Australian Institute for Teaching and School Leadership Limited

Spotlight

Evaluating the evidence for educational technology: Part 2 – enabling learning

March 2024

Contents

The key messages in this Spotlight reveal that:

- Despite the increase in the availability of educational technology (edtech), Australian students' digital literacy skills have decreased over time. Students need to be taught the skills relevant to acquiring digital literacy: practising digital safety and wellbeing, investigation, creating and exchanging, and managing and operating content.
- Implemented well, edtech has the potential to deliver greater benefits to several student cohorts, including those with disabilities, those learning remotely, and students from Aboriginal and Torres Strait Islander communities.
- However, despite the likely benefits, there are potential drawbacks associated with the overuse of technology, including the negative effects of screen time on student learning, as well as indirect effects (such as impacts on anxiety and social relationships).
- Teachers' perspectives, including the value they place on edtech, can influence its effective use. Confidence and ability to use edtech also have a significant impact on student outcomes.
- School-based professional learning (PL), especially PL that is collaborative and includes applied practice, is particularly effective for improving knowledge of,

and attitudes towards, edtech and its importance for developing the digital literacy of students.

Introduction

The term 'edtech' encompasses all digital technologies that are used for educational purposes even if those technologies were not initially developed for educational purposes. As such, edtech encompasses everything from classroom computers and mobile phones to augmented reality (AR) and artificial intelligence (AI) based learning platforms (Department for Education (England), 2019). This Spotlight is the second of two editions focusing on edtech; the previous edition, Spotlight: Evaluating the evidence for educational technology: Part 1 – the technologies (Edtech Part 1) focused on evaluating the technologies themselves.

Edtech has increased significantly in popularity, use and availability since the COVID-19 pandemic. Motivations for using edtech are typically related to either:

- minimising the amount of time that teachers spend on tasks that aren't student-facing, or
- improving student learning, engagement, attendance or behaviour.

Effective use of some edtech can promote better student outcomes, including increased engagement and learning (see Edtech Part 1). Although edtech is often presented as a panacea for improving a range of teaching and learning outcomes, not all uses of edtech deliver the intended benefits. This Spotlight explores how some individual factors can impact the integration of edtech and its effectiveness in achieving improved student outcomes. We also examine what characteristics of PL activities are most likely to promote successful use of edtech within the classroom.

Digital literacy skills

The term 'digital native', introduced by Mark Prensky in 2001, is used to describe young people who have been surrounded by digital devices for their entire lives. Prensky proposed that young people born after 1980 were, by virtue of growing up in an increasingly digital world, "native speakers of the digital language of computers, video games and the Internet" (Prensky, 2001). This idea continues to hold some attraction today, even though substantial research has since refuted this concept (Bennett & Maton, 2010; Eynon, 2023; Facer & Furlong, 2001). Responses from 1,876 Australian teachers, principals, and other relevant educational staff to a survey in 2019 demonstrated educators were aware of the limited digital literacy of many students (Gonski Institute for Education (GIE), 2020):

Still surprised at students' lack of in-depth understanding of the digital technologies they use.

Students are not as tech savvy as people imagine. They can access apps but cannot perform basic search functions or basic computing functions.

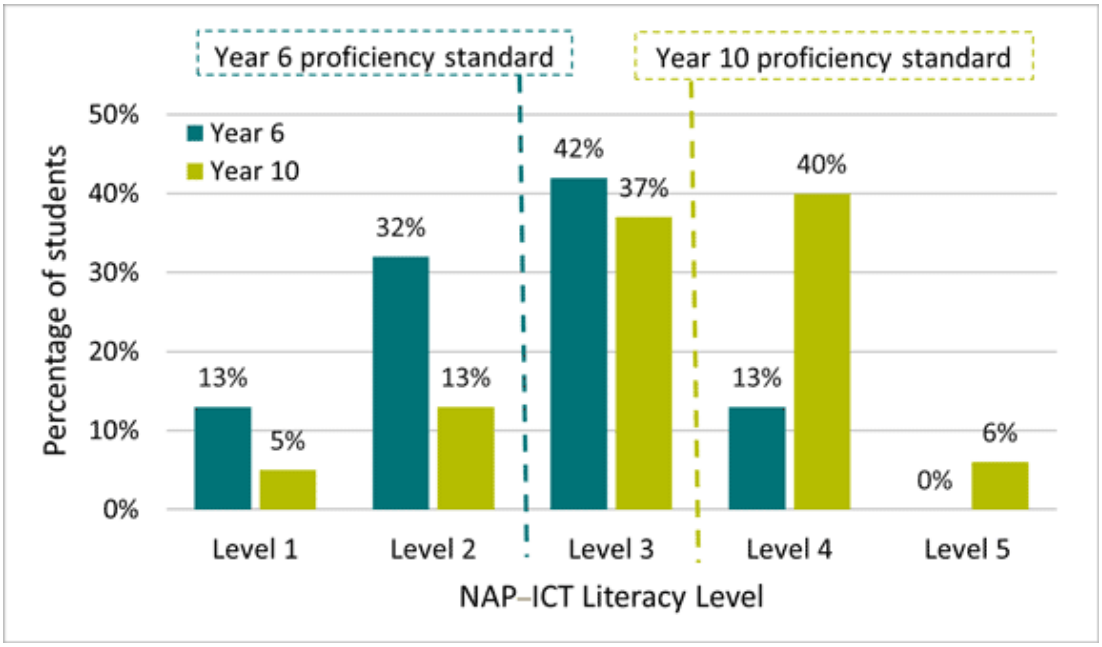
Despite the growth in the number of apps that can be used to create online content, many students are just passive content users.

–GIE, 2020 P. 22

Thus increased use of digital technologies by children and teenagers hasn't corresponded to an increase in the digital skills or literacy of these students (GIE, 2020 P. 22), despite almost 20 years elapsing since Prensky first coined the phrase 'digital natives'. Evidence from national and international assessments further refutes Prensky's suggestion that young people are innately developing high level information and communication technology (ICT) skills by virtue of living in a digital world (Fraillon, 2019).

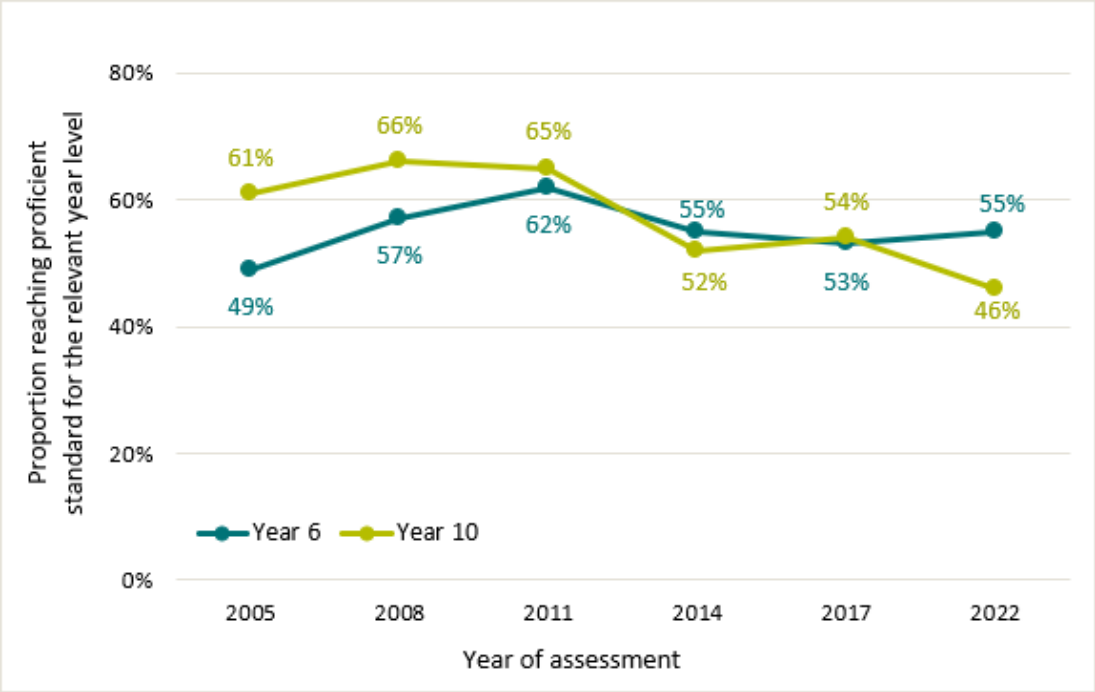
In Australia, the digital literacy of students is assessed periodically via the National Assessment Program – Information and Communication Technology Literacy (NAP–ICT Literacy). Commencing in 2005, this assessment has typically been undertaken on a 3-yearly basis, although the assessment due in 2021 was delayed until 2022 due to COVID-19 pandemic (Australian Curriculum, Assessment and Reporting Authority (ACARA), 2023a). In 2022, only 55% of Year 6 students and 46% of Year 10 students reached their respective proficient standard for NAP–ICT Literacy (see Figure 1). Concerningly, the 13% of Year 6 students and 5% of Year 10 students at level 1 have trouble with very basic digital skills, such as opening email attachments, copying and pasting a column in a spreadsheet, or finding specific information on a webpage.

Figure 1. Digital literacy of Australian students, as measured by the 2022 NAP–ICT Literacy. Source: ACARA (2023a).



Students have been increasingly immersed in a digital world over the last two decades, but the digital literacy of Australian students has not improved over time. For example, the proportion of Year 6 students reaching the proficient standard has typically hovered around 55% throughout this period (Figure 2; ACARA, 2023a). Furthermore, the proportion of Year 10 students who reach the proficient standard has declined over time, from a high of 66% in 2008 to a more recent low of 46% in 2022 (Figure 2).

Figure 2. Changes in the digital literacy of Australian students since 2005, as measured by NAP–ICT Literacy. Source: ACARA (2023a).



This demonstrates why students need to learn about digital literacy throughout their school years. The Australian Curriculum Version 9.0 includes Digital Literacy as a general capability (ACARA, 2023b), emphasising its fundamental importance for students' future lives. The Digital Literacy capability

encompasses four elements (Figure 3; ACARA, 2023b), with a greater emphasis on students maintaining their digital safety and wellbeing than was seen in the previous general capability of ICT Literacy (ACARA, 2021).

Figure 3. The four elements of the Digital Literacy general capability outlined in the Australian Curriculum Version 9.0. Source: ACARA (2023b).

Resource list

Teacher resources to develop digital literacy of students

Australian Curriculum (V9)

This page outlines the key skills and concepts that students should master for this general capability, including examples highlighting how various activities can be integrated into specific learning areas (e.g. Health and Physical Education or Mathematics), at various year levels.

https://v9.australiancurriculum.edu.au/f-10-curriculum

Computer Science Education Research Group (CSER) - University of Adelaide

Established in collaboration with Google in 2016, CSER provide case studies and lesson plans demonstrating how edtech can be embedded into teaching and learning across all years. Notably, they also have a lending library to enable schools (especially those in remote regions or schools that participate in CSER professional learning activities) to access classroom kits for FREE.

https://csermoocs.adelaide.edu.au/

Digital technologies hub

Website with comprehensive resources (primarily information for teachers, but with some intended for parents too) spanning everything from understanding core concepts in the Digital Technologies curriculum, lesson plans, effective pedagogies and integrating assessment to inclusive education and support for creating school-wide implementation plans.

https://www.digitaltechnologieshub.edu.au/

eSafety education

Offers free online safety resources (such as toolkits, videos, worksheets and scenario-based discussions) as well as training for teachers, schools and communities. Free webinars are also available for students. Topics covered include cyberbullying, and online hate directed towards Aboriginal and Torres Strait Islander communities. The website also presents a Best Practice Framework for Online Safety Education, developed specifically for the Australian context.

https://www.esafety.gov.au/educators:

Grok Academy

Offers introductory videos and courses on digital technologies and digital literacy – both for teachers and students. Some are free, some are subsidised for Australian students. One section – DT Applied – contains free resources for teachers, including some 'unplugged' (offline) activities, covering:

- design thinking
- user interfaces/user experience (UI/UX)
- data analytics, and
- cloud computing.

https://groklearning.com/

Webwise

Although based in Ireland, this site offers relevant online resources covering elements of digital literacy such as information sharing and privacy, cyberbullying, and using social networks effectively and responsibly. Resources include lesson plans, slides, videos, worksheets, teachers' handbooks and more.

https://www.webwise.ie/teachers/resources/

Using edtech with diverse learners

> *Results revealed that technology is neither beneficial nor harmful for learning when used primarily as a means of presenting information (e.g., information viewed on a computer screen vs. on paper) but can be beneficial when it involves unique affordances that leverage effective learning principles.*
>
> –Yeung et al, 2021, P. 1583

As noted in Edtech Part 1, edtech has the potential to enable greater personalisation and differentiated learning to cater to the differing academic abilities of students. Beyond this, edtech also has potential to better support inclusive education by addressing the varying needs of diverse students (irrespective of their academic ability). Although inclusive education initially focused on students with special educational needs associated with various disabilities, this term has since been broadened to encompass other groups of students with diverse learning needs (e.g. students with English as a second or additional language), to increase the benefits for all learners (Mezzanotte, 2022). Inclusive education is "an ongoing process aimed at offering quality education for all while respecting diversity and the different needs and abilities, characteristics and learning expectations of the students and communities, eliminating all forms of discrimination" (UNESCO, 2009 cited in Gottschalk & Weise, 2023).

Loble & Hawcroft (2022) state that high-quality edtech can, in the right environment, be used to improve outcomes for disadvantaged students "but only if this edtech is well-designed, well-used and well-governed". The effective use and integration of such edtech within teaching and learning is essential for narrowing the gap between disadvantaged students and students that have not experienced disadvantage (Loble & Hawcroft, 2022).

Edtech has the potential to offer greater affordances [1] for diverse learners than those seen in traditional classrooms, with a wide variety of digital tools and resources that can shape the learning environment into flexible and inclusive spaces for learning. For example, edtech can offer:

- virtual and assistive technologies for students and teachers with disabilities (Fernández-Batanero et al., 2022)
- genuine and culturally appropriate educational resources for students from other backgrounds or cultures (including Aboriginal and Torres Strait Islander communities), and
- asynchronous learning activities (e.g., blogs, streamed lectures and discussion forums) for students who are unable to attend campus due to professional or personal commitments or characteristics (illness, work, caring responsibilities, living in remote locations) (Badia et al., 2011).

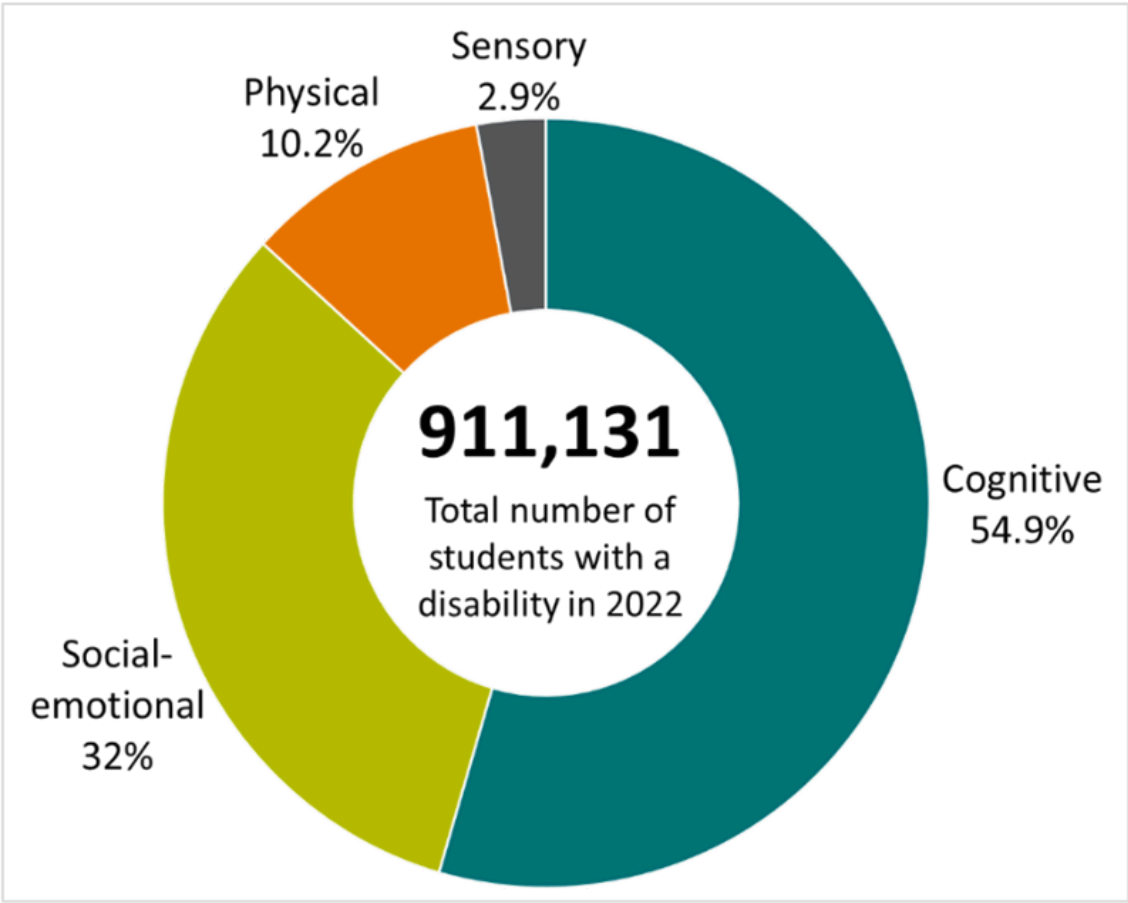
There are many benefits in developing and implementing ways to support diverse learners with edtech, including improved accessibility, engagement and learning for most students.

Careful consideration of affordances is crucial for developing an inclusive learning space as many online learning activities involve communication and collaboration, either between learners or between learners and the teacher (Rose-Munro, 2021). The affordances of edtech are, however, dependent on the way teachers adapt their practices. Where edtech is simply used to transfer traditional teaching methods to an online environment, this will likely limit the potential benefits for most students. One exception to this is that several different types of edtech (such as interactive whiteboards and learning management systems) enable greater use of multiple media formats, which typically has a positive impact on student outcomes, especially for students from diverse backgrounds or with some disabilities (see Edtech Part 1).

Edtech affordances for students with a disability

In 2022, 22.5% of school students received an educational adjustment due to disability, an increase of 7.8 percentage points since 2015 (ACARA, 2022). Over half of these students (~55%) have a cognitive disability (Figure 4; ACARA, 2022). Given the growing number of students with identified disabilities, many schools are redesigning classrooms and teaching methods to support a more inclusive learning environment.

Figure 4. Relative proportion of school students who needed an adjustment due to a disability in 2022, by disability classification. Data source: ACARA (2022).



Many students with a disability need adjustments beyond academic support. Depending on the student, and the nature of their disability, other considerations may include communication, mobility, interpersonal interactions, and relationship building. For example, students with autism and their families ranked socio-emotional issues and behaviour as priority areas where more support was needed from schools, while academic learning support was rated the lowest (Table 1, Whitehouse et al., 2020). This likely reflects the high degree of variability in academic achievement and IQ observed across the autism spectrum (Keen et al., 2016; Vanegas, 2019), and many such students will not require any additional academic support.

Table 1. Needs of students with autism that were rated as having the most impact and requiring the highest levels of support. Source: Whitehouse et al. (2020).

Rating (high to low)	Student Needs
1	Social/emotional
2	Behavioural
3	Communication
4	Sensory
5	Academic/learning

The recent Royal Commission into Violence, Abuse, Neglect and Exploitation of People with Disability (the Disability Royal Commission; 2023), found that students with disability face many barriers to participating in mainstream schooling, including negative attitudes towards, and low expectations of, these students. As such, Commissioners unanimously agreed that "mainstream schools need major reforms to overcome the barriers to safe, equal and inclusive education" (Disability Royal Commission, 2023). Data from the Australian Bureau of Statistics (ABS) 2018 Survey of Disability, Ageing and Carers (the most recently published dataset) shows that students with disability are not all receiving the support they need to fully participate in education (ABS, 2019). Consequently, students with disability are twice as likely to leave school before they turn 16 than students without a disability (Australian Institute of Health and Welfare, 2022). As such, increasing support for, and the inclusion of, students with disability within mainstream schools is imperative. Edtech should help better facilitate this, enabling greater personalisation of learning material and activities for the individual students involved.

> *Despite the numerous challenges to achieving inclusive education, the strategic incorporation of digital technologies can support the teaching and learning process, enhance accessibility for those who need it, and provide more individualised learning experiences. If used appropriately, digital tools can contribute to more inclusive education systems…*
>
> –GOTTSCHALK & WEISE, 2023, P. 14

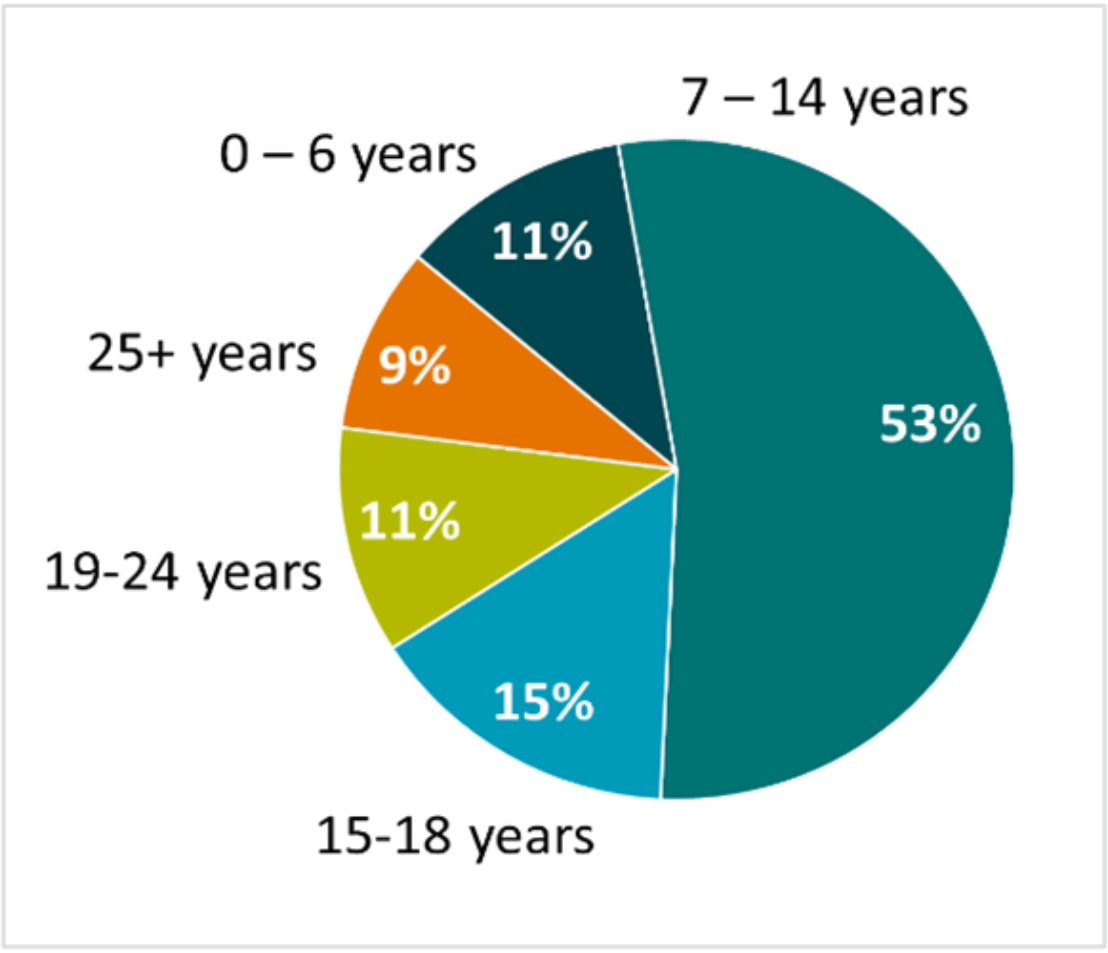
Edtech can effectively support students with disability to better participate in learning, including classroom activities (Rizk & Hillier, 2022). Assistive technologies [2] are a type of edtech designed to reduce the impediments individuals who have specific types of disability may face in accessing digital media. For example, screen readers or magnifiers may reduce the impact of visual disabilities, assuming the learning materials are appropriately designed (Kinash et al., 2018). Additionally, edtech that supports dyslexic or visually-impaired students (such as voice recognition software and text-to-speech software) can significantly improve their academic performance (Underwood, 2009).

Video modelling, simulations and some apps can be particularly useful for students with socio-emotional and socio-communication difficulties, enabling students to practice appropriate responses in a range of situations. Teachers can also utilise edtech to promote self-management by these students, including through reducing sensory input (e.g. noise cancelling headsets or listening to music via headphones) and managing emotions and anxiety through inward focus (e.g. mindfulness tools or apps that focus on breathing). As a cautionary note, more general use of tablets and mobiles in ways that may be a distraction (especially for entertainment rather than educational purposes) may decrease self-regulation and impulse inhibition in young learners (Radesky et al., 2023); thus only apps which support self-management strategies suitable for a given individual should be used. More generic edtech can also help mitigate disability-related challenges; for example, interactive touchscreens may assist students with poor fine motor skills (Rizk & Hillier, 2022). Similarly, multimedia learning can support some students with cognitive disabilities. For example, an online program to help children with attention deficit hyperactivity disorder (ADHD) develop their listening and concentration skills resulted in improved learning (Underwood, 2009). Use of edtech to promote the development of children with disability or other special needs is becoming more established (Loble & Hawcroft, 2022), including in early childhood education (Wyeth et al., 2023). Adaptive, student-centred edtech (such as personalised learning platforms, intelligent tutoring or adaptive assessment systems) can all contribute to better educational outcomes for students with disability (Loble & Hawcroft, 2022). An added advantage is that some edtech incorporates diagnostic tools to enable earlier detection (and thus potentially earlier and better management of the individual needs) of students with learning disabilities or ADHD (Millar et al., 2019; Simeoli et al., 2021), although some learning disabilities (e.g. dyslexia, dyscalculia) will not be expressed in early childhood settings (Wyeth et al., 2023).

Edtech to support students with autism

Both the number and proportion of students with autism (or autism spectrum disorder; ASD) is rapidly increasing within Australia and internationally (May & Williams, 2019). The National Disability Insurance Scheme (NDIS), which provides support to Australians with permanent disabilities, noted that the number of participants with autism as their primary disability increased by 20% in the 12 months to September 2022 (NDIS, 2022). At that time, 34% of NDIS participants had autism as their primary disability, with 80% of these participants aged under 18 (Figure 5, NDIS, 2022). As such, students with diagnosed autism are becoming increasingly prevalent in Australian classrooms.

Figure 5. Age groups of active NDIS participants with autism as their primary disability. Note that the vast majority are younger than 18.



Autism is one disability where edtech is frequently heralded as a potential adjustment to promote inclusion, often due to the belief that autistic students will have an interest in computing as this aligns with the observed characteristics, behaviours and preferences (including skillset) of many of these students. Multiple types of edtech have been suggested to improve outcomes for students with autism, including picture-supported text, augmentative and alternative communication [3], video modelling and prompting, and online communication boards (Edyburn, 2020).

When teaching an autistic child, edtech "may reduce the social demands of an intervention, complement a special interest a child may have in computers, and/or provide consistency in instruction that aligns with a child's preference for routine and sameness.

–Whitehouse et al., 2020

A review of recent research (published 2018–2022) evaluated the impact of edtech on young children with disability (aged 3–6) in educational settings and found that about half of these studies focused on assistive technologies as an adjustment for autism (Wyeth et al., 2023). This emphasis is also seen in Australian research, potentially due to recent work on the National Guideline for supporting the learning, participation, and wellbeing of autistic children and their families in Australia.

An umbrella review [4] of edtech interventions for students with autism found mixed results between, and within, different types of edtech (Table 2; Whitehouse et al., 2020), highlighting the need to adopt an individualised approach with each student. A review of the effects of extended reality (XR) found improvements in social skills (including communication and emotional regulation) in students with autism, however, there were mixed findings as to whether or not these improvements were greater than those seen with face-to-face skill instruction (Carreon et al., 2022). Additionally, the levels of skills acquired were related to the degree of realism and presence within the XR environment.

Table 2. Overview of evidence demonstrating the impact (or lack thereof) of edtech on learning outcomes for students with autism. Adapted from Whitehouse et al. (2020).

		Edtech (overall)	Apps	Augmentative & Alternative Communication	Computer Based Instruction	Robots
	Number of review papers	5	2	3	2	1
Education & participation	General outcomes	?		?		
	School/ learning readiness	+				
	Academic skills	+		+	?	
Key skills for students with autism	Social-communication	O	O	?	+	?
	Communication	+	O	+		
	Cognition	+	+			
	Motor	+	+	+		
	Social-emotional/ challenging behaviour	O		+		
	Play	+		+		
	Adaptive behaviour	+				

+	positive effect(s)	?	variable effects	O	no effects
	no evidence found in systematic reviews				

Evidence quality:	high	moderate	low

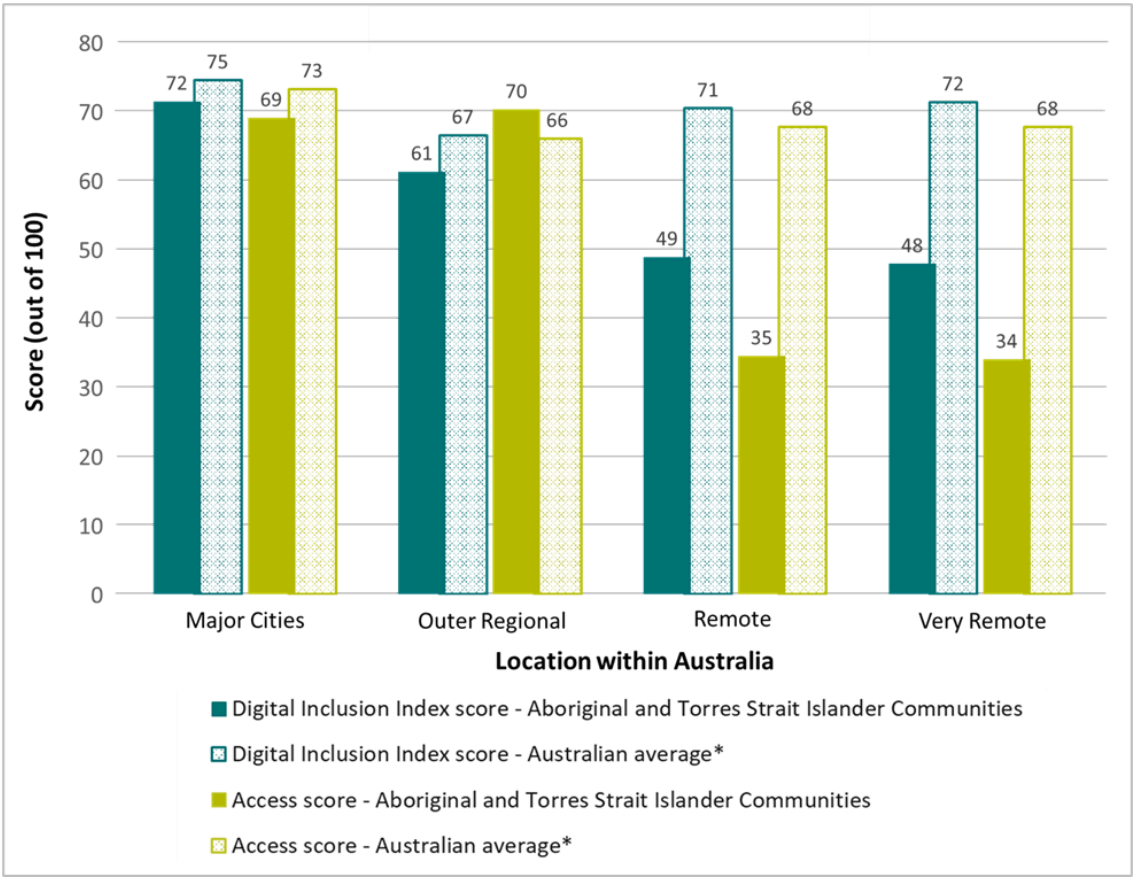
Whitehouse et al. (2020) reported mixed results for communication skills, depending on the edtech examined (Table 2); for example, they found that computer-based instruction improved communication skills, but apps did not produce a significant improvement. There was also moderate evidence that robots and communication supports had mixed effects on learning outcomes (Whitehouse et al., 2020). This further reinforces the need to critically evaluate the effectiveness of edtech interventions for autistic students on an individual basis.

Using edtech with students from Aboriginal and Torres Strait Islander communities

There are marked differences in access to digital technologies across Australia, whether at schools or at home, with socio-economic status and remoteness both being key factors (Loble & Hawcroft, 2022). Aboriginal and Torres Strait Islander communities in remote and very remote regions have significantly

worse access than other communities in these regions (Figure 6; Thomas et al., 2023). Furthermore, access is often via pre-paid mobile phones which impacts how the internet is used and, consequently, limits the digital literacy of students from these communities (Thomas et al., 2023).

Figure 6. Australian Digital Inclusion data, highlighting the lower levels of digital inclusion and access in remote and very remote Aboriginal and Torres Strait Islander communities. *excluding Aboriginal and Torres Strait Islander communities. Data from Thomas et al. (2023).



Given the disparity in access and digital inclusion, it is not surprising that the 2022 NAP–ICT Literacy data showed a markedly lower number of Aboriginal and Torres Strait Islander students were proficient using ICT, relative to students from other backgrounds. Only 23% of Year 6, and 19% of Year 10 students who identified as Aboriginal and/or Torres Strait Islander reached the proficient standard in 2022, compared to 57% and 47% of non-Indigenous students in Year 6 and 10, respectively (Thomas et al., 2023). The percentage of Aboriginal and Torres Strait Islander students reaching the proficient standard has neither improved nor declined in a meaningful way since 2014, when reporting began for these groups (Thomas et al., 2023).

An assessment of the impact of computer-based instruction (specifically the program Abracadabra) on the English literacy and reading skills of young children found that this edtech improved learning for all students (Wolgemuth et al., 2014). “Indigenous students at risk of reading difficulties” (Wolgemuth et al., 2014) experienced the greatest benefit, which the authors reasoned reflected the additional instructional time the edtech afforded, combined with otherwise limited opportunities to practise English literacy skills. As such, students from non-English speaking backgrounds more broadly may also benefit from such edtech.

The lack of cultural context in many literacy interventions may hamper the development of literacy skills in students from Aboriginal and Torres Strait Islander communities (Fogarty et al., 2018; Guenther et al., 2023; Gutierrez et al., 2023). This is particularly pronounced for upper primary students (or older) who still struggle with basic English literacy as there is an existing scarcity of age-appropriate resources even before cultural relevance is considered (Riley & Webster, 2016). Lack of cultural relevance can also impede the development of digital literacy and other 21st century skills, although teachers addressing Standards 1.4 and 4.1 of the Australian Professional Standards for Teachers will likely already be embedding such cultural considerations within their teaching.

Edtech affords students the opportunity to access people and resources remotely, thus enabling cultural learning activities such as exploring media of Country, speaking with Elders from remote communities or sharing creative storytelling with community. As such, edtech can not only offer more culturally relevant resources to students from Aboriginal and Torres Strait Islander backgrounds, but it can also support students from all cultural backgrounds to gain a deeper understanding of Indigenous knowledge, histories and cultures.

Minecraft Education Competition

Minecraft Education offers the opportunity to create virtual worlds and thus provides an alternative mechanism by which Aboriginal and Torres Strait Islander students (or their teachers) can portray and share cultural heritage, knowledge and creation stories (Microsoft, 2023). This is the premise behind an Australia-wide competition run annually since 2020 as part of NAIDOC Week. In its inaugural year, students were challenged to work with local Elders to research and learn about Indigenous knowledge, histories, and creation stories in their local area and then to create mixed-reality characters and Minecraft worlds to answer the question “How might we build sustainable schools, cities, towns, or communities in 2030 using Indigenous science, technology, engineering, arts, and maths?”

Edtech provides key tools to integrate cultural relevance into the curriculum. For example, various edtech can be used to document local stories and facilitate storytelling (e.g. Digital Creative Storytelling), potentially in collaboration with Elders and community. The use of culturally relevant resources can promote engagement and learning in students from Aboriginal and Torres Strait Islander backgrounds. For example, culturally responsive digital games increased the engagement and motivation of primary school students (K–6) from Aboriginal and Torres Strait Islander backgrounds (Meston et al., 2023).

A 2021 meta-analysis of 25 studies found that maintaining a culturally responsive framework and the use of edtech were essential for developing appropriate teaching and learning strategies and resources to support Indigenous people's learning of language and literacy skills internationally (Li et al., 2021). Furthermore, teachers consistently reported that edtech use resulted in significant improvements in the literacy and numeracy of Aboriginal and Torres Strait Islander students, particularly when digital storytelling and digital cultural artefacts were incorporated. Teachers also revealed, however, that inadequate training and support for integrating edtech into teaching and learning hindered their teaching practice (Li et al., 2021). This reinforces the need for holistic PL that focuses not just on how to use edtech but how to teach effectively with it, in specific contexts and in culturally responsive ways.

Additional considerations for teachers regarding students' use of edtech

While edtech can produce positive outcomes, both socially and academically, there are also potential negative outcomes to its use. For example, ethical issues surrounding the use of edtech remain a concern. Transparency and accountability, safeguarding student privacy, avoiding bias and discrimination, and promoting inclusivity are all key issues to consider. Schools and education systems should establish clear guidelines and policies to ensure the responsible use of edtech, protecting students' rights and promoting equal opportunities (Organisation for Economic Co-operation and Development (OECD), 2023). Within the Australian context, the recently released Australian Framework for Generative AI in Schools provides key guidance to support schools to preserve the safety of students whilst they engage with this type of edtech. The importance of digital safety, and developing student skills in this area, is emphasised within the Digital Literacy general capability of the Australian Curriculum Version 9.0 (Figure 3; ACARA, 2023b).

Education researchers, teachers and parents have all highlighted the growing need for students to be able to self-regulate their use of digital technologies, both generally, and during learning activities (GIE, 2020; Graham & Sahlberg, 2021). In a recent survey of 2,000 Australian parents, over 90% said that excess screen time [5] was a key issue facing society today (Danchin, 2021). Cyberbullying and bullying was the second most commonly ranked concern (55% of parents; Danchin, 2021). Australian parents and caregivers would like schools to provide more guidance on how to manage these issues (Graham & Sahlberg, 2021).

Can too much screen time have a negative impact on students?

Two national surveys have recently demonstrated that many parents, carers and teachers are concerned about the impact of screen time on children (GIE, 2020; Graham & Sahlberg, 2021). The majority of parents and carers thought that excess use of digital technology had either negatively impacted their child by distracting them (83%) or caused conflict at home (65%). Few parents and carers (20%) reported that their child was primarily allowed to access digital technologies for educational purposes; most parents allowed their child to use these technologies for entertainment purposes (Graham & Sahlberg, 2021).

Student access to technology is high, with an average student spending 4½ hours a day at home looking at a screen (Howie et al., 2020); more than double that recommended in government guidelines (Table 3; Australian Government Department of Health and Aged Care (DoHAC; 2021). These guidelines apply to recreational screen time; the use of edtech in educational purposes is not included. Approximately 50% of parents and caregivers surveyed indicated they would like their child's school to provide (more) guidance on how to better manage use of these technologies at home; 85% of students aged over 5 exceed the screen time guidance on a regular basis (Graham & Sahlberg, 2021; Howie et al., 2020).

Table 3. Sleep and sedentary recreational screen time recommendations for children and young adults. * including naps. Source: DoHAC (2021).

Activity	Child's age			
	0-12 months	1-2 years	3-5 years	6-17 years
Sedentary recreational screen time	None.	Under 2 years: None.	Up to 1 hour per day.	Up to 2 hours per day.
		2 years: Up to 1 hour per day.		
Sleep	0 to 3 months: 14 to 17 hours* 4 to 11 months:12 to 16 hours*	11 to 14 hours*	10 to 13 hours*	5 to 13 years: 9 to 11 hours. 14 to 17 years: 8 to 10 hours.

Screen time is negatively linked with academic performance (Dumuid et al., 2017). Overall academic performance and scores in English and maths were all significantly higher in students that had less than 2 hours of home-based screen time a day (Howie et al., 2020). Students who are disengaged or struggling academically are more likely to be distracted when using edtech; consequently, edtech may exacerbate existing differences in education attainment between different students or student groups. For example, parents from lower socio-economic backgrounds are less likely to implement monitoring and regulation strategies at home, thus over-use of digital technology by these students is more likely – potentially reinforcing socio-economic divides in academic achievement (Graham & Sahlberg, 2021). Introducing digital literacy strategies in early childhood education can reduce these differences somewhat (Bers et al., 2022). Children who learn digital skills (including self-management and coping mechanisms) early in life will be better equipped for the challenges posed by rapid technological advances in the near future. As such, early integration of digital literacy skills could possibly help ameliorate long-standing divides in earning potential associated with socio-economic status.

3 in 10 families let their children go to bed with a digital device

3 in 5 students who are struggling at school go to bed with a digital device

Source: GIE (2021)

Another negative outcome potentially associated with excess screen time, especially at night, is less sleep; this likely results from a combination of displacement (e.g. using screens instead of sleeping) as well as increased alertness due to activity and blue light. Around a quarter of Australian children aged 12–15 do not get sufficient sleep on weeknights; the same is true of half of Australian children aged 16–17 (Evans-Whipp & Gasser, 2019). This negatively impacts students' attitudes, engagement, concentration, memory and overall ability to learn as well as their mental health (e.g. greater incidence of anxiety and depression) (Evans-Whipp & Gasser, 2019; Stiglic Hribernik & Viner, 2019). These impacts appear to be increasing over time; for example, 78% of teachers believe that children are less able to focus today than they were 5 years ago and 59% have observed a decline in students' readiness to learn within the same timeframe (GIE, 2020).

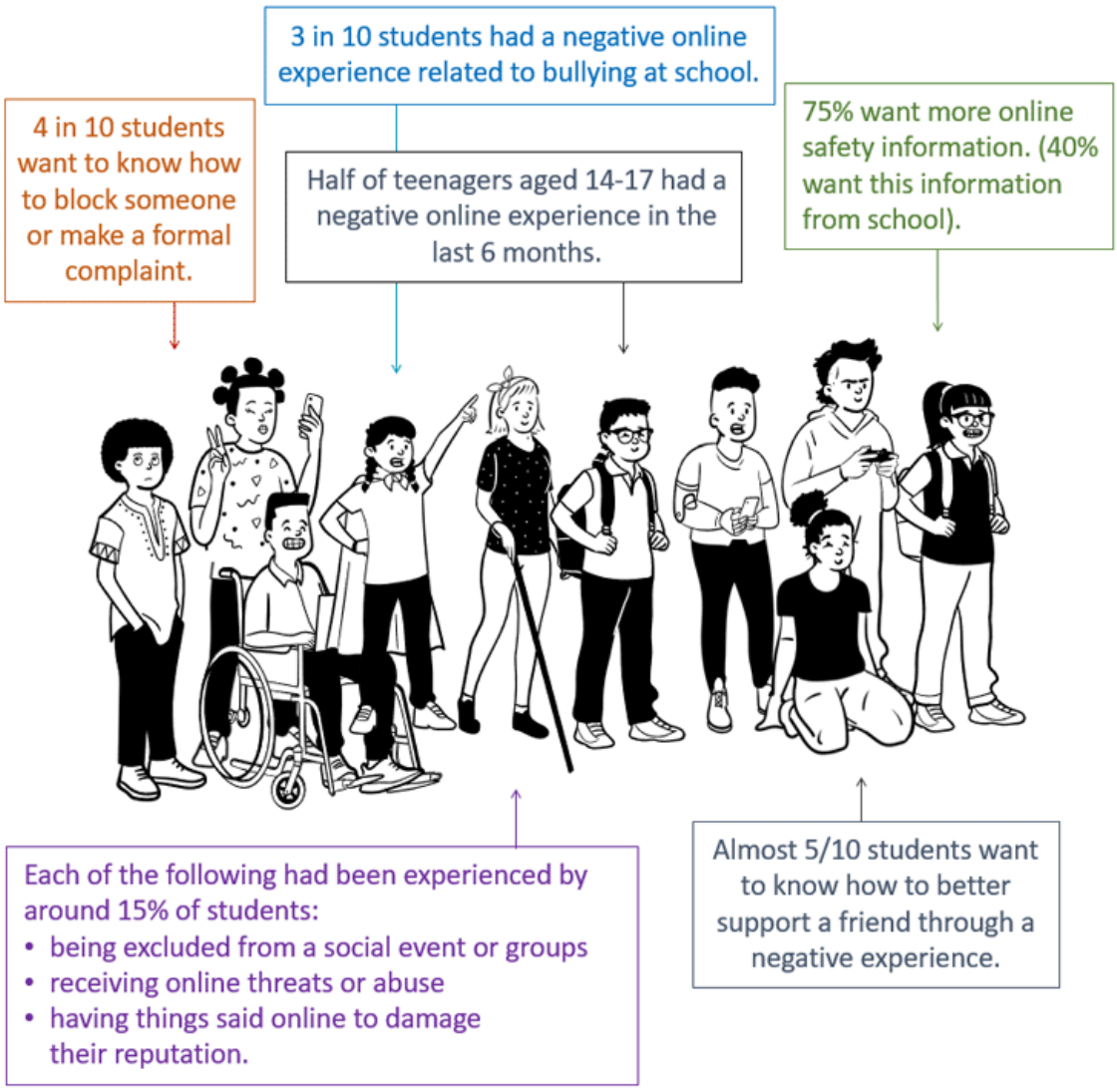
What about bullying?

The virtual nature of the technology, the lack of central control, and limitations for monitoring and its use, has enabled adolescents to adopt a new and pervasive form of covert aggression referred to as 'cyber bullying'.

–Cross et al., 2009, P.37

Statistics on bullying suggest that approximately 25% of students have been bullied in-person while around 15% have been victims of cyberbullying (Ford et al., 2017; Islam et al., 2022), such as social exclusion or threats (Figure 7). A key risk factor for cyberbullying is the amount of time spent online. Ironically, the amount of time spent online also contributes to students' bullying behaviour, as it provides multiple opportunities for bullying (e.g. hostile messages, social isolation or sharing embarrassing photos or videos online) (Islam et al., 2022; Marciano et al., 2020).

Figure 7. Key statistics on cyberbullying in Australia. Data source: eSafety Commissioner (2021).



Female students are more likely to have experienced cyberbullying than male students (Marciano et al., 2020; Thomas et al., 2017), which some authors have linked to increased use of social media. Girls are also more at risk of negative consequences, including anxiety, depression and self-harm, as a result of being bullied (Islam et al., 2022; Marciano et al., 2020). Anxiety and depression can also make

it more likely that a student is subjected to bullying or cyberbullying potentially creating a vicious cycle. Additionally, students who have been involved in bullying as either a perpetrator or victim are more likely to be subject to bullying in the future, both online and off.

Students from Aboriginal and Torres Strait Islander communities are more likely to have been bullied (including cyberbullying) within the last 12 months (Hall et al., 2020) and are less likely to have positive attitudes towards learning and their school (Cain & Hattie, 2020). Similarly, students with disabilities aged 15–19 are bullied (including cyberbullying) at twice the rate of students without disabilities in the same age group; 70% of this bullying is associated with educational settings (ABS, 2019). As such, both these student cohorts are more likely to disengage from education. This reinforces the need to better cater to these students so that long-standing disparities in educational attainment can be addressed; an issue clearly highlighted in the recently released 'Improving Outcomes for All' report (Department of Education (DoE), 2023).

Resource list

Useful resources about cyberbullying for teachers and students

eSafety (eSafety Commissioner; Australian Government)

Government website committed to promoting online safety of Australians, with a specific section for educators, including:

- eSafety's Best Practice Framework for Online Safety Education establishes a consistent national approach, based on the latest research, to support education systems across Australia to deliver high-quality programs, with clearly defined elements and effective practices.
- A toolkit of resources for schools as they prepare, engage and educate the school community and respond to online safety issues.
- Training for a variety of educational professionals including pre-service teachers, teachers and early childhood educators, counsellors, wellbeing officers and chaplains.

https://www.esafety.gov.au/

Bullying. No Way!

Website designed to support Australian school communities with evidence-informed resources and activities for a proactive approach to bullying prevention and education.

https://bullyingnoway.gov.au/

Kids Helpline

Free bullying and cyberbullying resources and learning for kids, teens, parents and teachers. This includes free online cyberbullying education sessions for school classes (max 50 students per session):

- See here for K–6
- See here for teens

https://kidshelpline.com.au/

What promotes effective use of edtech?

Traditionally, external factors (also called first-order barriers), such as the availability and reliability of edtech or the speed of internet, presented significant barriers to the use of edtech in many schools. Within most developed countries, these barriers have been largely overcome within the last two decades, although teachers' time can still pose an important barrier (Ertmer et al., 2015). Consequently, intrinsic factors (or second-order barriers) exert a greater influence on an individual's use of edtech within their teaching. These factors are typically more personal, ingrained, and experience-based, making them harder to change (Er & Kim, 2017). Key intrinsic factors relating to a teacher's use of edtech include:

1. the value they place on edtech for student learning, and
2. their own personal sense of effectiveness **when teaching with digital technologies** (emphasis added; Vongkulluksn et al., 2018).

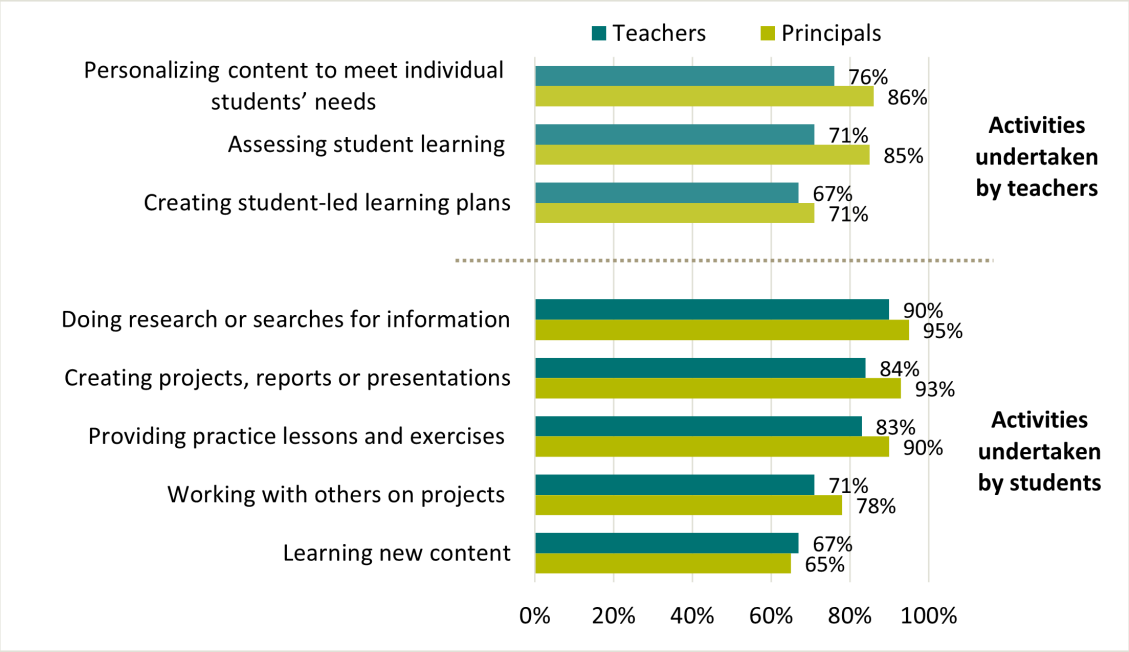
Furthermore, a teacher's beliefs and attitudes about edtech don't only affect their own practice, but also the impact of edtech on student learning.

The value of edtech

Teachers' beliefs about edtech have been studied widely as they can be a key driver of, or impediment to, use of edtech within classes (Tømte et al., 2023). The value teachers place on edtech has a greater impact on their integration of edtech than either their skills or confidence in using edtech. Teachers who recognise the value of edtech in teaching and learning are more likely to use edtech, irrespective of their skills and confidence, than teachers who have advanced technological skills but don't believe edtech promotes student learning (Vongkulluksn et al., 2018). Additionally, teachers who believe digital skills are essential for students' future employment are more likely to integrate edtech into their teaching on a regular basis (Tondeur et al., 2017). Consequently, multiple authors have recommended that PL activities related to edtech should stress why students need these '21st century' skills.

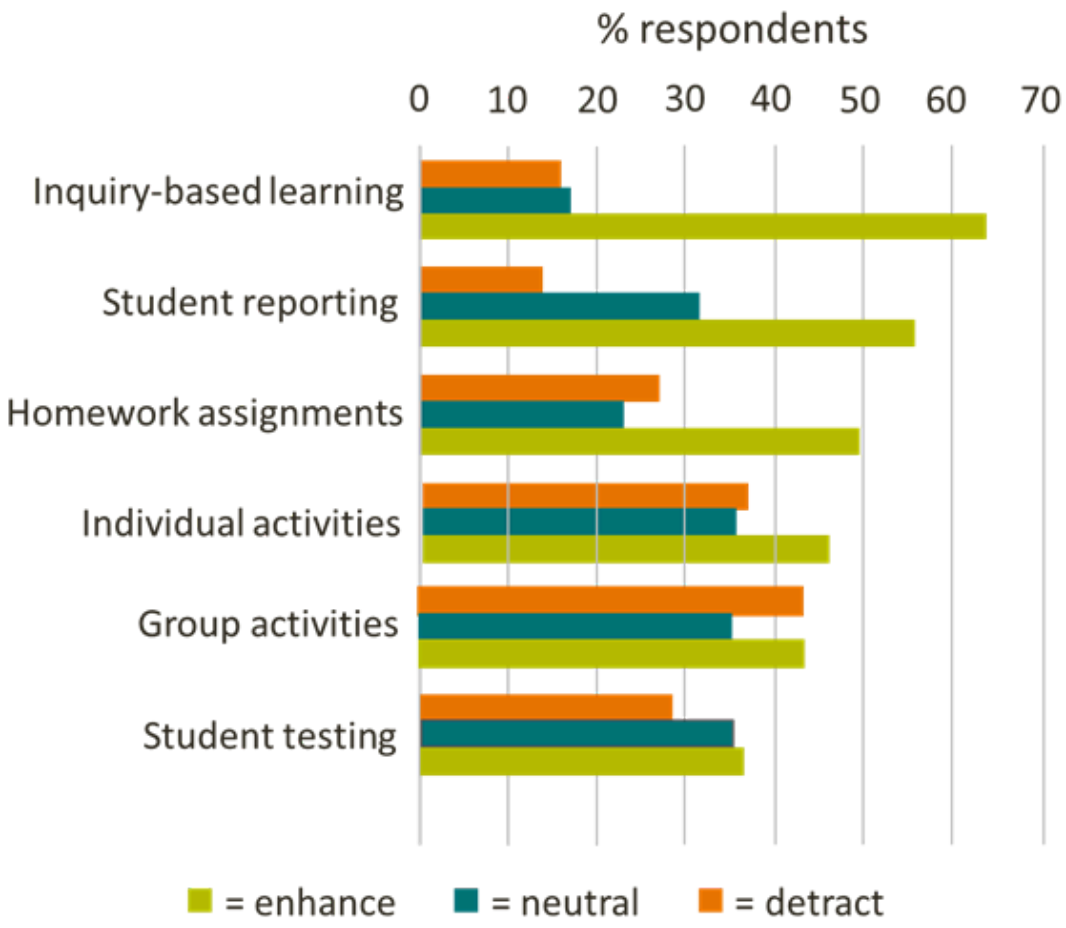
A recent survey of public school teachers and principals in the United States similarly found that the vast majority (>80%) thought edtech was useful for students, but with varying support for different activities (Figure 8; Gallup, 2019). A larger proportion of teachers agreed that that edtech was useful for students to undertake research or find information (90%), than for enabling students to learn new content (67%) (Figure 8; Gallup, 2019). Principals tended to be slightly more positive than teachers about the benefits of edtech, except in regard to edtech's ability to promote student learning of new content.

Figure 8. The proportion of respondents (US public school teachers and principals) who agreed that edtech was effective for the stated activities. Data source: Gallup (2019).



Within Australia, teachers and principals were both more positive about the opportunities edtech enables for inquiry-based learning, than learning more generally (Figure 9; GIE, 2020). Over 55% of teachers and principals thought edtech improved assessment, student reporting and learning for students with disabilities (GIE, 2020).

Figure 9. Perspectives of Australian teachers and principals as to the impact of edtech on various activities, indicating that most teachers thought the use of edtech enhanced inquiry-based learning. Source: GIE (2020).



Teachers' attitudes towards edtech are not strongly correlated with the availability of edtech (and associated infrastructure such as internet access). Infrastructure is an initial component of integrating edtech into teaching and learning, however, schools also need to develop:

- an appropriate culture
- relevant policies and guidelines, and
- the competency of staff and students alike (Costa et al., 2021; Panisoara et al., 2020).

A positive school culture that prioritises the digital literacy of staff and students, and where school leaders model effective use of digital technologies, typically promotes more positive attitudes of staff towards the use of edtech.

Ability and self-efficacy

A teacher's confidence and prior experience using edtech has a large impact on how effectively they use edtech within their teaching (Perrotta, 2013). A teacher's sense of self-efficacy refers to their confidence or belief that they can achieve the desired educational outcomes; this can be multi-faceted and vary with other aspects such as pedagogy or the year level taught. A teacher's sense of self-efficacy specifically relating to teaching with edtech (as opposed to teaching more generally) strongly influences the degree to which technology is integrated into their teaching (Li et al., 2019).

The latest International Computer and Information Literacy Study (ICILS) survey, conducted in 2018, revealed that whilst nearly all teachers felt confident using edtech for basic tasks (such as using the internet to find learning materials and resources, or producing presentations), fewer reported they

“knew how” to collaborate effectively online (Fraillon et al., 2020). Furthermore, teachers were more likely to use edtech daily within their own work (66%) than to integrate it into their teaching practice (45%). As many schools shifted to teaching online during the recent COVID-19 pandemic, this may have forced some teachers to use edtech that they had not previously incorporated. For example, the number of teachers who contribute to online documents and discussions (such as video calls) is likely to be much higher now than it was pre-pandemic.

The latest Teaching and Learning International Survey (TALIS), also conducted in 2018, shows 78% of teachers in Australia reported that they could support student learning through the use of edtech either “quite a bit” or “a lot” (OECD, 2020). This is well above the average of 67% across OECD countries (OECD, 2020). This indicates that most Australian teachers have good self-efficacy with regards to their ability to promote student learning via edtech. Despite this, only 45% of Australian teachers thought that edtech **enhanced** their teaching practice (GIE, 2020).

Professional learning

Edtech, when used with appropriate pedagogy, can enhance student outcomes. However, various types of edtech have their own affordances, thus students and educators need to use the ‘right tool for the job’. PL activities need to provide teachers with the skills and knowledge to best match different edtech to their specific subjects and associated activities (Gottschalk & Weise, 2023), at the appropriate level of skill and knowledge. Furthermore, PL needs to ensure that teachers possess sufficient digital skills to use edtech in a way that enhances their pedagogy (Ulferts, 2021). Whilst access to edtech tools and resources increased over the last two decades, training and technical support in using these has declined (Francom, 2020).

Consequently, not all teachers will have had the opportunity to learn to use the available edtech, or to teach with it in the most effective manner for their context. We note, however, that Australian teachers are less likely to report a high need for training in digital technology (11%) than their OECD counterparts (18%; OECD, 2020). This may reflect either greater digital skills, greater confidence in their abilities, or a combination of these factors.

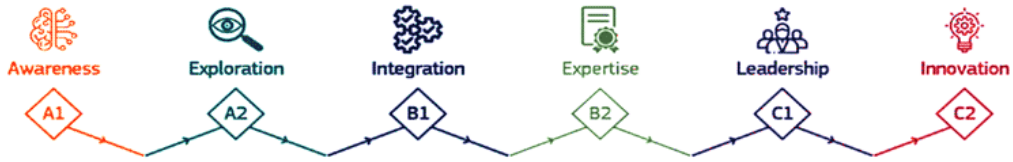
Digital competency of teachers

The digital competency of teachers impacts student learning and development, including the student’s digital literacy (Timotheou et al., 2023). Similarly, the digital readiness and culture of a school can influence teachers’ use of edtech and their development in this area.

Digital Competency Frameworks

The European Commission (EC) has created digital competency frameworks and for educational organisations (DigiCompOrg) and educators (DigiCompEdu). Aligned to these are separate assessment tools for educational organisations and educators to assess their current readiness to integrate edtech within teaching and learning. The self-reflection tool for teachers enables them to assess their current skills, knowledge and use of edtech against 6 proficiency levels (Figure 10).

Figure 10. The 32 reflection items and the 6 stages of competency within the ‘Selfie for Teachers’ self-reflection tool. Adapted from Economou (2023).



Allied with this, the European Schoolsnet Academy previously ran numerous PL courses online, covering a variety of teaching related topics (see Figure 11 for examples). The course materials remain available for teachers to use independently; some of which could easily be adapted for PL networks, peer learning groups or sequential staff development sessions within a school to provide a more collaborative, iterative experience (see 'What promotes effective professional development?' below).

Figure 11. Selected examples of online courses previously offered by the European Schoolsnet Academy now available as free, self-led learning.

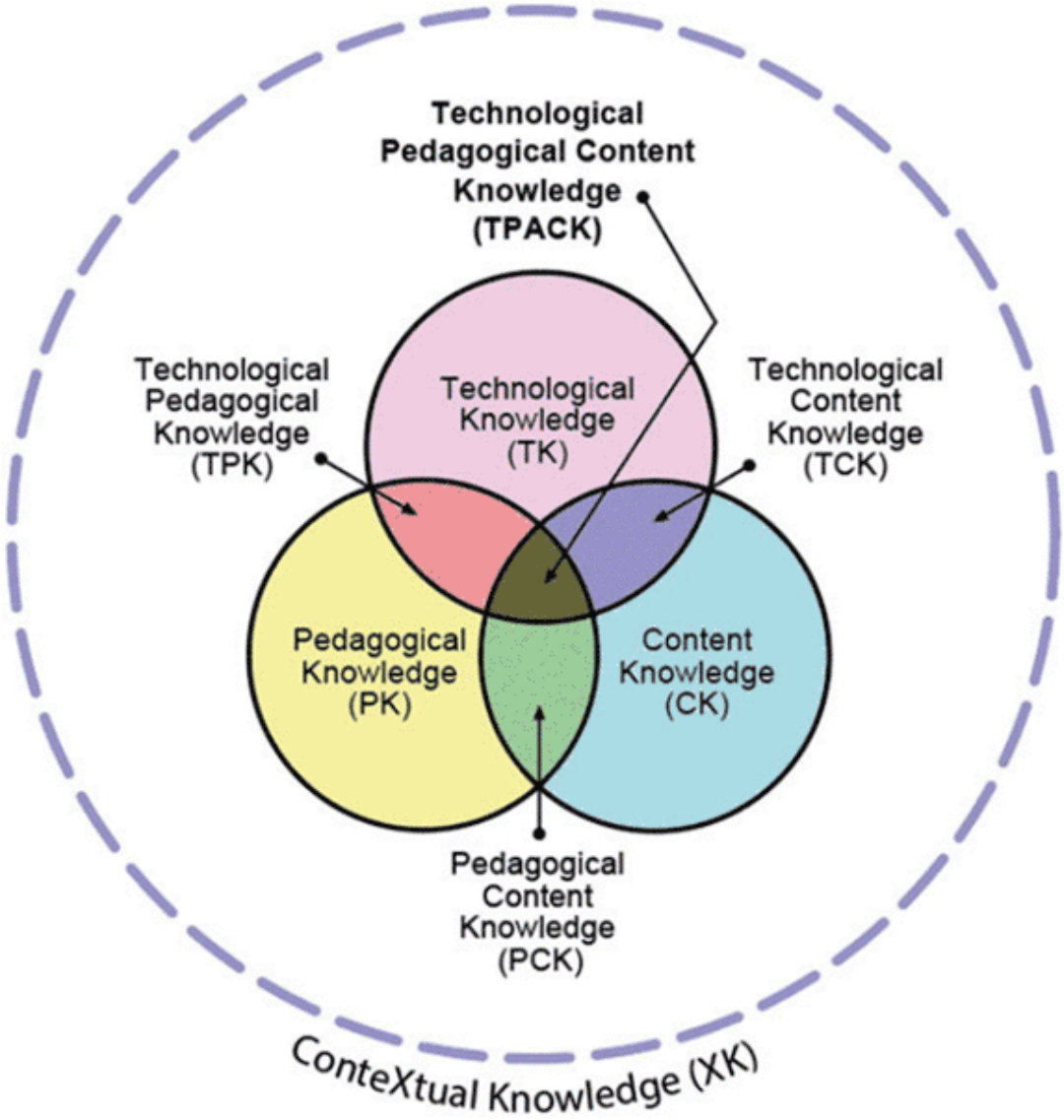
Numerous frameworks outlining the digital competencies required of educators have been developed, both within individual countries (examples include Norway, England, Wales, and Spain) and internationally (e.g., EC and UNESCO). Australia does not yet have a digital competency framework for teachers (Cosby et al., 2023) although a more generic version, based on the EC's DigiComp framework, has been developed for Australian workplaces (Department of Employment and Workplace Relations (DEWR), 2023). As such, the EC framework and self-reflection tool may provide a good starting point for teachers to identify any areas of digital literacy they wish to develop further. In addition, ACARA (2022) has developed a self-assessment matrix (available as a PDF document) to support teachers to assess their engagement with digital literacy as well as their engagement with, and understanding of, digital technologies.

What skills and knowledge do teachers need?

Many readers will be familiar with the Technological, Pedagogical and Content Knowledge framework (TPACK; Mishra & Koehler, 2006), shown in Figure 12. This states that, to achieve the best outcomes for students, teachers need a good knowledge and understanding of:

- the available edtech and the specific affordances of each tool (Technological Knowledge)
- their subject(s) (Content Knowledge)
- how to teach effectively (Pedagogical Knowledge)
- plus, interactions between these areas including the most effective pedagogies for that edtech, for their subject area (Technological, Pedagogical and Content Knowledge), and finally
- how to adapt this knowledge for a given context (ConteXtual Knowledge; Mishra, 2019).

Figure 12. The TPACK-XK model as presented in Mishra (2019).



The updated TPACK-XK framework (Figure 12; Mishra, 2019) highlights the inter-relatedness of different types of knowledge; thus, in relation to effective teaching with edtech, simply possessing a good knowledge of the edtech itself isn't sufficient. As such, effective PL also needs to focus on more than the technological skills and knowledge needed to use a specific type of edtech. Pegrum et al. (2013) specifically notes the need for pedagogical aspects to be emphasised over technology within teacher PL.

> *"Rather than narrowly focusing on the tools, training on ICT skills for teaching should reflect how technology can amplify great teaching and empower teachers…"*
>
> –OECD (2019, P. 31)

There is a need for PL programs and interventions supporting the inclusion of edtech within teaching and learning to increase the ability and value beliefs [6] of teachers involved. Several authors have also called for PL to emphasise the value component, including why developing the digital literacy of students is essential for the students' future life opportunities (Bowman et al., 2022). Currently, most PL opportunities focus primarily on the applied skills required (e.g. how to download and use a specific app), with some also promoting teacher confidence and ability belief (Bowman et al., 2022).

Some authors recommend that PL programs aimed at increasing the digital proficiency of teachers should encompass what are referred to as 'integrated competencies' linked to the ethical, societal, environmental and safety issues associated with student use of technology (Falloon, 2020). Translating such competencies into practice could include:

- actively modelling good digital hygiene to teach students how remain safe online, or
- mitigating negative behaviours (such as screen addiction, cyberbullying or social isolation).

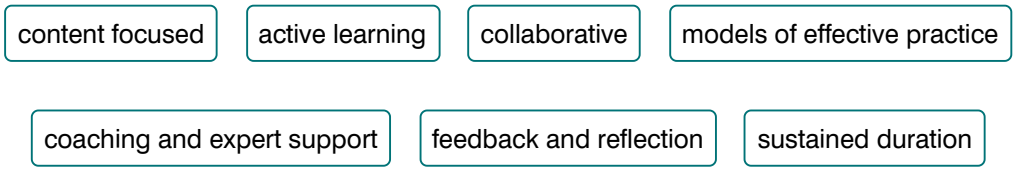
A critical thinking perspective should also be included within PL, to facilitate integration of edtech across all disciplines or, preferably, within inter-disciplinary teaching and learning.

What promotes effective professional development?

Hall and Trespalacios (2019) suggest there are five key components of effective PL that promote transference of learning about edtech into practice, namely:

- Active learning (teachers take responsibility for their own learning)
- Content focused (emphasises use with the relevant subjects or curriculum)
- Collaborative (builds professional networks and support, whilst maximising learning)
- Coherent with the teachers' learning goals and expectations (to maximise integration into practice) and
- Applied practice (allows multiple iterations and encourages reflection).

These are broadly consistent with the key components of effective PL more generally. For example, Darling-Hammond et al. (2017) state that effective PL for teachers typically address most of the following criteria:



Similarly, the Australian Charter for the Professional Learning of Teachers and School Leaders (AITSL, 2012) notes that *"Professional learning will be most effective when it is relevant, collaborative and future-focused, and when it supports teachers to reflect on, question and consciously improve their practice".* There is considerable overlap between effective PL and some pedagogies recommended for promoting 21st century learning in school students, particularly collaborative approaches and application to real-life issues.

Multiple opportunities to apply newly acquired digital skills and knowledge (e.g. to rehearse or practise their use) promotes transference of PL into classroom practice (Vongkulluksn et al., 2018), especially when followed by critical self-reflection. Consequently, formal training produces better results if it:

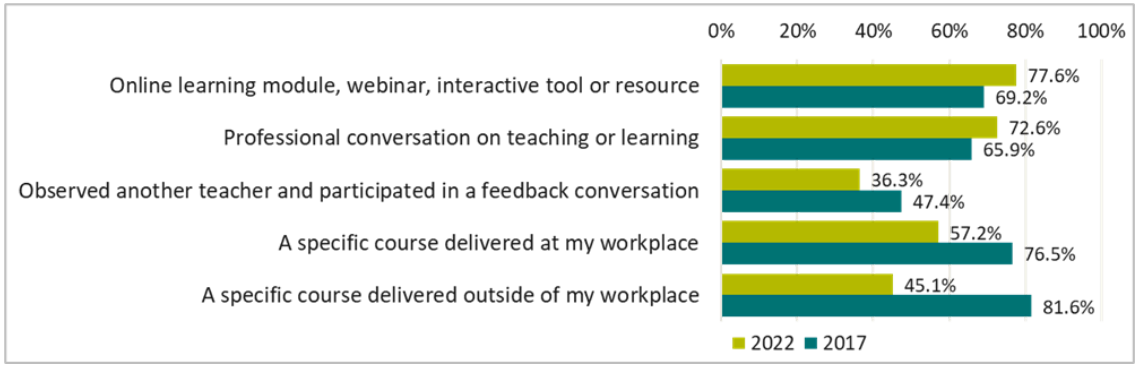
- contains multiple opportunities for teachers to practise implementation, reflect and then re-implement, and
- addresses the pedagogy and relevant curriculum, as well as the technology (Vongkulluksn et al., 2018).

Multiple reviews have found that extended PL opportunities, ideally school-based, are more effective at changing teacher practice than shorter or one-off events (Cordingley et al., 2015). Furthermore, PL that enables teachers to apply their new skills and knowledge to their teaching and then receive feedback can further stimulate teacher integration of edtech (Zhou et al., 2023). Long-term PL that incorporates self-reflection, critical analysis and thought-provoking discussion (e.g. mentoring or peer discussion) is more likely to promote transformation of teaching beliefs and practice in regards to edtech (Tondeur et al., 2017 and references therein). This is consistent with the idea of PL being a continuous and iterative process, "aimed at extending and updating the professional knowledge and beliefs of teachers in the context of their work" (Tondeur et al., 2017).

There have been numerous studies assessing the impact of various PL programs on teachers' integration of edtech into their teaching. However, despite its importance for the integration of edtech, relatively little research has been undertaken as to the effectiveness of PL in altering the value beliefs of teachers with regards to edtech (Bowman et al., 2022). Observing changes in student engagement and learning can promote shifts in teachers' beliefs and attitudes, particularly with regards to value beliefs and pedagogical preferences. Practical experience using edtech may support teachers to overcome anxiety or low self-efficacy in relation to teaching with edtech, especially when they see benefits for students (Chiu & Churchill, 2016). When teachers observed increased emotional and cognitive engagement in students, as a result of integrating edtech, they were more positive about developing, and participating in PL to foster, the skills and knowledge needed to successfully integrate edtech further into their teaching (Zhou et al., 2023). Furthermore, increased student engagement can increase the self-efficacy of teachers (Asare & Amo, 2023).

Research indicates that formal PL interventions are rarely implemented as intended but that implementation guidance is more closely followed when "interventions are aligned with schools' needs and existing practices, and when planned around the limited time available to teachers" (Sims et al., 2021). In this context, remote PL can be as effective as face-to-face options; the delivery mode is less influential than other aspects of PL, such as interactivity, reflection, and collaboration (Education Endowment Foundation (EEF), 2020). This is reassuring given the trend towards more digital PL for teachers recently seen within Australia (Figure 13; AITSL, 2023).

Figure 13. Changes in types of PL attended by teachers and educators (excluding middle leaders) between 2017 and 2022. Source: AITSL (2023).



Informal PL where teachers learnt through interactions with colleagues or students was more effective than formal PL courses at increasing the teachers' sense of self-efficacy and thus encouraging teachers to use edtech in the classroom (Vongkulluksn et al., 2018). Consequently, teachers wishing to improve edtech uptake within their school may be best placed modelling the desired behaviours within

their day-to-day work. Modelled examples demonstrating how to effectively integrate edtech and facilitate learning may better support teachers to adopt student-centric practices when using edtech (Palak & Walls, 2009).

Regardless of what learning opportunities teachers pursue, adequate support at a school and system level is required to ensure that teachers have the time to not only undertake related learning but to subsequently gain confidence using the selected edtech to achieve the desired outcomes (Joint Information Systems Committee (JISC), 2020). Key factors that influence a teacher's use of technology, and thus how edtech is integrated in schools, include:

- training and the support available (including both technical and administrative support)
- sufficient time to experiment and embed technology, and
- the existing culture and use of technology within their current workplace.

Time needed to become familiar with new forms of edtech was shown to consistently form a barrier to increasing edtech use in teaching and learning, as reported in two surveys of teachers from the United States (Francom, 2020).

> *Technology integration is unlikely to happen if a teacher does not have adequate time to test out a technology tool or resource, and plan for transformative ways that it can be used for teaching and learning.*
>
> –FRANCOM, 2020, P. 4

Conclusions

Edtech has expanded significantly during the last decade or so, including the variety and number of applications available as well as the number of users. Different types of edtech are variously intended to:

- support teachers (including reducing their workload)
- promote more effective school management
- foster student engagement and learning, in general, or
- provide greater affordances (and thus enhance learning) for students with additional needs.

Whilst these anticipated outcomes sound very positive, there are also several potential disadvantages of edtech, namely the negative effects of excess screen time on student learning and indirect effects (such as impacts on anxiety and social relationships). As such, any implementation of edtech should consider the individual student, the local context and learning environment as well as the intended outcomes.

Implemented well, edtech has the potential to benefit students, teachers and schools. However, edtech is not a magic wand and not all uses of edtech deliver the intended benefits. If the use of digital technologies alone increased student knowledge, the digital skills and literacy of Australian students would have increased concomitantly with increased uptake of these technologies. This has not been the case, with the digital literacy of Australian students either remaining relatively stable or decreasing (depending on the age of the students). As such, teachers have a crucial role to play in developing

students' knowledge and abilities. Furthermore, research clearly demonstrates that the quality of pedagogy underlying any use of edtech has a more significant impact on student outcomes than the use of edtech itself.

Edtech is typically most effective when teachers use learner-focused teaching strategies. Across multiple types of edtech, collaborative learning has shown the greatest potential for both student learning and motivation. Where edtech is simply used to transfer traditional teaching methods to an online environment, this will limit the potential benefits for most students. One exception to this is that several different types of edtech (such as interactive whiteboards or learning management systems) better enable multiple media formats which typically have a positive impact on student outcomes, especially for students from diverse backgrounds or with some disabilities. More generally, however, under-performing students and those from low socio-economic backgrounds are more likely to benefit from edtech than higher achievers or those from higher socio-economic backgrounds.

Edtech offers significant potential for supporting teachers with lesson planning, locating relevant learning materials and activities, and assessment options. However, the time "saved" by using edtech needs to more than offset the time spent learning how to use it effectively for this to result in a net decrease in a teacher's workload. Continuous PL, and support to undertake this, will likely be an ongoing requirement throughout a teacher's career so that they can develop their knowledge of, and ideally competence using, future innovations in edtech, thus maximising the benefits for themselves, their students and the education community.

Teachers' perspectives, including their sense of self-efficacy and the value they place on edtech as a tool for promoting student learning, influence its effective use within the classroom. Some knowledge and ability to use edtech is also required, although teachers do not need to be experts prior to using edtech with students. PL that is collaborative, applied and emphasises the positive benefits for both teachers and students is particularly effective for improving knowledge of, and attitudes towards, edtech and the digital literacy of students. Informal, school-based PL is more likely to promote a teacher's sense of self-efficacy than formal or off-site training. Increased support for teachers to undertake such PL, potentially even including short-term reductions in an individual's workload or relief from teaching, is likely to enable more impactful integration of edtech in teaching and learning, thus allowing the potential benefits to be realised.

Footnotes

1. Attributes that create the potential for learning; whether they be attributes of edtech, the user or result from interactions between these. Affordances can also include attributes that remove barriers to learning. Affordances for learning are typically pedagogical rather than technical per se (Badia et al., 2011)
2. Assistive technologies (AT) are specialised products designed to enable the user to undertake or perform an action that their disability would otherwise preclude or hamper. "The right AT for an individual augments, bypasses, or compensates for a disability" (Edyburn, 2020).
3. Augmentative and alternative communication refers to communicating by any means other than speech. This includes both "low tech" communication methods (e.g. facial expressions, gestures and hand-written notes) as well as "high tech" methods (such as text-to-speech generators).
4. An umbrella review synthesises information from published meta-analyses, each of which evaluates the effects of multiple studies. This approach captures a wide range of research in a time-efficient manner.
5. The number of hours a day that an individual spends looking at computers, smart phones, tablets and similar devices with screens.

6. In relation to edtech, value beliefs indicate how valuable teachers perceive edtech as being for their teaching practice and student learning. (Vongkulluksn et al., 2018).

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