp et al., 2008). For handwriting, the writer must perform a series of movements that define the shape of the character, and this produces a link between the letter that is written and the movement required to produce this letter. When typewriting using a keyboard, there is no specific relationship between the movement of finding the correct key to press on the keyboard, and the visual form of the character. Cognitive psychologists have shown that this difference has an impact on how students learn when writing, particularly in relation to note-taking (e.g. Mueller & Oppenheimer, 2016). Studies show handwriting is a more effective mode of note-taking. However, this does not mean it has to be done with a pen and paper. We get into this further, later in the discussion.

Changes

A shift away from communicating through pen and paper is reflected in changes to school policies world-wide, particularly around cursive handwriting. In 2013, the United States dropped cursive handwriting writing from their Common Core State Standards for English Language Arts & Literacy (Medwell & Wray, 2017). In the US, cursive writing was removed from the English/language arts standards. This decision was in part, based on feedback from teachers. The researchers thought "student communications and adult communications are via technology...knowing how to use technology to communicate and to write was most critical for students" (Loewus, 2016, p. x). In 2015, Finland removed the compulsory teaching of cursive handwriting and replaced by lessons in keyboard typing (Goeth Institute, 2015). Here in Australia, although learning cursive handwriting is still part of our curriculum (NESA, 2018), technology also plays a important role. For example, in the English syllabus outcome EN2-3A, students use "effective handwriting and publish texts using digital technologies" and use "a range of software including word processing programs to construct, edit and publish written text, and select, edit and place visual, print and audio elements" (NESA, 2018). These examples demonstrate how educational systems consider it important that students experience both handwriting and typing in schools.

Keyboarding and digital writing

Teachers can draw on a range of tools to support digital writing, such as interactive whiteboards, desktop PCs, laptops, tablets, e-book readers and smartphones to name just a few. There are a number of different writing input options, including physical keyboards, on-screen keyboards, fingers, or stylus pens. Each of these present different affordances and relations to learning. Pragmatically, digital writing has a number of affordances. The most basic of these include, but are not limited to:

- Automatic correction and suggestions for writing, access to dictionary and thesaurus functionality;
- Flexibility in the writing process;
- Speed of writing, enhanced by functionality such as predictive text completion;
- Increased efficiency through editing functionality;
- Interactivity and hypertextuality through links;
- Increases writing legibility;
- Ability to store large amounts of data, and portability depending on the device;
- Ability to search for keywords and phrases;
- The text can be adapted to viewer preference or requirements.

These are basic affordances of digital writing, primarily word processing. Fifty-percent of teachers participating in the 2012 Pew Research Center Internet & American Life Project Online Survey of Teachers in the United States said that today's digital technologies make it easier for them to shape or improve student writing. Teachers expressed that these tools allow them to not only teach the technical aspects of writing, but also allow them to "see their students thinking" and to work alongside students during the process. Teachers also indicate that digital tools, such as word processors, are more likely to positively influence the writing of their students through ease of revising and editing their work. Students were also more likely to be creative and clearly present their ideas (Purcell et al., 2013).

We note, however, that digital writing is not just about typing using a keyboard; it can also involve writing by hand using a stylus on a tablet device.

A stylus is a small pen-shaped instrument that is used to provide input to tablet devices. It functions as a replacement for finger or keyboard input with a touch screen, allowing the user to hold the stylus just like they would a pen(cil), and write, draw, and tap on the touchscreen of the tablet device. There are two main types of stylus:

Capacitive stylus - This is the most common type. It works with any touchscreen device. They are cheap and do not require batteries or charging. However, they are unable to sense pressure, or distinguish between writing and resting your hand or palm on the screen. This can cause errors when writing.

Bluetooth stylus - These function like a capacitive stylus, but they are paired with your device. This offers additional functionality, such as palm rejection, pressure sensitivity, using the end of the stylus as an eraser, and other features. However, they require batteries or charging, are more expensive. They also may need to be used with particular apps that support the added functionality.

A stylus allows students to perform the important physical movements of writing that support encoding, which can positively impact on learning (e.g. Jansen, Lakens, & IJsselsteijn, 2017). When using a tablet and stylus research has found positive results for improving letter formation, in conjunction with traditional letter practice with pen(cil) and pen (Spencer, Coutts, Fagan, & King, 2013). However, (Davis, Orr, Kong, & Lin, 2015) note that “in general very few students have experience using a stylus with a touch-screen device” (p. 26). When students are writing on a tablet, using a stylus for the first-time consideration should be given to a learning curve, while students adapt to the new tool. It is also important to teaching students how to write with a stylus to improve writing execution (Alamargot & Morin, 2015).

Assessments

A key driver in NSW Education, keeping handwriting at the fore of teachers’ minds, has been standardised testing (Howard & Mozejko, 2013). Assessment drives teaching practice (Wormald, Schoeman, Somasunderam, & Penn, 2009) students’ choice of digital technologies (Gašević, Mirriahi, Dawson, & Joksimović, 2017). However, standardized assessments in Australia and NSW are becoming more digital.

Changes

Until recently, standardized testing in Australia and in NSW has been using pen and paper, but this is changing rapidly. In the last few years:

- NAPLAN began trialing an online version of the test in 2016, with states determining their own adoption of the [new online system](#) (ACARA, 2016).
- In NSW, schools started to use the [new online system in 2018](#), with all schools transitioned by 2020 (NSW Department of Education, 2016).
- For HSC testing, it is still predominantly handwritten, but the newer [basic numeracy and literacy skills examinations](#) will be online (NESA, 2017). Students planning to sit HSC exams in 2020, which includes Year 10 students in 2018, will need to pass these additional exams.

These changes, happening internationally and in NSW, in relation to assessment show the effect of digital technologies. In addition to the affordances of data and assessment management, the shift to digital writing in assessment reflects the acceptance of these practices. This, in part, also confirms the move away from handwriting. The shift of assessments to digital platforms will dramatically change how NSW teachers prepare students to write for assessment, and therefore how they are taught to brainstorm, draft and edit their writing. Importantly, this is likely to be a positive change for students and teachers, given the usefulness and positive impact of word processing software on the writing process (DeVoss, Eidman-Aadahl, & Hicks, 2010).

Digital assessments

Moreover, research has shown that students perform better in assessments when they are online. The increasing popularity of touch-screen devices, such as tablets and smartphones, creates new opportunities “for assessment which will be more closely aligned with the way they experience the rest of the world” (Davis, Janiszewska, Schwartz, & Holland, 2015, p. 30). There is little research to determine “whether essay writing in an online medium differs from writing in a more traditional medium according to objective, quantifiable measures” (Kimmons, Darragh, Haruch, & Clark, 2017, p. 14). However, several studies have shown that students’ responses are more extended, they revise their content more, and they have increased enjoyment in the writing process when on a computer.

When it comes to the quality of writing, Kimmons et al. (2017) cautions that this is an area of conflicting results in the existing body of research. However, there are some positive findings in the literature:

- Bangert-Drowns (1993) reported that students with learning disabilities, elementary (primary-school) aged students, and students performing below the grade level had the largest improvements in their quality of writing;
- Morphy and Graham (2012) found the use of word processing programs had positive effects on different writing outcomes for weaker readers and writers.

What is interesting is that the speed of student typing is an important factor in doing well on a digitally written assessment. Importantly, this becomes problematic when students are completing writing tasks using iPads, where their typing has been found to be slower, less accurate, and it is difficult to copy and paste text (Pisacreta, 2013). Therefore, it should not be a surprise that students preferred external keyboards over touch screen keyboards particularly for writing essays, because their typing was faster and more accurate (Pisacreta, 2013). When considering different digital tools for conducting assessment, younger students did not have a strong preference, while Years 7 and 9 were found to favour PCs over tablet devices, because of the external keyboard (Davis, Orr, Kong, & Lin, 2015). These findings point towards affordances of some technologies that may be better suited to digital writing.

Note taking

There has been a long tradition of studying note-taking, to understand how it can be better and how it may be a detriment in learning, business and contexts where careful notation is required (Mueller & Oppenheimer, 2016). There are many situations in the classroom where students are required to take notes. Classroom goals for note-taking include: developing a deep understanding of content; facilitating long-term learning; and providing an external record of material for future review (Mueller & Oppenheimer, 2016, p. 140). In short, the practice is intended to support encoding of information (Jansen et al., 2017). There are a number of different methods of note-taking, but the core aim of all approaches is the selection and organization of information. These cognitive processes support encoding.

Changes

With the availability of digital technologies, there has been great interest in understanding how they can improve note-taking in various contexts. In the classroom, it is most likely that you would see students taking notes on a laptop. This is particularly the case of a BYOD classroom, where it is often expected that students would take electronic notes on their own laptops. There have been incredibly mixed results in research on note-taking and using digital technologies (e.g. Jansen et al., 2017).

Many of the questions around note-taking in schools is whether notes should be taken longhand or typing using a laptop. Jansen et al. (2017) conducted a review of the note-taking literature and found that - it depends. A few studies have cautioned note-taking on a laptop during lectures, because they observed better memory of lecture material when notes were taken longhand (e.g. Mueller & Oppenheimer, 2014, 2016). However, other studies have seen no difference or even a benefit to taking notes on a computer (e.g. Schoen, 2012). The review of the literature revealed that the most appropriate approach to note-taking was actually related to the lecture contents. More complex lectures, such as where a lot of new information is delivered without a lot of repetition, was better for longhand. Lectures with new information and moving at a quicker pace

were better for computer note taking, if students were proficient at typing. As typing was quicker, it allowed them more time to listen and focus on the lecture content (Jansen et al., 2017). Given that effective note-taking is task-related rather than related to the technology, it would be appropriate for students to have access to and the ability to use a range of strategies.

Digital note taking

Different digital technologies can support typed, handwritten, photo and voice note-taking. The affordances of using digital devices to take notes include (e.g. Kim, Turner, & Pérez-Quñones, 2009; Mueller & Oppenheimer, 2016):

- Quicker note-taking for students who type faster than write;
- Improved legibility for students with messy handwriting; and
- Enhanced search, storage, and sharing functionality through the digital nature of the notes.

A study investigating 211 5th grade students considered the efficacy of typed and voice note-taking, using software to read digital texts and record both typed and voice notes for science. Post-test scores showed students' science knowledge had improved, and there was a statistically significant higher score of students taking voice notes. Voice recording software is commonly available on tablets and smartphones and could play an important role in students' note-taking practices (Horney et al., 2009).

Using devices which utilise a stylus for input in note-taking could also potentially draw on the cognitive affordances of handwriting, where handwriting provides strong support for learning and remembering letters and words, which may subsequently contribute to memory and recall of learned letters and words (Arndt, 2016) and allow better conceptual understanding and deeper processing of content (Mueller & Oppenheimer, 2016). However, we note that is important to remember that "pedagogy is as much a part of successful note taking as the actual student skills involved [in] note taking" (Ostler & Topp, 2013, p. 73).

Given the cognitive benefits of note-taking to support encoding, it would make sense to use tools that support a range of effective note-taking strategies. For example, the app ShowMe acts as an interactive whiteboard on a tablet or 2-in-1 device. It supports a combination of handwritten text, drawing and voice recording for note-taking and brainstorming. It requires a touch surface for handwriting and drawing capabilities. and have been found to be beneficial to students in the revision or 'playback' mode, where after first creating the explanation or summary. Students were then able to 'learn from themselves' by repeatedly watching their creation (Ostler & Topp, 2013). Digital handwritten note-taking can also be supported by Microsoft OneNote, which is available bundled with Office365. This software can integrate voice, handwriting, image and text into a single notebook, providing flexibility for students to take a range of notes. However, it would still be important for teachers to instruct students on how to effectively take notes, in terms of identifying key points and also knowing which note-taking mode might be most appropriate.

Collaborative writing

Next, we look at collaborative writing. In many cases, this is essentially students engaging in a collaborative writing process, to produce a final product. Results from the survey conducted by Purcell et al. (2013, p. 24) indicated there were several key ways that digital tools benefited student writing:

- Encourages greater collaboration among students; and

- Enabled students to share their work with a broader and more varied audience due to the Internet.

Both of these affordances are directly linked to functions of online and collaborative writing tools. Collaborating and sharing are made easier by these tools and, therefore, promote these kinds of practices. There are a number of tools available to support collaborative digital writing in the classroom. These include both hardware tools such as interactive whiteboards, and software tools such as wikis, blogs, and Google Docs. These tools may be used in combination or individually, depending on the nature of the written task, such as the nature of brainstorming, planning, and even if the final product is intended to be text-only or multimodal. Part of collaboratively and digitally writing is understanding which tools are most appropriate for which tasks.

An important effect of students collaborating to write is increased engagement in the task, which has been reported by several studies. For example, Yi (2008) found that students participating in a collaborative relay writing task online where they had to build on each other's storylines. Courtland and Paddington (2008) also identified a high level of engagement in eighth grade students when collaboratively constructing an online 'e-zine' (digital magazine). Beach (2012) has also drawn attention to an additional affordance of collaborative online writing. Their research has found that students are more likely to apply an alternative perspective to a particular topic or issue in collaborative writing. Utilising social digital technologies, such as collaborative writing and/or social media, plays an important role in exposing students to alternative perspectives (Kahne, Lee, & Feezell, 2012) and challenge status-quo cultural perspectives (Hull, Stornaiuolo, & Sahni, 2010).

Changes

In the past, the audience for students' writing was typically limited to the teacher and their peers. Now with digital tools and access to the Internet, students are able to write for global authentic audiences, which "creates different thinking on the part of digital authors" (Cooperman, 2017, p. 4). There are many benefits to having students' writing exposed to wider audiences. It provides opportunities for students to receive diverse feedback, "which encourages them to think more consciously about audience as they write, and in turn leads to greater investment in what is written" (Purcell, et al., 2013, p. 25). When students are aware of their audiences, this helps to clarify their writing purpose and direction, and when students know that their writing will be read by an authentic audience, they pay more attention to their work (Cooperman, 2017).

A study by Genlott and Grönlund (2013) involved 1st grade students cooperating in pairs to produce digital texts using a keyboard, which were then published on a class website and subjected to discussion among students, teachers, and parents, and subsequently refined. This meant all of the students' writing had a purpose and an authentic audience, and the texts they produced were not static but further developed based on discussions and feedback. Researchers found that students improved both their reading and writing skills, writing "longer texts with better structure, clearer content, and a more elaborate language" (Genlott & Grönlund, 2013, p. 98). The social interactions between students that formed part of the discussion and feedback process also increased student motivation and also improved the students' understanding of how other people receive their texts. Further, when students are working collaboratively on a text, they are exposed to each other's particular literacy practices, resulting in their acquisition of those practices which builds on their own set of practices (Beach, 2012, p. 50).

An important point here is that the technology on its own did not improve the learning outcomes of the students; rather it was the technology together with the social collaborative arrangements,

which the authors believe, promoted the good results. Notably, the students initially undertook training in basic computer skills. The researchers also believed students' knowledge of the goals, feedback concerning their performance, the pedagogical ability of the teacher, and the support and encouragement from home were significant factors in success (Genlott & Grönlund, 2013).

Real-time collaboration

Beach (2012) identifies that a large number of apps for smartphones and tablets are able to afford collaborative writing. Through collaborative online text construction tools such as blogs and wikis, there is increased peer interaction and collaborative sharing of ideas, both student-to-student and student-to-teacher, particularly through the provision of real-time feedback through comments (Felix, 2008). Continuous feedback assists students to "remain invested" in what they are creating (Purcell et al., 2013, p. 28). Teachers however should be mindful that student safety online is paramount, particularly when allowing the public to view and comment on students' work. Further, students will not always know how to make constructive comments on the work of their peers, and may initially be hesitant about the idea. One teacher commented that "while at first students were hesitant and shy both to post work and make thoughtful and useful comments about others' writing, once the routine was established and the community proved to be a safe one, student writing has benefitted" (Kristen Purcell et al., 2013, p. 27).

Ultimately, to take full advantage of the affordances of collaborative digital writing, some work would need to be done to prepare students. Students would need to understand, at least, the basic affordances of a digital technology, etiquette for working collaboratively and possibly providing feedback. Students would also need to be aware of privacy issues of sharing their work with different audiences. Given the importance of this affordance, where possible sharing should be supported, but always with consideration for students' situations, age, and content of what is being shared.

New digital writing genres

The final topic in this section deals with newer digital writing genres. Writing experiences for students have changed in recent years. Writing in the classroom and the writing students engage in outside of school are less linear and more collaborative (Cordero et al., 2015). Students have access to digital technologies to create written texts, multimedia texts, collaborate from anywhere and share writing with people all over the world. Students also write in different forms and for wider audiences, through social media, discussion boards, blogs and other forms of writing. Some of these are formal writing and much of it is informal. It is important is that students are writing more than previous generations. Teachers have identified that the use of mobile devices and social media provide today's teenagers with "many more avenues for personal expression" and that students today "simply write more, in sheer quantity" (Kristen Purcell et al., 2013, p. 18) than in the past.

Changes

Texting friends and family is the most common mobile device-based communication outside of a school setting, with the next most frequently noted being Facebook postings and responding to friends, followed by writing emails and being on chat rooms (Vue et al., 2016, p. 91). Students engage in a range of non-traditional writing activities, but this has resulted in a disconnect between students' out-of-school and in-school literacy practices (Zheng, Warschauer, & Farkas, 2013). Students often do not count mobile device-based communications in their personal lives as 'writing', but they do view writing for school "as an entirely different activity than chatting with friends and family via tools such as smartphones" (Vue et al., 2016, p. 92).

A key focus in learning needs to be acknowledging students' experiences with digital writing in their personal lives. Students have "prior knowledge and interest to draw upon for developing their knowledge and skills of writing and motivation in writing" (Vue et al., 2016, p. 92). However, research has shown that teachers have not typically considered texting, blogging and posting on social media sites as writing, in the traditional sense or in an academic form (Purcell et al., 2013). Shorter forms were akin to "pre-writing" - a short piece of text that gets students engaged in a topic, which may lead to writing about it in a lengthier, more formal form. The idea of using short forms of writing as pre-writing, suggests a logic for integrating different types of digital writing in learning and the writing process. To integrate these well, it is necessary to understand the new forms of writing better and to identify some of the affordances.

New approaches in learning

The following table explains a few key online tools for fostering different forms of writing.

	Twitter	Blog	Wiki
Example	Twitter	Blogger	Wiki
What is it?	An online 'microblogging' social media tool. It has a 280 character limit. Users interact by posting 'tweets' from their account, which other Twitter users can then read and respond to.	An online journaling tool, where users create posts that are most commonly displayed in reverse chronological order.	A wiki is an online space where users can collaboratively develop and modify content. An example of a wiki is Wikipedia.
Privacy	Anyone can read posts made by public accounts; a user account is required to post tweets or respond to tweets.	Depending on the service used to create the blog, it can be set to public or private.	Wikis can be made public or private. Users can be given different rights and access to content.
Affordances	<p>This tool can be used for teaching and practicing writing and other communication skills (Helvie-Mason, 2011).</p> <p>Research shows that students believe the Twitter character limit encourages concise and clear writing (L. Davis & Roger, 2011).</p> <p>Students can connect their writing with a wide public audience.</p> <p>The hashtagging functionality allows tracking of and participation in trends or</p>	<p>Students can create multimedia compositions, including images, video and audio within their text post.</p> <p>A blog can serve as a online tool for students to publish completed compositions, or as a vehicle for practicing writing where they create multiple drafts with feedback (Witte, 2007).</p> <p>Blogs allow students to get feedback from multiple people, including peers and</p>	<p>Wikis are particularly suited to collaboratively creating informational texts (Sweeny, 2010).</p> <p>The nature of a wiki tool means that when students collaborate on an entry, the complete revision history is accessible, which allows the students to see exactly what changes between revisions, facilitating an understanding of the revising and feedback process.</p> <p>The public nature of Wikis has been shown to</p>

	topics.	external audiences, and this type of peer feedback may be more effective than traditional self-editing (Holder, 2006).	motivate the student writers to compose with audience in mind (Cooperman, 2017).
--	---------	------------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------

Careful planning is also a critical aspect of introducing any new online writing technology into the classroom (Kajder, Bull, & Van Noy, 2004). This includes any required explicit teaching of safe and responsible use of such online tools, and care and caution must be exercised to ensure student safety online with these forms of online communication.

Multimedia compositions

Research has shown that students are motivated by multimedia composition (Cooperman, 2017). Two commonly found forms of multimodal digital writing in schools are digital stories and ePortfolios. First, digital storytelling follows the same traditional processes of selecting a topic then developing an interesting story through the construction of a clip. However, in digital storytelling, this text is then combined with various forms of multimedia, including still images, recorded audio, and video clips. A storyboard may then be developed to structure these components, before they are then brought together in a software tool such as Microsoft PowerPoint, Windows MovieMaker, or Apple's iMovie. The finished digital story can then be played on a computer and shared.

Multimodal digital stories promote active learning, collaboration, and engagement (Sylvester & Greenidge, 2009), and are particularly useful in providing an additional avenue of expression for students who struggle with writing traditional texts (Reid, Burn, & Parker, 2002). Developing digital stories can promote 21st century skills including (Robin, 2008, p. 224):

- Digital literacy - the ability to communicate with an ever-expanding community to discuss issues, gather information, and seek help;
- Global literacy - the capacity to read, interpret, respond, and contextualize messages from a global perspective;
- Technology literacy - the ability to use computers and other technology to improve learning, productivity, and performance;
- Visual literacy - the ability to understand, produce, and communicate through visual images; and
- Information literacy - the ability to find, evaluate, and synthesize information.

Beach (2012) reviewed literature on how English Language Arts teachers used digital tools in their classrooms for digital storytelling. It was noted how elements of digital storytelling production transferred to enhancing traditional print literacies through student work creating scripts and storyboards. The use of authentic purpose and audience for student engagement in multimodal digital storytelling productions also proved to be important.

Additionally, the process of creating a storyboard after drafting helps writers visualise their story, helps to reveal gaps or omissions which can be fixed to make the story more comprehensive and fluid (Sylvester & Greenidge, 2009).

ePortfolios are a form of multimodal digital communication and show "great promise for supporting students' writing performance and facilitating peer feedback" (Nicolaidou, 2013, p. 404). ePortfolios can be constructed with a variety of tools, including generalised digital writing tools such blogs,

wikis, Google Docs, Microsoft Word, or specific tools such as [Mahara](#). According to Danielson and Abrutyn (1997) there are three main types of portfolios: working portfolios; display portfolios; and assessment portfolios.

Introduction to Using Portfolios in the Classroom

by Charlotte Danielson and Leslye Abrutyn

The three major types of portfolios are: working portfolios, display portfolios, and assessment portfolios. Although the types are distinct in theory, they tend to overlap in practice. [Read more here...](#)

As Danielson and Abrutyn (1997) point out, these three different types of portfolios tend to overlap in practice. Students begin with a working portfolio contains works in progress. As they review, reflect, evaluate and complete works, these works can then be moved to a display or 'showcase' portfolio, which contains the students' best work; or an assessment portfolio, which contains works selected to demonstrate what a student has learned. However, it is not necessary to think of the three portfolio types as 'linear'. Students can go back and forth, develop their portfolio as their understanding changes or they receive feedback. One of the most important aspects of using portfolios in teaching and learning is that students are engaged in the process (Yancey, 2009).

ePortfolios have a number of advantages over traditional paper-based forms. In a study of fourth grade students in Cyprus, students used WordPress blog platform as an ePortfolio tool, publishing their pieces of writing on the blog which allowed for peer and teacher feedback in the form of comments, and incorporating that feedback into subsequent drafts. Analysis of the students' writing performance over time revealed that there were learning gains with respect to students' writing performance and with respect to students' peer feedback skills (Nicolaidou, 2013 p. 406):

- ePortfolios can positively affect students' writing performance;
- Peer feedback can positively affect students' writing performance; and
- ePortfolios can support peer feedback.

Beach (2012) noted that with ePortfolios students can "organize their collections within categories, import images/videos, employ hyperlinks to connect texts to define consistent patterns in their work, and keep adding material over an extended period of time" (p. 53). Through their digital nature, ePortfolios provider easier access to students' work by a wider audience including peers, teachers, parents and others (Barrett, 2010; McLeod & Vasinda, 2009).

3. Key challenges

Key section points:

- Students should be made aware of good physical habits when using digital technologies for extended periods of time
- Students have reported mixed preferences for online and offline reading, annotating and writing, which suggests a 2-in-1 device may be an appropriate device solution
- Distractions and off-task behaviours can be managed through good learning design and engaging students in how they are learning and writing
- Teachers should not assume students have high digital literacy and purposefully teach students how to writing using digital technologies

In this section we will consider three broad areas of 'challenge'. The first is digital reading. Reading on screen is considered "the weak point of the digitalisation of the entire writing process" (Fortunati & Vincent, 2014, p. 48). The next is digital writing. We then consider digital literacy, which has significant effects on how students may be able to engage with and successfully write digitally.

Digital reading

There are drawbacks to digital reading that may affect writing, including headaches or eye-strain from reading on screens, and the device requiring a power/battery source (Farinosi, Lim, & Roll, 2016; Taipale, 2014). These points need to be considered when designing digital writing tasks and thinking about the learning space.

In terms of learning outcomes, Dündar and Akçayır (2012) compared 20 Turkish fifth grade students' electronic text reading performance, reading speed and reading comprehension with tablets and printed books. They found that there was no significant difference between reading from tablets or printed books in speed or comprehension (Dündar & Akçayır, 2012, p. 448). However, research has shown that while students prefer the printed form for longer texts (Fortunati & Vincent, 2014). Students preferred paper because they could underline and annotate (Farinosi et al., 2016; Taipale, 2014). Importantly, newer software packages, such as Google Docs, Adobe Acrobat and Microsoft Word, support annotation and marking-up of text. This can be done using commenting and notation tools. If students are using tablet devices with a stylus, they can annotate in the same way they would using paper, but with the advantage of searchability, sharing, editing, etc. Students valued the portability of books and paper, but also of tablets and e-book readers (Farinosi et al., 2016; Taipale, 2014). Students felt tablets were an effective tool for reading, with the display quality and ergonomic considerations (size, portability, weight). Annotating and reading is a good example of how students can be introduced to different ways to use digital technologies, based on their preferred paper-based habits, in learning and to support writing.

Findings also suggest that tablets promote positive attitudes towards digital technologies. Other studies had identified similar positive findings for digital reading with regard to portability and flexibility in adjusting for viewing preferences, the ability to store multiple books and the ability to search for keywords (Farinosi et al., 2016; Taipale, 2014). However, tablets have shown to not be the most appropriate device for writing, so this preference is potentially not helpful if students are expected to write using this type of device. Tablets were also found to slow students' typing, which results in diminished performance and experience. It is possible 2-in-1 devices, laptops with touchscreens, can allow students to move between reading and writing on one device. Teachers will need to address the issue of 'the right tool for the job' when it comes to negotiating effective reading and writing.

Digital writing

There are several basic environmental challenges associated with digital writing and digital technology use:

- Limited human contact with the medium and communication being "mediated and no longer direct", resulting in a sense of decontextualisation;
- Ergonomic considerations, such as posture and repetitive strain injury;
- High level of distraction, e.g. another program being used at the same time as digital writing.

The first two concerns can be managed in a classroom through teaching students about appropriate communication, e.g. 'netiquette', designing tasks that require face-to-face interaction, and teaching students to identify health-related issues, e.g. posture and proper wrist position. However, a bit more complicated is the question of 'distractions'. An ongoing concern about integrating digital technologies into learning has been 'distractions', such as being off-task or 'multitasking' (Spitzer, 2014). As teachers well know, when students are performing more than one task at a time, their ability to concentrate and engage in learning is reduced. Simply, when having to switch between two tasks (e.g. one learning and one unrelated to learning) a person is not able to commit mental resources to the primary learning task. However, it is not only an individual multitasking on a device that is distracting. Research has shown that it is more distracting to watch a person multitask, such as seeing a peer multitask within line of sight (Sana, Weston, & Cepeda, 2013).

Sana et al. (2013) stress that it is not appropriate to ban laptops and other digital devices from the classroom, as they offer a range of very positive benefits in learning. They instead suggest that teachers can make changes in the classroom to address distractions through learning design and engaging the students. Many of their recommendations will be familiar to teachers, but it may be useful to revisit these issues with students and include them in working on this problem.

To help teachers manage digital technology use they have identified a number of ways to reduce distraction and multitasking:

- Discuss the consequences of technology use with students and specifically addressing distraction and multitasking.
- Technologies should not be banned from classes, but if it is not needed its use should be limited. However, if a student needs to use it they should have the device.
- Design learning that is interactive and informative, which will engage students.
- Ask students for feedback on lessons to identify where they may be tempted to multitask or where they have been distracted.

While the use of digital technologies in the classroom poses certain issues and concerns for teachers, writing also has its own specific barriers and complications. In regard to the activity of digital writing, a number of challenges are perceived (Purcell et al., 2013, p. 2):

- an increasingly ambiguous line between "formal" and "informal" writing and the tendency of some students to use informal language and style in formal writing assignments
- the general cultural emphasis on truncated forms of expression, which some feel are hindering students' willingness and ability to write longer texts and to think critically about complicated topics
- the increasing need to educate students about writing for different audiences using different "voices" and "registers"
- disparate access to and skill with digital tools among their students

We will discuss some of these challenges below.

Informal language

Students' use of informal language is a particular concern for teachers implementing digital writing. Informal language includes the use of text shortcuts such as emoticons, acronyms and other informal writing styles. These originated from text messaging where shortcuts were often employed to communicate understandings within the character restrictions of early messaging services. However, even with improved messaging on smartphones, emojis and abbreviations have been retained and integrated into language.

Teachers have expressed concerned about “an increasingly blurry line between formal and informal writing, resulting in the creep of “text speak” into formal writing, and a general emphasis on short forms of expression”, worrying that they “ultimately undermine students’ formal writing” (Purcell et al., 2013, p. 35). In regard to the prevalence of communicating through short messages, a study of 12- to 17-year-olds in the United States found that 85% of teenagers were found to engage at least occasionally in some form of electronic personal communication, which included text messaging, sending email or instant messages, or posting comments on social networking sites. Studies have shown that nearly two-thirds of teenagers said they incorporated some informal styles from their text-based communications into their writing at school (Lenhart, Arafeh, Smith, & Macgill, 2008):

- 50% have used informal writing styles instead of proper capitalisation and punctuation in their school assignments;
- 38% have used text shortcuts in school work such as “LOL” (which stands for ‘laugh out loud’);
- 25% have used emoticons (symbols like smiley faces ☺) in school work.

The above statistics support perceptions that informal digital writing is coming into formal writing. Moreover, the media often portrays this informal language in a negative light. However, the evidence is not so straightforward. Research on the impact of student use of ‘textisms’ on English writing ability has shown that such concern is “unfounded” (Farina & Lyddy, 2011, p. 148). From the perspective of the children themselves, Lenhart et al.’s (2008) study of electronic communication showed that only 11% said it harmed writing while 73% felt it had no impact. We do however caution that research in this area is limited (e.g. Rosen, Chang, Erwin, Carrier, & Cheever, 2010).

Ultimately, it is important that students are able to recognise which styles of writing are appropriate in a particular situation (e.g. texting, e-mailing or writing an exam), a positive association between technology-mediated communication and literacy achievement can occur (Clark & Dugdale, 2009). A teacher comments on the balance between formal and informal language (Purcell et al., 2013, p. 37):

I see them as minor issues. I see Text Talk as another language. There's a time and place for it, but not everyone understands it. Still, there are contexts where it is socially acceptable and expected. I wouldn't rob them of that, but it is my job to teach them how to negotiate the many registers and codes they use in language every day. To me, this code-switching is an important part of being literate.

Therefore, teachers may consider monitoring students use of informal language in writing tasks and reminding or explicitly teaching students the appropriate use of language as part of considering the audience of their writing when required (Kimmons et al., 2017). Teachers should keep in mind that “some devices have tempted students to write everything as if it were a text...but at least the thought processes of writing are taking place,” (Purcell et al., 2013, p. 19). It is also

important for teachers to recognise that although they might not necessarily view personal technology-mediated communication as ‘proper academic writing’ (Lenhart et al., 2008; Vue et al., 2016), “much of this writing is creative, designed to entertain the intended audience, and covers many of the assessment criteria that are attached to academic writing” (Clark & Dugdale, 2009, p. 34). The role of the teacher is to focus that writing and direct it to an academic purpose.

Multimodal writing

Technology allows students to digitally compose multimodal texts. A typical multimedia text is a digital story. Sylvester & Greenidge (2009) noted that students may have a lack of knowledge and skills for digital storytelling, and additionally noted that although teachers may feel that digital storytelling is a “worthwhile endeavor”, they may be reluctant to implement it due to confidence or competence issues (p. 293-294). Research shows that we cannot assume students have the knowledge to appropriately combine graphics, video, and sound skills, particularly in a way that effectively communicates. Multimodal objects and compositions dominate popular media, games and tools. However, technology usage to create multimodal compositions is frequently, but not explicitly addressed in learning. Therefore, it is important that both teachers and students need to be familiar with the software and hardware utilised.

Cooperman (2017) found that students had difficulty “transferring meaning from written form to multimedia graphic, audio, and video formats” (p. 107):

Without suitable training in these modalities, students knew what they wanted to do, but lacked procedural knowledge to execute their visions. Traditional writing knowledge did not provide them with enough skills to compose a sound digital composition, highlighting differences in declarative, procedural, and technological knowledge.

Again, this is likely to come back to the issue of how students are taught to use digital technologies. This is potentially also a result of widespread misuse of multimedia in design. Teachers may want to consider reviewing Mayer and Moreno’s (2002) multimodal learning theory and broadly addressing some of the key elements in a way that is accessible to students. This framework can help teachers and students think about what different text and images are doing in a text and how they come together.

Multimedia principle: combining words and pictures is more effective than using either alone;
Spatial contiguity principle: Text should be near corresponding pictures;
Temporal contiguity principle: Text and pictures should be presented at the same time;
Coherence principle: Extra words and sounds should be removed from animations, videos and narration;
Modality principle: Combining animation and narration is more effective than animation and text;
Redundancy principle: ‘Less is more’; animation and narration are more effective without additional text;
Personalisation principle: Narration is more effective in an informal conversational style.

(adapted from Mayer & Moreno, 2002, p. 93-97)

Digital literacy

Davis et al. (2015) cautioned that although students may have general familiarity with digital technologies through personal use at home, “it is unlikely that playing games or using social media

applications will, by themselves, appropriately prepare students with strategies for using the devices for specific academic purposes like writing” (p. 193). The idea of students being ‘Millenials’ (Howe & Strauss, 2000, 2003) or ‘Digital Natives’ (Prensky, 2001), meaning those that have grown up with digital technologies, has often led teachers to believe that the students are automatically technology-savvy. However, this has been proven to not be the case (e.g. Bennett & Maton, 2010; Thompson, 2013).

In Australia, students’ digital literacy is assessed through the [NAP – ICT Literacy assessment](#), which addresses students’ knowledge of:

- Working with information
- Creating and sharing information; and
- Using ICT responsibly.

The average performance of Year 6 students on these topics increased consistently from 2005 to 2011, but then significantly decreased between 2011 and 2014 (Fraillon, Schulz, Gebhardt, & Ainley Kate, 2015). It was concluded that there was “no evidence to suggest that the measured decrease in student performance between 2011 and 2014 was caused by anything other than a decrease in students’ ICT literacy” (Fraillon et al., 2015, p. xxiv). It has been difficult to determine exactly what has caused this decrease in students’ ICT literacy, but ACARA does propose a number of factors for consideration (Fraillon et al., 2015, p. 114-115).

Possible in-school factors:

- Extensive usage may lead to students practising fewer ICT skills;
- Teachers focusing on different skills related to mobile devices and online communication;
- Less explicit teaching of skills associated with ICT literacy; and,
- Development of ICT literacy competencies being taken for granted.

At home factors:

- Differences in parental occupation and education are significantly associated with ICT literacy;
- Parental occupation is related to how students are prepared for a digital future;
- Divide between the ICT literacy of Indigenous and non-Indigenous students; and,
- Differences in ICT literacy among geographic locations.

This highlights that it cannot be assumed equitable distribution of technology access for students necessarily leads to the development of ICT skills and fruitful use of digital technologies in learning. In particular, research has noted particular skills needed to successfully engage in digital writing tasks (e.g. Purcell et al., 2013). Kimmons et al. (2017, p. 22-23) recommends:

- Students need keyboarding instruction, to develop efficient motor skills for typing;
- Students need word processing instruction and practice, to better understand software features and nuances of writing in electronic media e.g. mini-lessons on using spelling checks, thesaurus features; and
- Teachers need to explicitly teach and have students practice formal computer writing versus informal computer writing (similar to teaching students about audience).

It critical that teachers considering implementing digital writing are aware that students may need explicit instruction and practice, both in the task and the technology to allow all students the opportunity to succeed.

4. Choosing the right device

Key section points:

- Digital technologies are not homogenous and have different affordances in writing
- Teachers and students should be aware of these differences to make the best choices for specific learning aims
- 2-in-1 devices are the most flexible and versatile when it comes to digital writing

The popularity of BYOD (Bring Your Own Device) programs and tablets in schools has resulted in a wide range of possible digital technologies available for use. Further, there have been a lot of questions around which device is ‘better’. More recently, this has been around laptops, chromebooks, 2-1 devices, etc., Therefore, it is necessary to cover differences among some of the most common devices found in the classroom, which can support students’ digital writing.

Laptops and touch screens

For the most part, laptops and tablets are both portable, have similar software available to them. The main affordance of the tablet is the touchscreen. Interestingly, there is little research on the effect of using a touch screen in learning. Below are four device types, tablet and laptop, commonly found in the classroom.

	Laptops (and desktop computers)	Chromebooks	Mobile devices (Tablets/ Smartphone)	2-in-1 devices
What is it?	Laptops and desktops can be categorised as PC or Apple Mac.	A Chromebook is a cloud-based laptop. Software may not be accessible if the device is offline. It is designed to be used while connected to the internet.	Mobile devices (a tablet or smartphone) are a screen-only device, where you use your finger or stylus to provide input to the device. An Internet connection is often required for some functionality.	2-in-1 devices are ‘convertible’ device. They are essentially a laptop with a touchscreen. The screen is often detachable. Designs will vary between manufacturers.
Operating system	Windows operating system or MacOS operating system.	Instead of running a Windows or Apple MacOS operating system, it runs Google’s ChromeOS.	They run a special mobile operating system, such as Android or Apple iOS.	2-in-1 devices run a ‘full featured’ operating system such as Windows.

<p>Memory, processor, storage, and input</p>	<p>A range of memory sizes, processor speeds/power and hard disk storage sizes.</p> <p>Storage can be expanded by adding on external devices such as USB memory sticks and external hard drives.</p> <p>A range of external devices can be connected via USB.</p>	<p>Similar to a laptop; a range of processor speeds/power.</p> <p>The overall software and storage space available on a Chromebook is limited because the Chromebook relies on Cloud-based storage for files and apps.</p>	<p>Storage space on mobile devices is fixed; only some Android devices can expand on the built-in storage via SD cards.</p>	<p>Similar to a laptop; a range of memory sizes, processor speeds/power and hard disk storage sizes.</p> <p>Storage can be expanded by adding on external devices such as USB memory sticks and external hard drives.</p> <p>A range of external devices can be connected via USB.</p>
<p>How do you provide input to the device?</p>	<p>Built-in keyboard for typing, a built-in pointing device (such as a trackpad for laptops) or external device such as a mouse.</p>	<p>Built-in keyboard for typing, a built-in pointing device (such as a trackpad) or external device such as a mouse.</p>	<p>Virtual on-screen keyboard, finger or stylus on the touchscreen. An external Bluetooth keyboard can be connected.</p>	<p>Built-in keyboard for typing, a built-in pointing device (such as a trackpad) or external device such as a mouse.</p> <p>You can use the touchscreen of a 2-in-1 just like a tablet; unlike traditional laptop screens, you can use your finger or stylus to provide input to the screen.</p>

Internet	<p>Internet connection commonly via Wi-Fi.</p> <p>Desktops will connect to ethernet. Some laptops allow physical ethernet connection via a port and adapter.</p>	<p>Internet connection via Wi-Fi. The Internet connection is vital for using a Chromebook because it stores apps and files online in the Cloud.</p>	<p>Mobile devices will all use Wi-Fi. Smartphones will connect through cellular/data Internet access via the mobile phone network. Some tablets can use a data network.</p>	<p>Internet connection commonly via Wi-Fi or ethernet.</p>
Software applications	<p>There are many software titles available for both PC and Apple Mac laptops.</p>	<p>They feature Google's suite of applications, such as Google Docs and Google Sheets.</p>	<p>Access to apps is provided by downloads through either the Google Play or iTunes online stores (depending on the brand of the device).</p>	<p>The same software availability as a laptop, with added functionality of some touchscreen apps.</p>

Keyboards and writing

First, there is the question of the physical keyboard, such as a laptop, desktop PC, or an external keyboard connected (e.g. Bluetooth) to a tablet, and a 'virtual keyboard'. A virtual keyboard is software-based and appears on the screen of a smartphone or tablet. The differences in these two types of keyboards creates a number of challenges (Davis et al., 2015). There is also the option of using a stylus for writing on a touchscreen, which can also integrate keyboarding in some programs. Below we cover some of the key considerations of each.

	Physical keyboard	Virtual keyboard (touch screen)	Stylus (touch screen)
Physical size	<p>A user can choose the size of a physical external or portable keyboard that suits their needs.</p>	<p>The virtual keyboard is constrained to screen size, which is often smaller than a typical physical keyboard. There is no need to carry around a separate keyboard.</p> <p>The virtual keyboard can also take up quite a bit of</p>	<p>Stylus may be smaller than a regular pen(cil) and can be difficult to hold.</p> <p>Unless the tablet device or the case has built-in storage for the stylus, it may be easily lost.</p> <p>Writing is constrained to the screen area only.</p>

		room on the screen, which may result in significant additional scrolling to see the content above the keyboard.	
Hand placement	You can rest your keys on a keyboard, but not press them (Findlater & Wobbrock, 2012). This is more comfortable and less prone to error.	Fingers are either on the keys or off the keys. This may be unfamiliar if students know how to 'touch type' where fingers rest on the home keys. Mistyping/errors can occur.	Unlike a pen(cil) resting the stylus on a touch screen may activate other functions on the tablet, e.g. pop-up options. When using a capacitive stylus without 'palm rejection', resting hands or wrists on the screen when writing may result in unwanted mark-marking and/or the stylus not working.
Key layout	Depending on the size of the physical keyboard, certain keys may not be available, for example a set of specific numeric keys. Different keyboard layouts for different languages can be selected in software, but the keys themselves retain their original labelling.	Virtual keyboards typically have multiple layouts, e.g. alphabet characters displayed on one screen and numeric or symbolic characters on another. Unfamiliarity with the layout can cause students to make typing mistakes (L.L. Davis, Strain-Seymour, & Gay, 2013), which would not occur on a physical keyboard (Lopez & Wolf, 2013).	The stylus can be used to tap keys on a virtual keyboard, acting as a finger replacement.
Legibility	A full-size keyboard may reduce the number of typing mistakes and increase speed for students who are familiar with keyboards.	The small size and on-screen sensitivity may frustrate students still learning to type and may increase typing mistakes.	Some programs have handwriting recognition, which will convert written text to type. However, the accuracy of these programs can vary. Initially, students may have difficulty writing legibly using the stylus. This will improve with practice.

The challenges of the virtual keyboard have been found to result in slower typing speeds (Pisacreta, 2013). Several observational studies have found that students write less with a virtual keyboard than with a physical keyboard (Davis et al., 2013; Strain-Seymour, Craft, Davis, & Elbom, 2013). However, “student familiarity and flexibility with devices may overcome any potential disadvantages” (Davis, Janiszewska, et al., 2015, 181). In their study of 5th, 10th and 11th grade students undertaking a short essay with either a laptop, a tablet, or a tablet with an external keyboard Davis et al. (2015) found that Year 10 and 11 students expressed a “definite preference for a physical keyboard, [but] this preference did not translate into a performance difference across conditions.” (p.193). However, they also found that younger students who had little or no keyboarding training “were very facile with the virtual keyboard and even indicated preference for it over a physical keyboard that was external to the tablet device”. Although, it is cautioned that while students may be familiar with touch-screen devices, “it is unlikely that playing games or using social media applications will, by themselves, appropriately prepare students with strategies for using the devices for specific academic purposes like writing” (Davis, Janiszewska, et al., 2015).

Writing with a tablet and stylus

Digital writing with a stylus on a touch-screen should take into consideration potential differences in the tactile experience. Some difference include friction between paper and tablet screens, how marks are made and changes when pressure is applied to the stylus. If you have not written with a stylus on a tablet screen, consider the different experience of using a ballpoint pen to sign your name on a piece of paper versus signing your name on the back of a new credit card. Writing on the slippery surface of the plastic card can sometimes be a bit tricky.

There is limited research considering the difference of writing with a stylus on a tablet and writing using a pen(cil) on paper, in relation to learning outcomes and effect on writing. Alamargot and Morin (2015) compared how second grade and ninth grade students used a stylus with a tablet and pen(cil) on paper. They note that the students in their study were all writing on a tablet screen using a stylus for the first time. Results showed some initial decrease in legibility for both second and ninth grade students. Other studies have shown dramatic improvement in writing after several weeks of use (e.g. Spencer et al., 2013). Therefore, the researchers concluded that consideration should be given to teaching students this process, which may potentially improve writing. Suggestions include increasing the texture of the surface or a more frictional stylus tip to reduce difficulties experienced by the students.

There were also specific differences between the grades. Writing on the screen only had an effect on the movement in ninth graders, where they increased both pen pressure and pen speed. Second grade students were more likely to pause when using the stylus, which led to a greater increase in duration of the task (Alamargot & Morin, 2015b, p. 38). These results were consistent with writing development at different ages using more traditional tools.

5. Conclusions and looking ahead

- How and what students write has changed with the availability of digital technologies
- Teachers should attend to both issues of using digital technologies and digital writing in learning designs
- New digital technologies will continue to shape writing and change how we communicate, and should be introduced to students as an area of continuous change

Throughout this discussion, we have highlighted how changes in education and technology have led to innovations in digital writing - possibly changing how we think about writing and learning.

New practices, such as blogging, microblogging and ePortfolios have started to change how writing is understood. However, this is a shifting landscape and new digital technologies are coming out quickly. As we have stressed, the most important part of educational innovation is to keep pedagogy in the foreground of change.

The take-home messages of this discussion are:

1. Digital technologies should be used for writing, but they are not necessary for everything.
2. Be alert to how students are negotiating a digital device when writing and be aware if support is needed.
3. Be sure you and your students understand the affordances of different devices for digital writing. All devices are not equal.
4. Be aware of the different ways students are writing informally and formally, and how these can be used together to engage students in the writing process.
5. Involve students in thinking about digital writing, such as multimodal writing and developing their digital literacy, to encourage ownership of the process.

People are simply writing more on their digital devices and there is a range of affordances when using digital technologies to write. Students have preferences in how they write, which may impact on how well they perform on assessment, take notes and engage in collaboration. While evidence suggests students write more and enjoy using digital technologies to write, if a student is not able to type well or they are on the wrong device they may not perform as well. It is important here to not assume students are comfortable on all digital technologies. Teachers need to be alert to students' comfort levels and their preferences for certain devices. Teachers should put appropriate strategies in place, e.g. support, training, alternate task, etc., to help students develop digital writing skills so they are able to work across a range of devices successfully.

Looking to the future, a few of the big changes are likely to be:

- **Artificial intelligence (AI)** - AI is already present in writing, in the form of predictive text and computer written texts, e.g. news articles. AI is machine learning that may help students make choices about writing, in terms of their technique and their content.
Example: [Writing With Artificial Intelligence](#)
- **Virtual reality (VR)** - VR is an immersive computer-generated 3D simulation. Typically, a user will wear a headset, and possibly hand sensors or gloves, to interact in the computer environment. VR can be used as a way for students to experience new environments or situations, which they can use as part of a writing process. They may also write for a virtual setting, or to create their own simulation.
Example: [The impact of virtual reality on creative writing at Penybont Primary School](#)
- **Augmented reality (AR)** - AR is similar to VR, in that it is 3D and requires technology to experience it. However, AR is not immersive. It is often seen using a mobile directed at an object and an overlay will appear, which may be an image or information about the physical space. Research has shown that AR can be used as a writing scaffold for students and brainstorming technique (e.g. Wang, 2017, see like below).
Example: [Using Augmented Reality in Writing Classes](#)

These may be the next big things in digital writing, or something else might appear. Regardless, it is important to keep in mind that using the new technologies and understanding new genre needs

to be taught. Students may have some knowledge, but they will need to be showing how to use new technologies to support academic work and writing.

References

- ACARA. (2016). NAP - NAPLAN Online. Retrieved July 6, 2018, from <https://www.nap.edu.au/online-assessment>
- Alamargot, D., & Morin, M.-F. (2015). Does handwriting on a tablet screen affect students' graphomotor execution? A comparison between Grades Two and Nine. *Human Movement Science, 44*, 32–41. <https://doi.org/https://doi.org/10.1016/j.humov.2015.08.011>
- Arndt, P. A. (2016). Computer usage for learning how to read and write in primary school. *Trends in Neuroscience and Education, 5*(3), 90–98. <https://doi.org/https://doi.org/10.1016/j.tine.2016.07.003>
- Bangert-Drowns, R. L. (1993). The Word Processor as an Instructional Tool: A Meta-Analysis of Word Processing in Writing Instruction. *Review of Educational Research, 63*(1), 69. <https://doi.org/10.2307/1170560>
- Barrett, H. (2010). Balancing the two faces of ePortfolios. *Educação, Formação & Tecnologias, 3*(1), 6–14.
- Beach, R. (2012). Uses of Digital Tools and Literacies in the English Language Arts Classroom. *Research in the Schools, 19*(1), 45–59. Retrieved from http://www.msera.org/old-site/Rits_191/Rits_191_Beach_5.pdf
- Bennett, S., & Maton, K. (2010). Beyond the 'digital natives' debate: Towards a more nuanced understanding of students' technology experiences. *Journal of Computer Assisted Learning, 26*(5), 321–331. <https://doi.org/10.1111/j.1365-2729.2010.00360.x>
- Clark, C., & Dugdale, G. (2009). *Young People's Writing: Attitudes, behaviour and the role of technology*. Retrieved from <https://files.eric.ed.gov/fulltext/ED510271.pdf>
- Considine, D., Horton, J., & Moorman, G. (2009). Teaching and Reaching the Millennial Generation Through Media Literacy. *Journal of Adolescent & Adult Literacy, 52*(6), 471–481. <https://doi.org/10.1598/JAAL.52.6.2>
- Cooperman, S. (2017). *Sixth-Grade Students' Compositional Processes in Traditional and Digital Writing*. Fordham University. Retrieved from <https://search.proquest.com/openview/ea2de897540f4bc992d098c949d7a642/1?pq-origsite=gscholar&cbl=18750&diss=y>
- Cordero, K., Nussbaum, M., Ibaseta, V., Otaíza, M. J., Gleisner, S., González, S., ... Carland, C. (2015). Read Create Share (RCS): A new digital tool for interactive reading and writing. *Computers & Education, 82*, 486–496. <https://doi.org/https://doi.org/10.1016/j.compedu.2014.12.006>
- Courtland, M. C., & Paddington, D. (2008). Digital literacy in a grade 8 classroom: An e-zine webquest. *Language and Literacy: A Canadian E-Journal, 10*(1), 1–23. Retrieved from <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.1025.1794&rep=rep1&type=pdf>
- Danielson, C., & Abrutyn, L. (1997). Introduction to Using Portfolios in the Classroom. United States: Association for Supervision and Curriculum Development. Retrieved from <http://www.ascd.org/publications/books/197171/chapters/The-Types-of-Portfolios.aspx>
- Davis, L. L., Janiszewska, I., Schwartz, R., & Holland, L. (2015). *NAPLAN ONLINE RESEARCH AND DEVELOPMENT Device Effect Study*. Retrieved from <https://www.nap.edu.au/docs/default-source/default-document-library/naplan-online-device-effect-study.pdf?sfvrsn=2>
- Davis, L. L., Orr, A., Kong, X., & Lin, C.-H. (2015). Assessing Student Writing on Tablets. *Educational Assessment, 20*(3), 180–198. <https://doi.org/10.1080/10627197.2015.1061426>
- Davis, L. L., Strain-Seymour, E., & Gay, H. (2013). *Testing on tablets: Part II of a series of usability studies on the use of tablets for K-12 assessment programs*. Retrieved from <http://docplayer.net/19176443-Testing-on-tablets-part-ii-of-a-series-of-usability-studies-on-the-use-of-tablets-for-k-12-assessment-programs.html>
- Davis, L., & Roger, Y. L. (2011). The Use of Social Networking Tool Twitter to Improve College Students' Business Writing Skills. *Issues in Information Systems, 12*(1), 401–406.
- DeVoss, D. N., Eidman-Aadahl, E., & Hicks, T. (2010). *What Is Digital Writing and Why Does It Matter?* San Fransisco: Jossey-Bass. Retrieved from <https://www.nwp.org/cs/public/print/resource/3310>
- Dündar, H., & Akçayır, M. (2012). Tablet vs. paper: The effect on learners' reading performance.

International Electronic Journal of Elementary Education, 4(3), 441–450.

- Farina, F., & Lyddy, F. (2011). The Language of Text Messaging: "Linguistic Ruin" or Resource? *Irish Psychologist*, 37(6), 145–149.
- Farinosi, M., Lim, C., & Roll, J. (2016). Book or screen, pen or keyboard? A cross-cultural sociological analysis of writing and reading habits basing on Germany, Italy and the UK. *Telematics and Informatics*, 33(2), 410–421.
<https://doi.org/https://doi.org/10.1016/j.tele.2015.09.006>
- Felix, J. (2008). Edublogging: Instruction for the Digital Age Learner. In K. McFerrin, R. Weber, R. Carlsen, & D. Willis (Eds.), *Proceedings of SITE 2008--Society for Information Technology & Teacher Education International Conference* (pp. 3741–3748). Las Vegas, Nevada, USA: Association for the Advancement of Computing in Education (AACE). Retrieved from <https://www.learntechlib.org/p/27830/>
- Findlater, L., & Wobbrock, J. O. (2012). From plastic to pixels: in search of touch-typing touchscreen keyboards. *Interactions*, 19(3), 44–49. <https://doi.org/10.1145/2168931.2168942>
- Fortunati, L., & Vincent, J. (2014). Sociological insights on the comparison of writing/reading on paper with writing/reading digitally. *Telematics and Informatics*, 31(1), 39–51.
<https://doi.org/https://doi.org/10.1016/j.tele.2013.02.005>
- Fraillon, J., Schulz, W., Gebhardt, E., & Ainley Kate, J. (2015). *National Assessment Program – ICT Literacy Years 6 & 10 Report 2014*. Sydney. Retrieved from https://www.nap.edu.au/_resources/D15_8761__NAP-ICT_2014_Public_Report_Final.pdf
- Gašević, D., Mirriahi, N., Dawson, S., & Joksimović, S. (2017). Effects of instructional conditions and experience on the adoption of a learning tool. *Computers in Human Behavior*, 67, 207–220. <https://doi.org/10.1016/J.CHB.2016.10.026>
- Genlott, A. A., & Grönlund, Å. (2013). Improving literacy skills through learning reading by writing: The iWTR method presented and tested. *Computers & Education*, 67, 98–104.
<https://doi.org/https://doi.org/10.1016/j.compedu.2013.03.007>
- Goeth Institute. (2015). *Cursive Handwriting: The Demise of a Cultural Technique* - Goethe-Institut. Retrieved July 27, 2018, from <https://www.goethe.de/en/spr/mag/20732745.html>
- Helvie-Mason, L. (2011). Twitter and student reflection. Retrieved July 22, 2018, from <http://www.comhighered.com/2011/04/twitter-and-student-reflection.html>
- Holder, C. R. (2006). New Media and New Literacies: Perspectives on Change. *EDUCASE Review*, 41(6), 76–77. Retrieved from <https://er.educause.edu/articles/2006/1/new-media-and-new-literacies-perspectives-on-change>
- Horney, M. A., Anderson-Inman, L., Terrazas-Arellanes, F., Schulte, W., Mundorf, J., Wiseman, S., ... Frisbee, M. L. (2009). Exploring the Effects of Digital Note Taking on Student Comprehension of Science Texts. *Journal of Special Education Technology*, 24(3), 45–61. Retrieved from <https://eds-b-ebshost-com.ezproxy.uow.edu.au/eds/detail/detail?vid=1&sid=5f77420f-9b65-463e-8f56-1446200aa8dd%40sessionmgr102&bdata=JnNpdGU9ZWRzLWxpdmU%3D#AN=52962001&db=ehh>
- Howard, S. K., & Mozejko, A. (2013). *DER-NSW Evaluation: Conclusions on student and teacher engagement and ICT use*. Sydney.
- Howe, N., & Strauss, W. (2000). *Millennials Rising: The Next Generations*. New York, NY, USA: Vintage Books.
- Howe, N., & Strauss, W. (2003). *Millennials go to college*. Washington D.C.: American Association of Collegiate Registrars and Admissions Officers.
- Hull, G. A., Stornaiuolo, A., & Sahni, U. (2010). Cultural Citizenship and Cosmopolitan Practice: Global Youth Communicate Online. *English Education*, 42(4), 331–367. Retrieved from <http://www.jstor.org/stable/23018017>
- Jansen, R. S., Lakens, D., & IJsselsteijn, W. A. (2017). An integrative review of the cognitive costs and benefits of note-taking. *Educational Research Review*, 22, 223–233.
<https://doi.org/10.1016/J.EDUREV.2017.10.001>
- Kahne, J., Lee, N., & Feezell, J. (2012). Digital media literacy education and online civic and political participation. *International Journal of Communication*, 6, 1–24. Retrieved from <http://ijoc.org/ojs/index.php/ijoc/article/view/999>
- Kajder, S., Bull, G., & Van Noy, E. (2004). A Space for "Writing without Writing" Blogs in the Language Arts Classroom. *Learning and Leading with Technology*, 31(6), 32–35.

- Kim, K., Turner, S. A., & Pérez-Quiñones, M. A. (2009). Requirements for electronic note taking systems: A field study of note taking in university classrooms. *Education and Information Technologies*, 14(3), 255–283. <https://doi.org/10.1007/s10639-009-9086-z>
- Kimmons, R., Darragh, J. J., Haruch, A., & Clark, B. (2017). Essay Composition across Media: A Quantitative Comparison of 8th Grade Student Essays Composed with Paper vs. Chromebooks. *Computers and Composition*, 44, 13–26. <https://doi.org/https://doi.org/10.1016/j.compcom.2017.03.001>
- Kristen Purcell, Judy Buchanan, & Linda Friedrich. (2013). *The impact of digital tools on student writing and how writing is taught in schools*. Pew Research Center's Internet & American Life Project (Vol. 16). Washington D.C. Retrieved from [http://www.pewinternet.org/files/old-media/Files/Reports/2013/PIP_NWP Writing and Tech.pdf](http://www.pewinternet.org/files/old-media/Files/Reports/2013/PIP_NWP_Writing_and_Tech.pdf)
- Lai, K.-W., & Hong, K.-S. (2015). Technology use and learning characteristics of students in higher education: Do generational differences exist? *British Journal of Educational Technology*, 46(4), 725–738. Retrieved from <http://10.0.4.87/bjet.12161>
- Lenhart, A., Arafeh, S., Smith, A., & Macgill, A. R. (2008). *Writing, Technology and Teens*. New York, NY, USA. Retrieved from <http://www.pewinternet.org/2008/04/24/writing-technology-and-teens/>
- Loewus, L. H. (2016). Why Don't the Common-Core Standards Include Cursive Writing? Retrieved June 18, 2018, from http://blogs.edweek.org/edweek/curriculum/2016/10/why_dont_the_common-core_standards_include_cursive_writing.html
- Longcamp, M., Boucard, C., Gilhodes, J.-C., Anton, J.-L., Roth, M., Nazarian, B., & Velay, J.-L. (2008). Learning through Hand- or Typewriting Influences Visual Recognition of New Graphic Shapes: Behavioral and Functional Imaging Evidence. *Journal of Cognitive Neuroscience*, 20(5), 802–815. <https://doi.org/10.1162/jocn.2008.20504>
- Lopez, A., & Wolf, M. K. (2013). A study on the use of tablet computers to assess English learners' language proficiency. Anaheim, CA: California Educational Research Association.
- Mayer, R. E., & Moreno, R. (2002). Aids to computer-based multimedia learning. *Learning and Instruction*, 12(1), 107–119. [https://doi.org/10.1016/S0959-4752\(01\)00018-4](https://doi.org/10.1016/S0959-4752(01)00018-4)
- McLeod, J. K., & Vasinda, S. (2009). Electronic portfolios: Perspectives of students, teachers and parents. *Education and Information Technologies*, 14(1), 29–38. <https://doi.org/10.1007/s10639-008-9077-5>
- Medwell, J., & Wray, D. (2017). *What's the use of handwriting? A white paper*. Hoboken, NJ. Retrieved from <http://s7d9.scene7.com/is/content/NewellRubbermaid/Write Your Future/White Paper FINAL 3APR2017 w logo.pdf>
- Morphy, P., & Graham, S. (2012). Word processing programs and weaker writers/readers: a meta-analysis of research findings. *Reading and Writing*, 25(3), 641–678. <https://doi.org/10.1007/s11145-010-9292-5>
- Mueller, P. A., & Oppenheimer, D. M. (2014). The Pen Is Mightier Than the Keyboard: Advantages of Longhand Over Laptop Note Taking. *Psychological Science*, 25(6), 1159–1168. <https://doi.org/10.1177/0956797614524581>
- Mueller, P. A., & Oppenheimer, D. M. (2016). Technology and note-taking in the classroom, boardroom, hospital room, and courtroom. *Trends in Neuroscience and Education*, 5(3), 139–145. <https://doi.org/https://doi.org/10.1016/j.tine.2016.06.002>
- NESA. (2017). HSC minimum standard. Retrieved July 6, 2018, from <http://educationstandards.nsw.edu.au/wps/portal/nesa/11-12/hsc/hsc-minimum-standard>
- Nicolaidou, I. (2013). E-portfolios supporting primary students' writing performance and peer feedback. *Computers & Education*, 68, 404–415. <https://doi.org/10.1016/J.COMPEDU.2013.06.004>
- NMC. (2017). 2017 K-12 Edition. Retrieved July 23, 2018, from <https://www.nmc.org/publication/nmccos-horizon-report-2017-k-12-edition/>
- NSW Department of Education. (2016). NAPLAN Online | Student assessment. Retrieved July 6, 2018, from <https://education.nsw.gov.au/teaching-and-learning/student-assessment/naplan-online>
- NSW Education Standards Authority (NESA). (2018). English K–10 - Stage 2 - Outcome C. Retrieved July 6, 2018, from <https://syllabus.nesa.nsw.edu.au/english/english-k10/content/889/>

- Oh, E., & Reeves, T. C. (2014). Generational Differences and the Integration of Technology in Learning, Instruction, and Performance. In *Handbook of Research on Educational Communications and Technology* (pp. 819–828). New York, NY: Springer New York. https://doi.org/10.1007/978-1-4614-3185-5_66
- Ostler, E., & Topp, N. (2013). Digital Note Taking: An Investigation of an iPad Application as a strategy for Content Review and Practice in Intermediate Algebra. In R. McBride & M. Searson (Eds.), *Proceedings of SITE 2013--Society for Information Technology & Teacher Education International Conference* (pp. 72–77). New Orleans, Louisiana, United States: Association for the Advancement of Computing in Education (AACE).
- Pisacreta, D. (2013). *Comparison of a test delivered using an iPad versus a laptop computer: Usability study results*. National Harbour, MD.
- Prensky, M. (2001). Digital Natives, Digital Immigrants Part 1. *On the Horizon*, 9(5), 1–6. <https://doi.org/10.1108/10748120110424816>
- Purcell, K., Buchanan, J., & Friedrich, L. (2013). *The impact of digital tools on student writing and how writing is taught in schools*. JULY (Vol. 16). Washington D.C. Retrieved from [http://www.pewinternet.org/files/old-media/Files/Reports/2013/PIP_NWP Writing and Tech.pdf](http://www.pewinternet.org/files/old-media/Files/Reports/2013/PIP_NWP_Writing_and_Tech.pdf)
- Purcell, K., Buchanan, J., & Friedrich, L. (2013). The Impact of Digital Tools on Student Writing and How Writing is Taught in Schools Summary of Findings. *The National Writing Project*, 16, 1–114. Retrieved from [http://www.pewinternet.org/files/old-media/Files/Reports/2013/PIP_NWP Writing and Tech.pdf](http://www.pewinternet.org/files/old-media/Files/Reports/2013/PIP_NWP_Writing_and_Tech.pdf)
- Reid, M., Burn, A., & Parker, D. (2002). *Evaluation Report of the Becta Digital Video Pilot Project*. Retrieved from http://homepages.shu.ac.uk/~edsjlc/ict/becta/research_papers/what_the_research_says/dvreport_241002.pdf
- Robin, B. R. (2008). Digital Storytelling: A Powerful Technology Tool for the 21st Century Classroom. *Theory Into Practice*, 47(3), 220–228. <https://doi.org/10.1080/00405840802153916>
- Rosen, L. D., Chang, J., Erwin, L., Carrier, L. M., & Cheever, N. A. (2010). The Relationship Between “Textisms” and Formal and Informal Writing Among Young Adults. *Communication Research*, 37(3), 420–440. <https://doi.org/10.1177/0093650210362465>
- Sana, F., Weston, T., & Cepeda, N. J. (2013). Laptop multitasking hinders classroom learning for both users and nearby peers. *Computers & Education*, 62, 24–31. <https://doi.org/10.1016/j.compedu.2012.10.003>
- Schoen, I. (2012). Effects of Method and Context of Note-taking on Memory: Handwriting versus Typing in Lecture and Textbook-Reading Contexts. *Pitzer Senior Theses*, 20.
- Spencer, K. M., Coutts, T., Fagan, T., & King, A. (2013). Connections, diversity, coherence: Three vignettes exploring learning with iPads in primary schools. *Computers in New Zealand Schools: Learning, Teaching, Technology*, 25(1–3), 38–55. Retrieved from <https://www.otago.ac.nz/cdelt/otago065355.pdf>
- Spitzer, M. (2014). Information technology in education: Risks and side effects. *Trends in Neuroscience and Education*, 3(3–4), 81–85. <https://doi.org/10.1016/J.TINE.2014.09.002>
- Strain-Seymour, E., Craft, J., Davis, L. ., & Elbom, J. (2013). *Testing on tablets: Part I of a series of usability studies on the use of tablets for K-12 assessment programs*. Retrieved from http://educationdocbox.com/Homework_and_Study_Tips/80597033-Testing-on-tablets-part-i-of-a-series-of-usability-studies-on-the-use-of-tablets-for-k-12-assessment-programs.html
- Sweeny, S. M. (2010). Writing for the Instant Messaging and Text Messaging Generation: Using New Literacies to Support Writing Instruction. *Journal of Adolescent & Adult Literacy*, 54(2), 121–130. <https://doi.org/10.2307/20775367>
- Sylvester, R., & Greenidge, W.-I. (2009). Digital Storytelling: Extending the Potential for Struggling Writers. *The Reading Teacher*, 63(4), 284–295. <https://doi.org/10.2307/30249378>
- <https://doi.org/10.2307/30249378>
- Taipale, S. (2014). The affordances of reading/writing on paper and digitally in Finland. *Telematics and Informatics*, 31(4), 532–542. <https://doi.org/https://doi.org/10.1016/j.tele.2013.11.003>
- Thompson, P. (2013). The digital natives as learners: Technology use patterns and approaches to learning. *Computers & Education*, 65, 12–33. <https://doi.org/http://dx.doi.org/10.1016/j.compedu.2012.12.022>

- Vue, G., Hall, T. E., Robinson, K., Ganley, P., Elizalde, E., & Graham, S. (2016). Informing Understanding of Young Students' Writing Challenges and Opportunities. *Learning Disability Quarterly*, 39(2), 83–94. <https://doi.org/10.1177/0731948715604571>
- Witte, S. (2007). "That's Online Writing, Not Boring School Writing": Writing With Blogs and the Talkback Project. *Journal of Adolescent & Adult Literacy*, 51(2), 92–96. <https://doi.org/10.1598/JAAL.51.2.1>
- Wormald, B. W., Schoeman, S., Somasunderam, A., & Penn, M. (2009). Assessment drives learning: An unavoidable truth? *Anatomical Sciences Education*, 2(5), 199–204. <https://doi.org/10.1002/ase.102>
- Yancey, K. B. (2009). Electronic Portfolios a Decade into the Twenty-first Century: What We Know, What We Need to Know. *Peer Review*, 11(1), 28–32. Retrieved from <http://ezproxy.uow.edu.au/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=38119819&site=eds-live>
- Yi, Y. (2008). Relay Writing in an Adolescent Online Community. *Journal of Adolescent & Adult Literacy*, 51(8), 670–680. <https://doi.org/10.1598/JAAL.51.8.6>
- Zheng, B., Warschauer, M., & Farkas, G. (2013). Digital Writing and Diversity: The Effects of School Laptop Programs on Literacy Processes and Outcomes. *Journal of Educational Computing Research*, 48(3), 267–299. <https://doi.org/10.2190/EC.48.3.a>