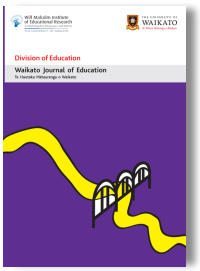

Waikato Journal of Education

Journal website: http://wje.org.nz

ISSN 2382-0373

Published by the Wilf Malcolm Institute of Educational Research

Wilf Malcolm Institute of Educational Research
Te Pūtahi Rangahau Mātauranga o Wilf Malcolm
THE UNIVERSITY OF WAIKATO

Vol 29, Issue 1, 2025

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Cite this article: Cullen, J.; Marsh, S.; Simmonds, L.; & Duncan, S. (2024). The impact of digital technologies on children and adolescents in Aotearoa New Zealand: A case for the development of best-practice recommendations for schools. *Waikato Journal of Education, 29*(1), 75-92. https://doi.org/10.15663/wje.a1095

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The impact of digital technologies on children and adolescents in Aotearoa New Zealand: A case for the development of best-practice recommendations for schools

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Abstract

The use of digital technologies is increasing in Aotearoa New Zealand (NZ) schools to support future-focused learning and allow students to gain 21st century skills that can enable them to participate and thrive in a digital future. NZ students have among the highest use of digital technologies in the world, and digital devices present both opportunities and risks to educational outcomes and health/well-being. Pragmatic guidelines have been developed internationally to support the safer use of digital technologies in education settings, and a review was carried out to examine the need for such guidance in a NZ context. While studies present mixed results, emerging evidence from analysis of international and national standardised assessments indicates that the impact of digital technologies on learning outcomes is not neutral, and while some use can benefit learning, frequent use has been associated with reduced learning outcomes. Conditions and context of use seem important, including factors such as task selection, length of use, and whether device use is teacher-led or independent. Further research is needed to better understand the most effective ways to use digital technologies for learning. Additionally, emerging evidence highlights numerous negative health impacts that are associated with frequent and extended use of digital devices. Informed recommendations for the use of digital technologies in NZ schools may allow students to get the best that digital technologies can offer to learning, with lower risk.

Keywords

Digital technology, devices, education, educational outcomes, health

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Introduction

There has been increasing interest in the use of digital technologies (screen-based digital tools such as computers and devices) in education, where digital devices are promoted as having the potential to support future focused learning, provide out-of-school learning opportunities, and to facilitate contextually relevant learning opportunities (Darragh & Franke, 2023; Fletcher, 2020). Aotearoa New Zealand (NZ) has been an early and enthusiastic adopter of these tools in education, with a marked increase over time in both school and recreational use of digital devices for children and adolescents (International Association for the Evaluation of Educational Achievement [IEA], 2016; Lee et al., 2023; Organization for Economic Cooperation and Development [OECD], 2015, 2021a; Sutcliffe & Webber, 2021). Rates of adolescent screen use in NZ are among the highest in the world, having increased from an average of 22 to 42 hours per week from 2012 to 2018, including both home and school use (OECD, 2021a). In NZ classrooms, students have among the highest use of digital devices, and the highest use of internet in class in the world (Bolstad, 2017; Medina & McGregor, 2019; OECD, 2015, 2021a; Wylie & MacDonald, 2019). Daily screen use further increased during the Covid-19 pandemic (Meissel & Bergquist, 2021), with studies suggesting current rates of screen use remain elevated above pre-pandemic levels (Hedderson et al., 2023).

Advancement in digital technologies have progressed more quickly than any innovations throughout history (United Nations, 2022). The inclusion of digital technologies in education comes as a necessary response to a changing world. Digital fluency has now been recognised as an essential skill to achieve future prosperity. In NZ, the Ministry of Education has defined digital fluency as the competent and effective use of digital technologies to enhance learning outcomes, being an "adept producer of digital content", and understanding the social costs and benefits that are associated with use (Ministry of Education, 2022b, p.1). While digital learning opportunities have been described as a "game-changer" for lifting achievement (Harju et al., 2019; Harris et al., 2020), the use of digital technologies for learning differs widely across NZ schools, with time spent using devices in class varying from school to school and also from classroom to classroom (Lips et al., 2017). Frequency can range from delayed to near-ubiquitous use of devices, including schools with digital immersion models at primary level and schools with delayed use of digital platforms until Year 9 (Federation of Rudolf Steiner NZ, 2015; Taitokerau Education Trust, 2023).

NZ's early uptake and high rates of use relative to global norms may in part reflect historical attitudes and identity as a country of innovators (Lee et al., 2023). Further, equity and the digital divide have been at the forefront of decision-making in NZ for both government and private organisations. Digital technologies within NZ are seen as a pathway to reduce socioeconomic and cultural barriers by providing equality of educational opportunity (Newton, 2019) and a priority to raise achievement (Lee et al., 2023). Various initiatives have aimed to improve access to devices for prioritised students and schools, with the government focusing on high school students and private organisations targeting primary school students from low socioeconomic communities (Hipkins, 2020; Manaiakalani, 2007).

Despite complexities, there is no question that digital technologies have the potential to support learning (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2023), including within specific NZ contexts (Ka'ai, 2017). Yet assumptions that digital technologies can solve major challenges in education and will be transformational to learning have been questioned (Reich, 2021; Sutcliffe & Webber, 2021; UNESCO, 2023). Digital technologies present both opportunities and risks to young people, in home and school settings. Advantages include increased opportunity for social connection and exposure to support networks, access to online resources that can support physical and mental health, and potential for educational gain (Chassiakos et al., 2016; Hill et al., 2016). In the classroom, devices can be used in many ways and for different tasks, so the context of use is important when considering their impact on learning (Bouygues, 2019). However, results of research exploring the impacts of device use on educational outcomes is at best, mixed (Hattie & Hamilton, 2021). While some use of educational technology can support learning, robust evidence for its effectiveness remains limited, and analysis of data from international surveys and standardised assessments has found that frequent use of digital devices is associated with reduced learning outcomes (Bouygues, 2019; Gubbels

et al., 2020; Hattie & Hamilton, 2021; OECD, 2015; Sutcliffe & Webber, 2021; UNESCO, 2023; Zhu & Li, 2022).

Recently, an increasing body of evidence also highlights potential risks to children and youth associated with screen use. This includes exposure to inaccurate and harmful content, cyberbullying, and compromised privacy and confidentiality (Chassiakos et al., 2016; Hill et al., 2016). In addition to its impacts on learning, frequent and extended screen use is associated with risks to child and adolescent health and well-being (Chassiakos et al., 2016; Cullen et al., 2024; Hill et al., 2016; UNESCO, 2023). These risks are of concern to educators, caregivers, and young people alike (Sahlburg & Graham, 2020) leading to calls for public intervention (UNESCO, 2023).

Strategies and services have been developed in NZ to address some of these challenges within the education sector, largely focusing on cybersecurity, cyberbullying, and reducing exposure to harmful online content (Lee et al., 2023; Ministry of Education, 2022a). However, there has been very little consideration of how educational screen use might impact on child and adolescent health/well-being (Merga & Williams, 2016). This disconnect has recently been noted, and the United Nations Special Rapporteur has called for a full discussion on the age-appropriateness for introducing digital technologies into schools, along with impacts on health and development (United Nations General Assembly, 2022). In a NZ context, educational technology tends to be viewed through a lens of opportunity and engagement (Newton, 2019). Despite seeming assumptions that educational technology per se is inherently beneficial (Darragh & Franke, 2023), international research has found there is also limited consideration given to the level of evidence for technology products prior to adoption in the classroom by teachers and administrators (UNESCO, 2023).

This narrative review sets out to examine the need to support NZ schools and kura with best-practice recommendations for the safer use of digital technologies. At the time of this manuscript submission, NZ guidelines to promote safer use of screens for young people had been developed, but these refer only to recreational use (Ministry of Health, 2017a, 2017b). Legislation and guidelines have been adopted internationally for the safer use of digital technologies in schools, but despite the comparatively high use of screens in NZ schools, only digital citizenship is comprehensively addressed (Ministry of Education, 2021a). There is an opportunity in NZ to support the health and well-being of students when using digital technologies to learn. Along with reducing inequitable health outcomes, this initiative could promote equitable opportunities for learning, which may positively impact population health (Hahn & Truman, 2015).

The following questions are addressed: 1) What is the impact of using digital technologies for school work on learning outcomes? 2) What is the impact of high screen use on the health and well-being of children and adolescents, and how does this relate to education? 3) What current guidelines exist to support child and adolescent health and well-being when using digital technologies?

What is the impact of using digital technologies for school work on learning outcomes?

With the relatively early and fast adoption of digital technologies for school work, and variation between NZ schools and classrooms in implementation, it is increasingly important to understand both the opportunities and impacts of digital technology on learning (Lips et al., 2017). As well-being should be at the centre of education, consideration must be given to both the potential educational benefits and the risks associated with the use of digital technologies (Merga & Williams, 2016).

Digital technologies certainly enable some learning opportunities above and beyond what can be achieved with more traditional methods, and positive effects can be found on academic outcomes. Digital devices have potential to allow students access to resources and information online to support learning and to collaborate beyond the school campus (Chen et al., 2018). Additional factors such as digital fluency, engagement, and how prepared schools are to integrate digital technologies are important considerations. Teachers' learning, access to resources, and connections can be supported by digital technologies (Haleem et al., 2022). Teaching pedagogy (design and practice) also influences the effectiveness of digital technologies for student learning (Timotheou et al., 2023). Future technologies and innovations may offer a new range of opportunity and advantage to students. Overall, however,

evidence to date for the impact of digital technologies on learning outcomes is mixed, with broad pre-Covid impacts described as "at best average, more likely well below" (Hattie & Hamilton, 2021, p.1), and the quality and independence of research has been found lacking (Hattie & Hamilton, 2021; Hood, 2019; UNESCO, 2023). However, digital technologies have been found to have above average impacts for students with special learning needs (Hattie & Hamilton, 2021; Nicolai et al., 2023).

This section considers the impact of digital technologies on educational outcomes using studies and reports comparing national and international standardised assessments including: 1) Progress in International Reading Literacy Study (PIRLS) (Forkert & Chamberlain, 2020; IEA, 2016), 2) National Assessment of Educational Progress (NAEP) (Bouygues, 2019), and 3) Program for International Student Assessment (PISA) (Bouygues, 2019; Gorjón & Osés, 2023; Gubbels et al., 2020; OECD, 2015, 2021a; Sutcliffe & Webber, 2021). Additional studies were incorporated to review the impacts of digital technologies on student engagement and to facilitate discussion. Time spent using digital technologies is a significant focus of these reports and studies, which is highly relevant not only in relation to student health/well-being, but as duration of educational technology interventions has been found to impact the size of effects (UNESCO, 2023). The Australian National Assessment Program – Information and Communication Literacy (NAP-ICTL) and NZ National Monitoring of Student Achievement study (NMSSA), both national large-scale assessments of student outcomes including student achievement in the learning area of technology, were further included to discuss digital fluency (Australian Curriculum Assessment and Reporting Authority, 2015, 2023; Educational Assessment Research Unit & New Zealand Council for Educational Research, 2022).

The impact of digital technologies on learning

Several large-scale international and NZ studies and reports have compared academic results with time spent using digital technologies at school (Bouygues, 2019; Gorjón & Osés, 2023; IEA, 2016; OECD, 2015; Sutcliffe & Webber, 2021; Zhu & Li, 2022). After accounting for demographics and teacher experience, these studies found a "ceiling effect" with improvements in some areas of learning with moderate computer or device use; but with higher use, students had significantly lower educational outcomes. Specific to primary-aged students, more frequent device use had a clear negative relationship with testing outcomes (Bouygues, 2019; IEA, 2016).

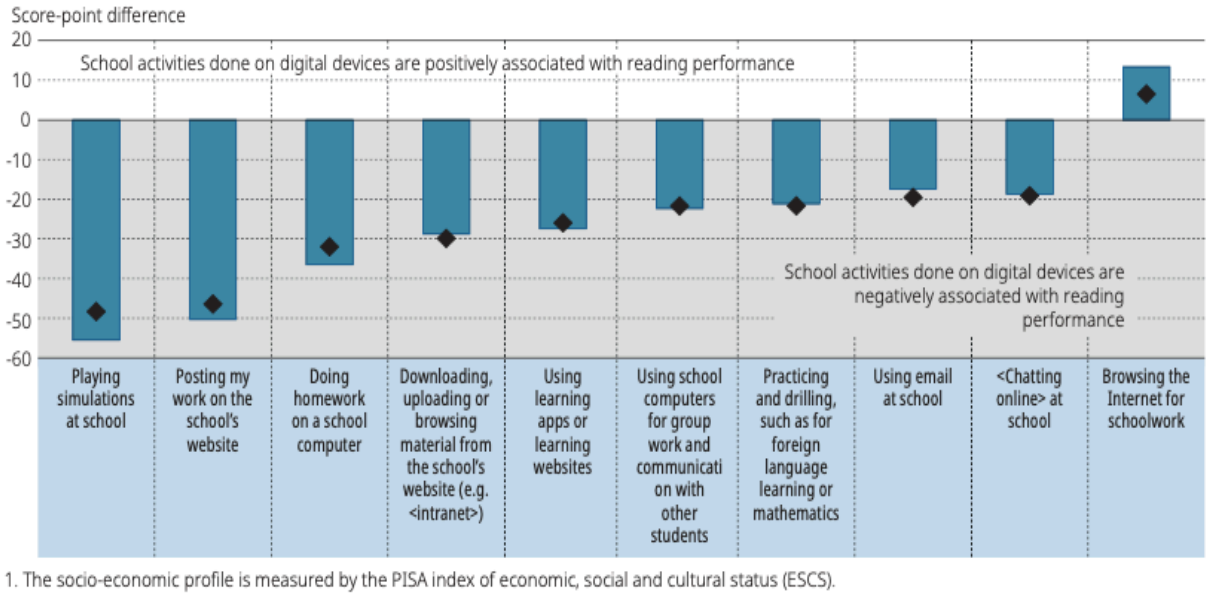
Complicating the comparability of these results, definitions used for moderate computer or device use compared to frequent or high use varied between studies. Moderate use was defined as: 1) once a week or less, 2) from several minutes up to half an hour per day, 3) less than 60 minutes per week, and 4) "in some classes". Frequent, lengthier, or high use was described as: 1) more than once a week, 2) more than 30 minutes a day, 3) more than 60 minutes per week, and 4) ranging from "in half of classes" to "in all or almost all classes". While this limitation (lack of consistency of definitions) must be acknowledged, the term "moderate" broadly measures the limited use of digital technologies alongside other learning modalities and still gives valuable information. These terms are important to note, as levels defined as moderate may seem lower than expected in countries or schools where devices can be used as the primary platform for learning. Internationally, the prevalence of digital device use in class is not frequent, including in the world's richest countries (UNESCO, 2023).

Digital technologies can be used both effectively or ineffectively, and the context of use is an important factor when considering the impact on learning outcomes. An analysis of NZ PIRLS data found that Year 5 students who engage in digital activities weekly or more have reduced enjoyment of reading (Forkert & Chamberlain, 2020). While 93% of Year 5 students use digital devices/computers when learning to read in NZ, compared to an international average of 44%, this year group ranked last for reading performance across English-speaking countries who took part in the PIRLS assessment (IEA, 2016). Bouygues (2019), based on data from NAEP, noted that technology appeared least helpful for children learning to read. In this context, non-digital tools seem better for learning about language, following a trend seen both internationally and in NZ (Delgado et al., 2018; Furenes et al., 2021; Harju et al., 2019; IEA, 2016).

Conversely, analysis of PISA 2018 data found that NZ 15-year-old students, along with Australia and three other countries, "bucked the trend" of a negative association between time spent using digital devices and "21st century reading performance" (OECD, 2021a). This is positive; however, it is worth noting that the measure of reading performance had changed to reflect the information-processing strategies involved in digital reading (digital skills required for reading online). Assessments need to shift to reflect a changing society, and examples of differences in the assessment focus include whether students could distinguish fact from fiction and online navigational skills. Australian students also had a positive association between time spent using devices and digital reading performance, after accounting for school and student socioeconomic status, however, Merga and Williams (2016) noted that Australian students already had comparatively high digital skills from 2012 data (Merga & Williams, 2016; OECD, 2015). While NZ data is similar to that of Australia, the comparison in digital skills from 2012 to 2018 is not available. The 21st Century Reading report was supported by Vodafone (a telecommunications company), raising the possibility of funding bias. In contrast to 21st century reading skills, reading literacy measured from 2018 PISA data showed a slight decline in NZ 15-year-olds' performance (Medina & McGregor, 2019; OECD, 2021a).

Along with frequency of device use, specific online learning activities were analysed to better understand whether they were linked to improved or reduced academic outcomes. The only digital activity positively associated with reading performance included browsing the internet for school work (OECD, 2021a). All other measured digital activities had a negative association with reading performance, including using learning apps and websites, doing homework on computers, and posting on school websites (see Figure 1) (Gorjón & Osés, 2023; Gubbels et al., 2020; OECD, 2021a; Sutcliffe & Webber, 2021; Zhu & Li, 2022). This aligns with a large-scale study by Bouygues (2019), which found that researching on the internet had positive associations with learning outcomes, while educational tablet-related activities like games, apps, and electronic textbooks were associated with poorer outcomes (Bouygues, 2019). For NZ and international students, this trend of reduced outcomes with most digital learning activities held across all subjects measured (English, mathematics, science), excluding checking email which had a neutral effect (Gorjón & Osés, 2023; OECD, 2021a; Sutcliffe & Webber, 2021). While most reports and studies only show correlation, the negative impact of "very intensive" use of digital devices at school (defined as students using digital devices on average between 1–2 times per week to almost every day) was found to be causal using PISA data from 15-year-olds in three countries (Gorjón & Osés, 2023). This relationship was found using inverse probability weighting analysis and included countries with advanced policies on integration of digital technologies for educational purposes, such as Finland and Estonia.

Figure 1. Score-point Difference in Reading Between Students Who Reported Using Digital Devices for the Following Activities at School Compared to Those Who Reported They Never Did, OECD average



Note. All score-point differences are statistically significant. Items are ranked in order of the score-point differences in reading for students' and schools' socioeconomic profile. From *21st Century Readers: Developing Literacy Skills in a Digital World*, PISA, 2021, OECD publishing, https://doi.org/10.1787/a83d84cb-en. Copyright 2021 by OECD.

Along with task selection, when it comes to learning it is important to consider who is using the device. PISA data from NZ students in 2018 indicated that for English and science classes, when teachers used devices to teach, or when students used devices with their teachers, test performance generally improved. When students used devices independently to learn, test performance declined. In mathematics, test performance only improved when teachers alone used devices (Sutcliffe & Webber, 2021).

The impact of digital technologies on digital fluency

Educational outcomes are not the only measure of impact, and achieving digital fluency is an important aim of the 2020 digital curriculum (Ministry of Education, 2021c). How best to achieve fluency has been questioned, and NZ Ministry of Education publications note that the inclusion of digital technologies in the curriculum does not always require a device (Ministry of Education, 2021b). Digital skills required for reading and mathematics were evaluated in 15-year-olds from 2012 PISA data, finding that while moderate use of computers and devices was associated with improvements, more frequent use was associated with significant declines in performance (Bouygues, 2019; OECD, 2015). Some examples of these skills included knowledge of navigation techniques and tools, critical evaluation of information and assessment of credibility, and ability to solve problems online and use digital technologies as a mathematical tool. Possible explanations for these results considered that students reporting more frequent use of digital technologies to learn could potentially only have been using these tools for a short time (leading to unfamiliarity), or they could have contributed to non-productive class time. Authors noted that context and variation of use may further influence outcomes (OECD, 2015).

More recently, Australian research found that Year 6 and Year 10 students' digital literacy has declined despite increased and extensive use of devices in primary school (Australian Curriculum Assessment and Reporting Authority, 2015, 2023). A potential reason suggested for this reduced performance included an assumption that students would gain necessary skills simply by using digital devices, compared to previous attendance of computer labs where digital skills were specifically taught.

Achievement in technology declined in NZ Year 4 and Year 8 students between 2016 and 2021, despite extensive changes to the technology learning area of the New Zealand Curriculum and increased use of devices to learn (Educational Assessment Research Unit & New Zealand Council for Educational Research, 2022). However, authors noted that interruptions to their assessment programme due to Covid-19 meant that care should be taken when interpreting results, particularly for smaller groups in the sample, such as Pasifika students.

The impact of digital technologies on student engagement

Student engagement is an important rationale for learning with digital platforms. However, research shows mixed results regarding the impact of digital devices on student engagement with learning (Heflin et al., 2017; Nkomo et al., 2021; Schindler et al., 2017; Sean & Maakrun, 2020). Further, engagement does not necessarily lead to improved educational outcomes and is only an advantage if the activity is aligned with effective device use and pedagogy (Higgins et al., 2012; Hood, 2019). When aligned, some studies note enhanced student interaction and engagement through use of digital tools, such as interactive whiteboards (Mun & Abdullah, 2016), through collaborative forums, such as online discussion platforms (Kilinc & Hakan, 2021), by prompting parents to engage with their child's learning in some contexts (Nicolai et al., 2023), and while less effective than real-life training, using training simulations for high school students can be more effective than watching video demonstrations (UNESCO, 2023). Risks digital technologies present to distraction in the classroom, however, are frequently ignored by research and evaluation (UNESCO, 2023). This is of concern, given Growing Up Digital Australia commentary describes potential for a new digital divide, where lower achieving students, in particular, are most at risk of distraction from interactive media use (Sahlburg & Graham, 2021).

The impact of school capacity to integrate digital devices for learning

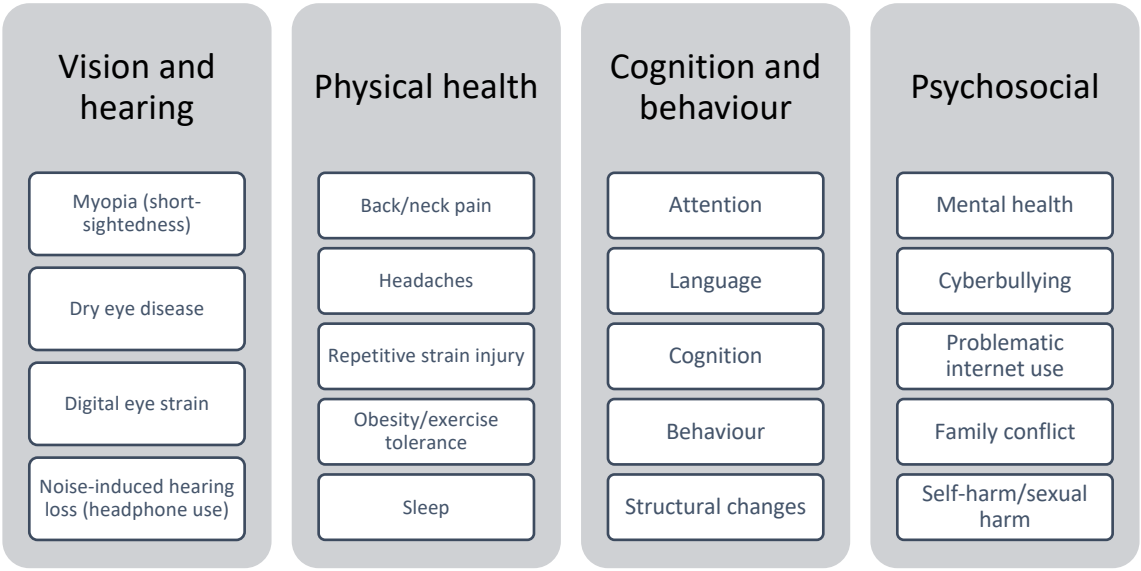
The impact of school preparedness to use devices for learning was recently analysed using NZ 2018 PISA data, investigating whether programmes and policies to support the integration of devices lead to improved outcomes. Results suggested that in schools with sufficient internet access, where teachers have access to resources on how to use devices, and where teachers are considered to have the skills to integrate devices in instruction, academic results were *lower* compared with schools without those capacities (Sutcliffe & Webber, 2021). In short, authors noted that programmes and policies to support integration of devices may result in poorer outcomes. While considering that there was a possibility this result could reflect an overconfidence in perceptions of teachers' digital literacy and lesson preparation time, if taken as accurate, they described concern with these findings in the context of widespread digital device use in NZ schools. Whether this reflects a lower frequency of device use by students to learn in schools who report being less resourced, it highlights both the importance of understanding how devices are being used and suggests that the capacity to use devices for learning is only helpful when of high value (Sutcliffe & Webber, 2021).

Overall, it appears that digital technologies have the potential to support learning, but results to date have been underwhelming. The conditions of use are important; task selection, context of use, and moderation of time spent using devices to learn seem key, including for gaining digital skills (Bryant et al., 2020; Hattie & Hamilton, 2021; OECD, 2015; Sutcliffe & Webber, 2021). Limitations exist in available studies, such as survey questions that lack specificity, meaning the development of measures that better capture relevant information is needed (Sutcliffe & Webber, 2021). The impacts of digital distraction present a risk to academic achievement and require ongoing evaluation and consideration. Further research is needed to clarify the best uses of digital technology to make a positive impact, including its use within a NZ context.

What is the impact of high screen use on the health and well-being of children and adolescents and how does this relate specifically to education?

Screen media content and context of use are highly relevant to health/well-being outcomes. Some uses of digital technologies, such as well-designed apps to increase physical activity, screen use supporting social connection, or accessing health support, can show benefits to health and development in young people (particularly to adolescents) (Hill et al., 2016). However, emerging evidence suggests that frequent and extended screen use by children and adolescents is associated with numerous risks to health and well-being (Joshi & Hinkley, 2021; Ponti, 2023; UNESCO, 2023). These impacts fall broadly into four categories (see Figure 2): vision and hearing, physical health, cognition and behaviour, and psychosocial.

Figure 2. Categories: Impact of Digital Technologies on Children/Adolescent Health and Well-being



Note: Adapted from *Impact of digital screen use on health and wellbeing of children and adolescents: A narrative review.* By J. Cullen et al, 2024. New Zealand Journal of Physiotherapy, 52(1), pp 62–77. https://nzjp.otago.ac.nz/nzjp/article/view/364

Conditions relating to total time spent using screens have direct relevance to screen use occurring in the classroom as well as at home. Significant emerging health issues include dry eye disease, digital eye strain, and myopia in children and adolescents, which have been associated with lifestyle factors including time spent using screens, unrelated to screen media content (Foreman et al., 2021; Stapleton et al., 2017; Wolffsohn et al., 2023). Safe practice in using headphones with digital devices in class and home settings could reduce harms, as current evidence suggests young people are at risk of hearing loss due to the use of headphones/earbuds (World Health Organization, 2015, 2017, 2021). Physical complaints have been described in association with high screen use in young people, with posture thought to play an etiological role. Such complaints include back and neck pain, repetitive strain injury (RSI) of the upper limb and recurrent headaches (Joergensen et al., 2021; Öğrenci et al., 2018; Straker et al., 2007; Young et al., 2012). Screen time is thought to be linked to obesity in children and adolescents, while excessive screen use and bedtime screen use are linked to sleep disturbance in the majority of studies investigating the topic (Cullen et al., 2024).

Impacts of screen use on mental health and cognition are emerging areas of research, where both benefits and risks to child and adolescent health and development can been seen (Campbell & Twenge, 2018; Wilkinson et al., 2021; Yang et al., 2013; Zhang et al., 2020). While excessive screen use is linked to poorer outcomes in both mental health and cognition, a number of studies have found a dose-

dependent relationship, and inverse U-shaped correlations where some internet use is better than none for adolescent well-being, but multiple hours have a detrimental effect (Campbell & Twenge, 2018; OECD, 2015; Yang et al., 2013; Zhang et al., 2020). Several studies found that pre-existing mental health, online content, and gender impacted results, in addition to time spent on screens (Tang et al., 2021; Twenge & Farley, 2021). The impacts of digital technologies on cognition are not well understood and appear to have particular relevance to the developmental stage of the child/youth as well as the type of device and content of screen media activity (Gottschalk, 2019; Kirlic et al., 2018; Stewart et al., 2019). While intentional learning tasks (such as researching on the internet for school work) are linked to educational gains, even educational content for young children is recommended to be used in moderation, as time spent using screens may displace other tasks that would be more beneficial to learning and development (Cullen et al., 2024). The relationship between different forms of screen media on cognition and well-being may be of particular interest to educators due to the intrinsic connection between cognition and learning, and further studies are needed in this complex area (Wilkinson et al., 2021).

A definition of what constitutes excessive screen use is difficult to clarify (McNaughton, 2021). Frequency of screen use associated with harmful impacts in children over five years old are reported between studies to range from between two and six hours per day (Cullen et al., 2024). While these figures have considerable variation, they nonetheless highlight the significance that school screen use can contribute to total daily use. Some children in NZ can exceed these hours of screen use daily using digital devices in school hours and for homework, before factoring in additional hours of recreational screen use. Therefore, health impacts associated with high screen use are relevant both to schools and caregivers, and the use of digital devices for school activities need to be considered within the context of a child's entire day and overall screen exposure (Wilkinson et al., 2021).

Equity, as noted previously, is also pertinent when considering the impacts of digital technology for young people. Issues of equity and access to digital technologies are complex. While technology offers benefits to prioritised students and indigenous peoples (Li et al., 2021; Sianturi et al., 2023), international research shows that digital platforms alone have done little to lower the educational gap for prioritised communities (OECD, 2015; Yanguas, 2020). Previous research identified that the digital divide specifically related to access is shrinking for Māori, the indigenous people of NZ (OECD, 2021b); however, it is noted that this does not necessarily mean the digital divide has improved for rural Māori (Pacheco & Melhuish, 2019; Taiuru, 2020). Children from Māori and low socioeconomic communities have significantly higher screen and internet use than their more affluent peers, potentially increasing health risks associated with frequent and extended screen use (Pacheco & Melhuish, 2019; Stewart et al., 2019). Internet use of more than six hours on weekdays and weekends is most predominant in Māori adolescents (Digital Government, 2019).

In summary, while some screen-based activities can offer advantages to health and well-being, excessive screen use (including mechanisms of use and/or activities displaced by screen use) has been linked to adverse outcomes. As screen use can occur frequently throughout the school day in NZ, it is important for educators to be aware of these impacts. Risks to physical health and well-being relating to frequent and extended device use in the classroom apply beyond health and safety considerations; health, well-being, and learning are also interdependent constructs, with physical health in turn impacting children's cognitive development (Midford et al., 2020). This means health becomes an important consideration for educators. Due to the rapid pace of technological change, further research in a NZ context is needed; however, with a broad and growing body of evidence, guidance to encourage healthy engagement with screens and to reduce harms seems important.

What current guidelines exist to support child and adolescent health and well-being when using digital technologies?

Internationally, guidelines, legislation, and policy addressing the use of digital technologies in education have been put in place in a number of countries, with a range of recommendations and rationales. Recreational guidelines for screen use in NZ specifically focus on time limits. These guidelines recommend that daily screen time is discouraged for children under two years old, less than one hour for two to five-year-olds, and no more than two hours for five to 18-year-olds (Ministry of Health, 2017a, 2017b). The online organisation Netsafe, under an agreement with the Ministry of Education, provides information mostly relating to cyber-safety in schools (Netsafe, 2022).

Recently, UNESCO has issued an urgent call for regulation ensuring appropriate use of technology within education, with awareness by decision-makers of the profit-driven agenda of technology companies and lobbyists who are often advisers to the education sector (UNESCO, 2023). Discussions are strongly recommended, with focus on how best to balance both the rights of young people within education, including the need to "access, master and use" technologies as a tool, against risks of digitisation (United Nations General Assembly, 2022). Policies and supports are also being developed in NZ and abroad to harness the opportunities that artificial intelligence can bring to learning, evaluating and minimising risk to increase safe, fair, and effective use (Ministry of Education, 2023; U.S Department of Education, 2023).

Discussion

Research suggests that digital technologies can have positive impacts, they are not universally harmful, and will be an important part of the future for our young people. This paper has shown that more research to understand the impacts of these tools is warranted.

From here, digital recommendations which are contextualised for the education setting in NZ could enable students to gain the benefits that digital technologies can offer to learning with reduced risk of harms. Currently, schools lack support to consider the negative health risks of frequent and extended use of digital technologies (Merga & Williams, 2016). This is despite some children being at risk of excessive exposure to screens through educational use, exacerbating their overall risk to health (UNESCO, 2023).

All screen use is not equal, and this needs to be taken into account for future research to allow us to understand effects more clearly. However, the impact of educational technology on raising student achievement and providing learning opportunities has not been the panacea that was anticipated. In contrast, to benefit learning, emerging evidence suggests that time indications for moderate use may need to be recommended, particularly for primary school students. Due to their stage of development, these children may face greater risks in a number of areas when compared to older students yet appear to have less to gain in educational outcomes. Context and conditions of use are highly relevant, and additional factors, such as task selection, along with who is using the device (teacher, student or both), are important considerations. The Ministry of Education response to NZ PISA data highlighting these trends noted that while digital technologies have potential to enhance learning, currently there are only a few situations where this is occurring in NZ, alongside many situations where devices may be disadvantaging students (MacCallum & Brown, 2021).

To balance both the rights of young people to access digital technologies in education, to use technologies in ways that benefit learning, and to gain essential digital skills, recommendations for discussions that focus on safer, fairer, and effective uses of technology "where it is demonstrated that it brings a significant added value" have been made (United Nations General Assembly, 2022, p.1, para 4). Among other factors, this includes raising awareness for teachers and students of risks associated with frequent and extended screen use, alongside considering carefully whether digital devices clearly add benefit to teaching and learning, and supplement learning as opposed to replacing more traditional methods (Hood, 2019; MacCallum & Brown, 2021; UNESCO, 2023).

Our understanding of the relationship between high screen use and children's health is evolving, and the current strength of evidence varies in different health domains, from levels where harm is accepted by leading health organisations, to weak and emerging in others. Further, as handheld device use and increasing screen use are recent phenomena, more time is required for longitudinal studies. However, the current evidence for impacts that digital devices have on well-being and learning have led to recommendations for cautious, purposeful, and well-researched use in the classroom (Gorjón & Osés, 2023; Sutcliffe & Webber, 2021).

Screen media content and quality can impact health, well-being, and learning outcomes, and effects on cognition may be of particular interest within the education sector. Further research and analysis are required to explore this complex field, and, importantly, the teaching pedagogy and practices that effectively support children's learning and cognitive development. Emerging research is also showing differences in cognitive processes occurring when students learn to write and read using traditional methods compared to digital devices (Delgado et al., 2018; Hood, 2019; Ihara et al., 2021; Kiefer et al., 2015). Incorporating the strengths of both analogue and digital tools in the classroom, where age-appropriate, has potential to enhance learning and allow essential digital skill acquisition, while supporting balanced screen use during the school day and beyond.

Despite time limits for screen use in school being a component of a number of international guidelines, several reports suggest that current evidence is too weak to support guidelines for optimal screen time (Gottschalk, 2019; Wilkinson et al., 2021). The lack of data proving causation with which to inform evidence-based guidance is problematic; however, this stance may present a dilemma, particularly when considered alongside rates of screen use in NZ children/youth. Longitudinal studies are unlikely to yield conclusive results for a number of years if not decades, yet emerging evidence indicates that associations of harm from frequent and extended screen use exist. Dose-dependent relationships between time spent on screens and negative outcomes have been found in numerous areas of health. To reduce risk, giving information and guidance that supports our young people to engage positively with screens will be important (Sahlburg & Graham, 2021; Wilkinson et al., 2021). An active approach to educating students on healthy screen behaviours and continuing to educate students about digital citizenship and cyber security is therefore important to address this complex issue.

Additional limitations must be considered within this review. While analysis of data based on standardised assessment can provide a useful indication of impacts, context-specific information gained from smaller studies may be obscured and mechanisms of impact overlooked (Bouygues, 2019; Gubbels et al., 2020; Schleicher, 2019). While most studies focus on academic achievement, research suggests that additional aspects of learning, such as socio-emotional skills and collaboration, can also be positively or negatively impacted by teachers design and implementation of digital technologies in the classroom (Kärchner et al., 2022; McNaughton et al., 2018; Wilkinson et al., 2021). Without a full systematic methodology and formal analysis of quality of evidence of included reports and studies, risk of bias is introduced. While beyond the scope of this review, further pragmatic guidance for schools on appropriate and effective uses of digital devices in learning would be useful, including guidance around the use of devices to deepen learning and practices supporting these pedagogical approaches.

Conclusion

The challenge to ensure that digital technologies benefit children and adolescents, enhance equity, and do not cause harm will require integrated solutions for both caregivers and education providers. To maximise the benefits of digital devices while reducing risks, guidelines for digital technologies have been developed for recreational use, school cyber-safety, and the adult workplace; however, NZ is behind its international counterparts in setting comprehensive guidance for schools. Developing recommendations that encourage the safer use of digital technologies in schools and that reflect the principles of Te Tiriti o Waitangi could support our children and youth to build healthy habits. Encouraging consideration of evidence for the effectiveness of digital products, along with use to supplement but not replace traditional teaching methods, may further allow students to gain the best that digital technologies have to offer, with lower risk. As schools have a fundamental role in informing and

educating both students and caregivers on health issues, these actions would likely have a wider public health impact in supporting healthy child/youth screen use.

Acknowledgements

Acknowledgements to Dr Lisa Darragh for her feedback and comments on early drafts of the article, and to educator Max Bean for feedback on draft manuscripts.

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