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Computer education in Australian schools 2022

**Enabling the next
generation of IT
professionals**





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About the author

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Foreword

Australia has a problem. As in much of the world, the demand for technology talent significantly outstrips its supply. Every year for the next five years, Australia will need more than 50,000 new IT professionals to meet the needs of industry and government. In 2019, the most recent year for which we have numbers, there were slightly less than 7,000 domestic IT graduates nationally.

That is a huge gap to bridge, and it can't be done solely by importing people from overseas. **We need a better domestic pipeline.**

In 2014, the Australian Government introduced a key building block for that pipeline: the new Digital Technologies curriculum, designed to engage students from Foundation to Year 12. More than just 'how to use computers', it was about creative engagement with technology, the kind of engagement that enables life-long careers.

As might be expected, the implementation of the curriculum has been somewhat spotty. Although the Australian Curriculum, Assessment and Reporting Authority (ACARA) publishes a national curriculum, it is not mandated across all states, and many schools and teachers are struggling with the requirements of the curriculum. Teachers are being asked to teach skills that they themselves did not learn in school, and we have not done a great job as a nation of equipping teachers and schools for the realities of teaching the new technologies.

The Australian Computer Society (ACS) decided to examine the issues and pain points for educators when it came to digital technologies. In 2021, our ICT Educators Committee surveyed hundreds of schools across Australia to see how the Digital Technologies curriculum was being implemented, with a view to developing solutions that could improve the quality and the delivery of the curriculum.

From the results of that survey (which you can see in full in Appendix A), we have developed a set of recommendations and goals: for ourselves, for federal and state government, for educators and for educational bodies. You will find these through the report, and we intend to move on those and encourage others to do so.

It is not a simple task ahead. There is no single silver bullet that will turn Australia into a global leader in digital technologies education. But we believe that it's worth putting everything we can into it, and we hope others agree. At the end of the day, it's not really about the raw numbers, and it's not even really about ensuring we have enough workers to keep the wheels of industry turning; it's about making sure our children and the generations to come have a bright place in the world, and that they, and our nation, don't fall behind in a changing world.

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Introduction

In examining the current state of computer education in Australian schools, this report is informed primarily by the Australian Computer Society's survey response to the 2020/21 Australian Curriculum review (ACS, 2021), but it also includes a selection of recent research into the various aspects of computer education in Australia and internationally.

The report gives a background into how computer education has developed in Australia, the significant changes occurring due to the implementation of the Australian curriculum, and the development of Digital Technologies as a compulsory subject in all primary and lower secondary schools.

It explores the approaches schools are taking to implement the curriculum and the challenges they are facing in establishing an entirely new subject. Specific attention is given to areas of confusion such as the distinctly different but parallel Digital Literacy and Digital Technologies curricula, the lack of focus on coding, the potential for focusing on developing thinking skills, and the impact of the compulsory curriculum on senior secondary computing subjects and tertiary pathways.

The barriers to implementation are unpacked and support mechanisms detailed, with a focus on initial teacher education and ongoing professional learning. Overall, the report provides a snapshot of the state of Australian computer education in schools at the start of 2022, and presents a series of 55 recommendations to various organisations that can assist in advancing Digital Technologies education.

CRITICAL RECOMMENDATIONS

SUMMARY OF CRITICAL RECOMMENDATIONS

This report contains 55 recommendations in full; here are eight that we define as critical:

Recommendation 3: Schools and school systems should provide increased support for Digital Technologies teachers to obtain formal training and qualifications in Digital Technologies, with the aim of at least one teacher in every primary school having formal qualification in the teaching of Digital Technologies; all secondary computer education teachers having at least some formal training in a programming language; and all senior secondary computer education teachers having formal tertiary qualifications in a computing field.

Recommendation 4: States and territories should rigorously report to parents on student outcomes in the Digital Technologies subject, to provide a key initial indicator of their success in implementing the subject in their schools.

Recommendation 5: Government school systems and schools should use Digital Technologies initiatives and school achievement awards to signal to principals and teachers the importance of implementing Digital Technologies within their schools.

Recommendation 9: Schools and school systems should implement annual equipment, software and network audits in line with industry-wide norms, to ensure frontline teachers have the requisite resources to effectively teach computer education subjects and the Digital Literacy curriculum.

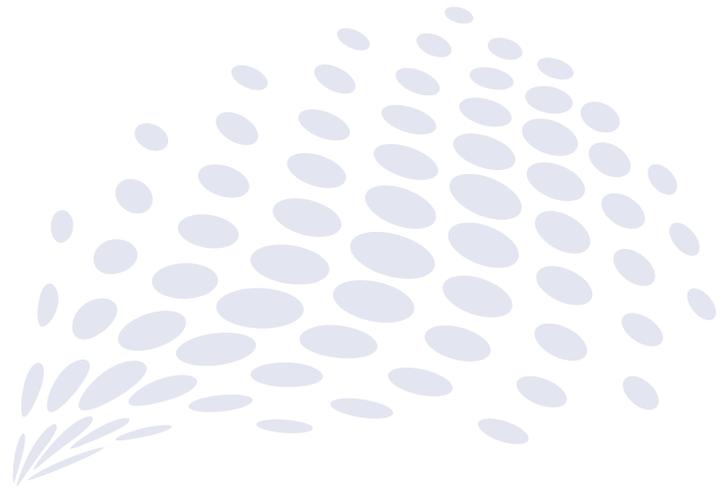
Recommendation 25: To guide state and territory curriculum development, ACARA should develop a national senior secondary computer education curriculum with the agreement of all states and territories, as has been achieved for English, Mathematics, Science, and Humanities and Social Sciences.

Recommendation 39: Schools and school systems should develop appropriate and systematic professional learning support programs to upskill all teachers in the Digital Literacy curriculum and all primary teachers and secondary teachers in the Digital Technologies curriculum.

Recommendation 41: State and federal education ministers should prioritise funding large systemic professional learning programs to support the teaching workforce to implement the Digital Literacy and Digital Technologies curricula.

Recommendation 55: Further investigation, supported by research, should be conducted into the implementation of senior secondary computing courses in each state and territory, and into the equitable access of Australian students to computer education, including issues of teacher training, schooling sector, regionality, gender, ethnicity and socioeconomic status.

01



Fifty years of Australian computer education

Computer education in Australian schools over the past 50 years has seen fundamental shifts from a computer science focus (programming and information systems) to the learning of applications (office applications and multimedia) and is currently shifting back towards a focus on computer science concepts. Likewise, there have been oscillations from where the predominant mode of teaching computing has been as a discrete subject to where it has been integrated within other subjects, and it is currently moving back to being taught separately.

1970

Computer education in schools began as a component of mathematics education, focusing on algorithm design and programming, and while few schools had their own computers, paper-based programming cards processed by university mainframes were used.

1980

As personal computers became available in schools, senior secondary computing subjects mirroring introductory (first-year) university subjects were introduced. However, these initiatives generally lacked support or were opposed by universities, which considered the subject of little serious academic worth and not an appropriate subject to study at a secondary school level. This attitude of preferring to have students with no knowledge of computing, to whom they could freshly introduce computing concepts, rather than ones 'who have learned bad programming', remains generally prevalent in academia.

The Commonwealth Schools Commission (1983) recognised a need to support schools and provided funding to establish State Computer Education Centres for teachers' professional development. Within educational systems themselves, however, there was a growing concern that computer education was becoming an elitist academic subject, too difficult for most students, and that the gender ratio of students was as poor as that of physics. There were internal concerns over limited access to computers, and also concerns that specialist computer education subjects were inhibiting the use of computers 'across the curriculum', integrated into all subject areas. This foreshadowed the creation of the Digital Literacy curriculum.

1990

More generalist computing courses that appealed to a wider range of students were introduced in schools, creating further divergence between computer education and established tertiary pathways. Without a generalised curriculum policy framework, courses combined popular trends in ICT skills, website development and learning software applications.

A technology boom increased the focus on vocational education and training. Secretarial courses transitioned from teaching typing to business studies, greatly influencing the move towards teaching skills in software applications in schools.

2000

With the 2000 dotcom crash, interest in computing as a career path and subject to study waned. While senior secondary computer science-focused courses survived in most Australian states, they became increasingly marginalised as enrolments fell. Generalist subjects chased popular vocational trends in media production and game development to sustain interest, or relegated computer education to a subset of a vocationally based Technologies curricula, dominated by woodworking and home economics.

In 2008, the Commonwealth Digital Education Revolution provided a 1:1 computer to student ratio and reliable internet access to high schools. This accelerated the integration of computer use in all subject areas, and questions were again raised within educational systems as to the need for specialist computer education courses.

Within universities, the challenge of generalist computer education was also being explored, with Jeannette Wing (2006) proposing computational thinking as a 'universally applicable attitude and skill set' to utilise 'abstraction and decomposition' to tackle complex real-life problems with the mindset of a computer scientist.

2010

In 2011, after criticism of the UK computer education curriculum by the Royal Society (Furber, 2012) and Google chairman Eric Schmidt, the UK Government halted computer education in schools, ordering a fundamental realignment towards computer science.

Serendipitously, Australia was in the process of developing the Australian Curriculum (Digital Technologies was first developed in 2014) and was able to incorporate the radical changes occurring in the UK with the computational thinking framework proposed by Wing (2006) to reframe computer education in Australia.

Extensive consultation and curriculum development processes produced a nationally agreed Digital Technologies curriculum across all years of schooling, excluding the final senior years.

This was a fundamental shift, from computer education being a marginalised subset of the Technologies curriculum as set out in the 1999 Adelaide and 2008 Melbourne Declarations on Educational Goals for Young People (Ministerial Council on Education, Employment, Training and Youth Affairs, 1999, 2008) to becoming the first new compulsory subject since the introduction of geography in the 1960s. Australian schools now had comprehensive policy frameworks in which to deliver computer education, as well as a parallel Digital Literacy framework in which to provide generalist ICT capabilities integrated into all subject areas.

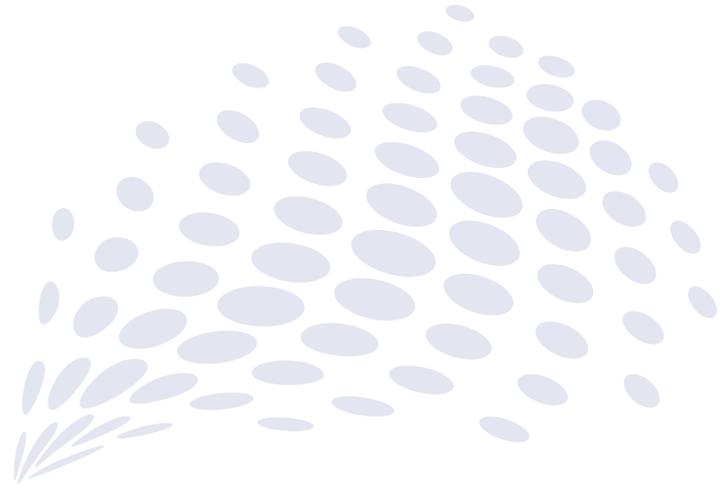
2020

A comprehensive review of the Australian Curriculum largely endorsed the Digital Technologies subject with only minor changes, while Digital Literacy expanded upon its generalist approach to incorporate a greater focus on cyber safety. Artificial intelligence concepts were also incorporated into the curriculum.

There is still a lack of support for the development of a national senior secondary computer education curriculum for the final years of schooling, as Digital Technologies does not have the level of political interest of English, mathematics, science and HASS (Humanities and Social Sciences).

The international trend towards incorporating computational thinking into all subjects as an expression of Digital Literacy (as was the original intent of Wing; 2006) continues. This is a challenge to the distinct character of the Digital Technologies curriculum.

02



The challenge of defining computer education

Defining what computer education involves is complex, and neither academia nor industry have yet to invent all-encompassing terminology to cover it. School computer education incorporates elements from all the current Association for Computing Machinery (ACM) and Institute of Electrical and Electronics Engineers IEEE (2020) disciplines of computer science, computer engineering, software engineering, information technology, information systems, cybersecurity and data science. Combining these into a single curriculum to be taught developmentally over 13 years and in parallel to a Digital Literacy curriculum requires a very different approach to that undertaken in tertiary studies.

The ACM and IEEE (2020) have reported a global shift in computer education-related baccalaureate degree programs from outcome-based learning to competency-based learning. This is not appropriate for a comprehensive education in schools, where the focus is on the gradual development of conceptual understanding outcomes and developing cognitive processing abilities over 13 years. For senior secondary students, competency development is a focus of vocation-based courses but university pathway courses remain outcomes-focused, although in senior years these are more highly defined than in earlier years, because of competitive assessment processes.

Recommendation 1: *High schools and universities should introduce measures to assist students in transitioning from an outcomes-based education in schools to increasingly competency-based education in tertiary studies.*

In 2014, the Digital Technologies subject of the Australian Curriculum was developed for F–10 computer education studies, encompassing the very first year of schooling (referred to as F for Foundation) through to Year 10, generally the end of compulsory schooling. Building upon Bloom’s Taxonomy of educational learning objectives (Bloom, 1956) and various collections of 21C Skills (‘21st century skills’, 2020), a loose framework of thinking skills specific to computer education was constructed. These comprise computational, design and systems thinking, along with project management approaches and elements of futures thinking.

These skills are progressively developed by students through their achievement of a range of increasingly specific computer education outcomes each year, progressing from simple concepts, knowledge and skills to more advanced outcomes in later years.

These outcomes are detailed in curriculum documents as ‘content descriptions’, with statements such as ‘Investigate how data is transmitted and secured in wired, wireless and mobile networks, and how the specifications affect performance’ and ‘Implement modular programs, applying selected algorithms and data structures including using an object-oriented programming language’.

Digital Technologies learning outcomes are generally demonstrated by students solving problems in various computing contexts using defined skills and knowledge, and through this, improving their various thinking skills.

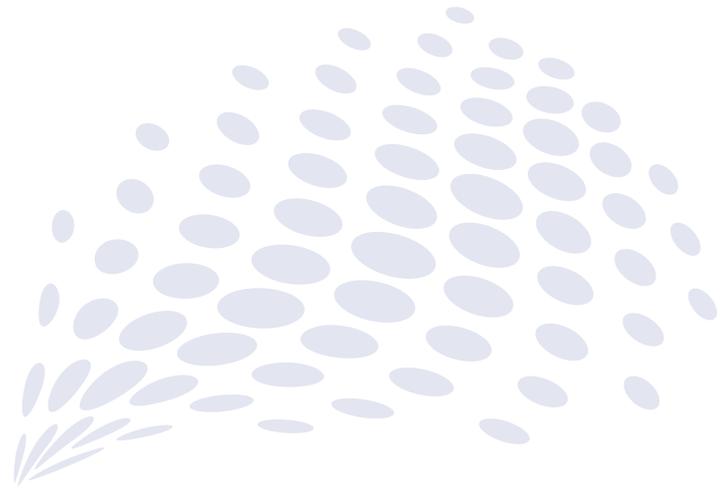
Currently, there is no framework to measure Digital Technologies thinking skills, and assessment in Digital Technologies is focused on broad ‘achievement standards’ and measuring the degree to which students demonstrate their mastery of Digital Technologies content description outcomes.

This distorts the focus of the curriculum, as the overall aims of the subject are not being directly assessed. Subsequently, most focus in practice is on teaching and assessing skills and knowledge outcomes, not on measuring and fostering the development of thinking skills.

With increasing research available into processes for assessing thinking skills related to digital technologies (Lockwood & Mooney, 2017; Dosi et al., 2018; Tang et al., 2020), there are greater opportunities now to measure these fundamental curriculum outcomes.

Recommendation 2: *ACARA should develop processes to assess Digital Technologies thinking skills, either directly or through a formalised secondary process derived from content description outcomes.*

03



Implementation issues with Digital Technologies

Since 2014, the Digital Technologies subject of the Australian Curriculum has been progressively commenced in all Australian states and territories, with New South Wales being the last state to commence, in 2019.

While the intent of the Australian Curriculum is to reduce redundancy and permit easier transitions of students from one state to another, not all states adhere closely to the Australian Curriculum; Victoria, New South Wales and Western Australia reframe the curriculum the most. However, there are reasonably consistent outcomes and curriculum structures across all states and territories.

The introduction of a new compulsory subject into an already crowded curriculum was always going to be difficult, and this remains the case in all states and territories. In primary years, Digital Technologies represents an entirely new set of content that most teachers have not experienced in their own education or teacher preparation. In secondary education, Digital Technologies was a dramatic shift from teaching ICT applications to teaching computer science, many junior secondary computing teachers having only rudimentary, self-taught programming skills and no information systems or query language experience.

As the Australian Curriculum does not extend to the senior years of high school for computer education, there is a significant disparity between what is taught from F-10 and senior courses.

Results from a survey ACS (2021) conducted of 307 Australian schools (Appendix A, Table 11) show in more than 50% of primary schools, 75% or more of teachers had no prior experience or training to teach computer education, and 24% of lower secondary, 15% of middle secondary and 10% of senior secondary schools had 75% or more of their computer education teachers teaching 'out of field', meaning with no formal training to teach the subject. In contrast, only 16% of primary, 34% of lower secondary, 54% of middle secondary and 51% of senior secondary schools reported more than 75% of their teachers teaching computer education subjects were trained to teach computer education.

Within the teaching population surveyed, self-identified teachers of computer education showed their confidence to teach computer education (Appendix A, Table 12) was relatively low. Only 26% of lower primary, 37% of middle primary and 50% of upper primary school teachers considered themselves proficient at teaching computer education. At high school level, 52% of junior secondary, 65% of middle secondary and 69% of senior secondary school teachers considered themselves proficient.

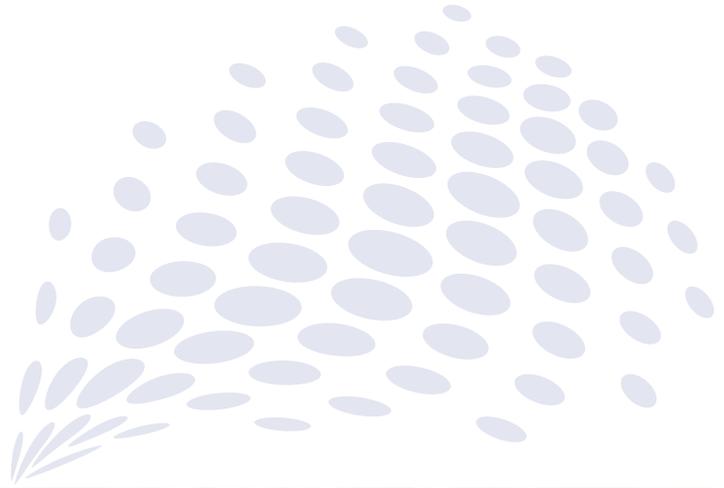
More than half (51%) of teachers teaching the Digital Technologies subject to students in primary schools had no formal qualification to teach the subject, and only two-thirds (66%) of teachers in high schools had a bachelor's or master's degree qualification related to the subject. This lack of preparation to teach Digital Technologies is not surprising given the scale of retraining required, but addressing this skills gap is essential to successfully introduce Digital Technologies education as a compulsory subject in Australian schools.

Recommendation 3: *Schools and school systems should provide increased support for Digital Technologies teachers to obtain formal training and qualifications in Digital Technologies, with the aim of at least one teacher in every primary school having formal qualification in the teaching of Digital Technologies; all secondary computer education teachers having at least some formal training in a programming language; and all senior secondary computer education teachers having formal tertiary qualifications in a computing field.*

Digital Technologies teachers surveyed (Appendix A, Table 3) unsurprisingly reported the teaching of Digital Technologies in their schools. This does not, however, represent the full implementation of the Digital Technologies subject. Some schools are unable to effectively staff and unwilling to allocate curriculum time to the implementation standard expected of the Australian Curriculum.

In addition, reporting to parents of student outcomes in the Digital Technologies subject has only recently begun in some states and is yet to become widespread in most.

04



Approaches to Digital Technologies in schools

Many schools, almost 50% of primary schools (Appendix A, Table 8), have combined the teaching of Digital Technologies with other subjects, most commonly with Science (22%), Mathematics (19%), Humanities (15%), English (15%), the Arts (14%), Health and Physical Education (5%), Languages (4%), integrated STEM (Science, Technologies, Engineering and Mathematics) or STEAM (Science, Technologies, Engineering, Arts and Mathematics) subjects (Appendix A, Table 9).

While Design and Technology was not included as a selectable survey option, 'other' responses indicate at least 4% of primary schools have combined the teaching of Digital Technologies with it, and likely significantly more in practice.

While integration can provide a rich learning environment, unfortunately, some schools may have done so to minimise the impact of Digital Technologies on existing subject time allocations.

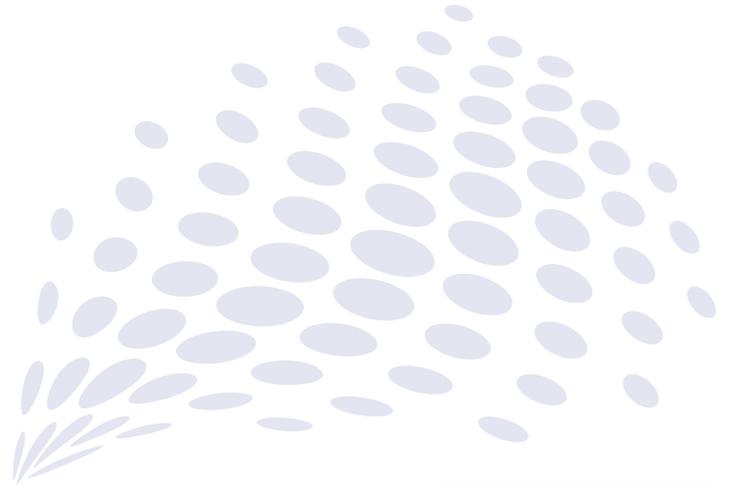
Other approaches include concentrating the study of Digital Technologies into a few weeks of intense learning each year, often culminating around a showcase technology event where students publicly present project solutions. In many cases, the teaching of the Digital Technologies subject occurs in only a portion of the year, alternating with other smaller subjects. This results in a gap of up to a full year between student engagement with Digital Technologies as a subject.

Where a focus on computer education is a priority in a school, a proportion of the school discretionary curriculum time – which represents between approximately 20% and 50% of the total curriculum time available, depending on the year level – is allocated in addition to the advised minimum time needed to address the curriculum appropriately.

This is reflected in the survey of Digital Technologies teachers (Appendix A, Table 4), where the proportion of additional discretionary curriculum time allocated is roughly consistent with that possible for the year level.

The time allocations reported by surveyed teachers in all cases exceed the minimum time considered necessary to achieve the outcomes described by the curriculum at all year levels. Nevertheless, many teachers report time pressures to achieve the outcomes required in the Digital Technologies curriculum. Inexperience in the subject is a contributing factor in some cases.

05



Indicators of implementation

A key implementation indicator of the curriculum is when student outcomes start to be reported to parents. It's possible to teach much of the Digital Technologies curriculum superficially and opaquely, but reporting, and the assessment it involves, focuses attention on the effective teaching of the Digital Technologies outcomes.

While it's required in all states and territories, in practice, reporting is currently inconsistent, which generally is a reflection of the short time since the implementation of the Digital Technologies curriculum. While it is gradually improving, there remains a significant number of schools in each state that will need greater incentives to complete, or indeed to start, implementing the Digital Technologies subject and to report outcomes to parents.

Even the schools represented by those engaged Digital Technologies teachers that completed the survey (Appendix A, Table 5) report significant failures to commence reporting and uncertainty over whether they will commence in the near future.

It's of significant concern that survey respondents indicate there are low numbers of schools reporting outcomes to parents in Victoria (66%) and Tasmania (56%), despite commencing implementation early.

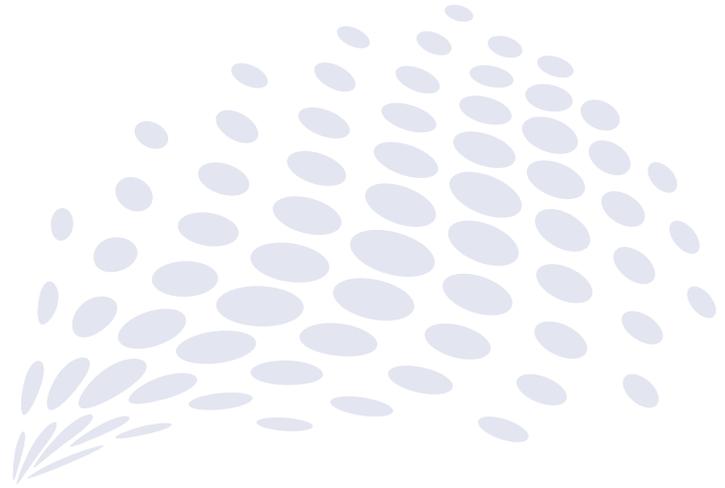
Recommendation 4: *States and territories should rigorously report to parents on student outcomes in the Digital Technologies subject, to provide a key initial indicator of their success in implementing the subject in their schools.*

In general, rates of reporting to parents are significantly higher in independent (76%) and Catholic (68%) schools (Appendix A, Table 6) than in government schools (55%). While this is generally a result of the flexibility in smaller systems to respond to curriculum changes, it can also reflect a stronger interest in computer education by more affluent parents and well-resourced schools, and a focus in these school systems on the implementation of Digital Technologies to signal competitive advantage in attracting students.

Recommendation 5: *Government school systems and schools should use Digital Technologies initiatives and school achievement awards to signal to principals and teachers the importance of implementing Digital Technologies within their schools.*

Recommendation 6: *Australian Government Department of Education, Skills and Employment should address the low rate of government schools reporting on Digital Technologies outcomes to parents nationally (55%), as this indicates that they need additional support and incentives through federal funding arrangements to meet their agreed obligations to the Australian Curriculum.*

06



Resourcing for schools

Schools have always lagged well behind business in the provision of digital technologies, but in 2008 the Digital Education Revolution (DER) allocated more than \$2.1 billion over seven years to achieve a 1:1 computer to student ratio for students in Years 9 to 12 and connect Australian schools to broadband internet (dandolopartners, 2013).

This established an expectation within Australian schools for greatly increased access to devices, and as DER funding ended, education systems and schools struggled to achieve a sustainable funding model to continue to meet this expectation.

This has resulted in a mix of models ranging from programs entirely funded by schools or education systems to those entirely funded by parents, known as BYOD (bring your own device; Lee, 2013). The mix in many schools involves differing levels of access to technologies, generally prioritising older year levels.

Of the surveyed schools (Appendix A, Table 7), BYOD programs are used in 70% of high schools, and 32% of primary schools used BYOD programs in upper primary years, 17% in middle primary years and 6% in lower primary years.

Within schools, mobile devices predominate, with tablet computers generally used in the younger years of primary schools (86%), transitioning gradually to laptops in high schools (96%). Desktops deployed in computer labs, classrooms and libraries remain in 40% of high schools and 25% of primary schools. There may be only one device per classroom or a small number of desktop computers, laptops or tablets per classroom, concentrated in computer labs or libraries, or in classroom sets shared between several classes.

In general, outdated equipment that is prone to failures reinforces teacher disengagement from using technologies to support their teaching, and results in little time being spent on Digital Technologies and Digital Literacy teaching.

Systemic programs are generally hampered by low levels of investment in equipment and the support structures required to sustain their operational use. Many primary schools, in particular, are forced to share equipment between classes and technical support services between multiple schools.

Even where available, technical support staff are often not highly qualified or experienced in relation to the large user base and complexity of school IT environments.

There are positive examples where schools have invested heavily in resourcing Digital Technologies and Digital Literacies, using technologies to support all learning areas, and have implemented systemic Digital Technologies and Digital Literacy programs throughout the curriculum to leverage their investments in technology to improve student learning. However, these remain the exception.

Of the schools surveyed by ACS (Appendix A), 18% of schools overall reported extensive use of technologies within all subject areas (Digital Literacy). There were 31% of independent schools, 14% of government schools and 13% of Catholic schools that reported extensive use of technologies within all subject areas; and 4% of independent, 8% of government and 11% of Catholic schools reporting no use of technologies in other subject areas. This has implications for Digital Literacy concepts such as cyber safety, with 25% of independent, 35% of Catholic and 38% of government schools reporting ineffective cyber safety programs.

Recommendation 7: Schools should assess student Digital Literacy outcomes and reporting provided to parents. This should be coupled with parental awareness programs covering the elements of Digital Literacy that have been addressed during each year. This will inform the community of the general integration and academic use of digital technologies by teachers and the degree to which Digital Literacy outcomes are addressing cyber safety concerns.

Recommendation 8: Industry (through ACS) should provide guidance to schools and government on benchmarks based on industry-wide norms for computer education infrastructure investment, update cycles and support staffing.

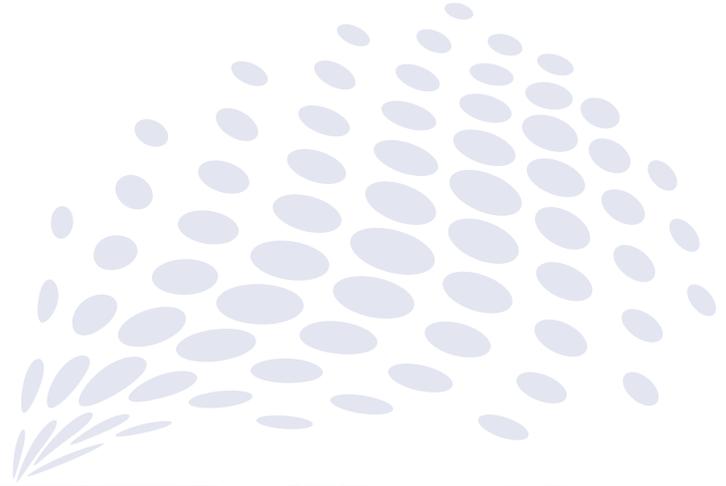
Recommendation 9: Schools and school systems should implement annual equipment, software and network audits in line with industry-wide norms, to ensure frontline teachers have the requisite resources to effectively teach computer education subjects and the Digital Literacy curriculum.

Recommendation 10: Industry (through ACS) should provide guidelines on the expected qualifications for school technical support staff, ranging from junior IT support technicians to CIO leadership positions.

Recommendation 11: Industry (through ACS) should provide or support the development of professional training frameworks for qualification of school-based IT professionals.

Recommendation 12: Industry (through ACS) should provide professional pathway advice and encouragement for ACS members to enter school-based IT positions.

07



Controversies and restrictions

The use of some digital technologies in schools has caused controversy, from email bans in the 1990s through to computer games and, more recently, concern over social media, screen time and distractions from mobile phones.

Surveyed teachers (Appendix A, Table 7) indicated that mobile phones are entirely banned in 68% of their schools, partially banned in a further 7%, but fully permitted in 25%, with up to 5% of high schools using mobile phones as BYOD devices.

All new technologies involve some level of risk, and the conservative and risk-averse nature of most schools and school systems can have a detrimental effect on preparing students to engage with new technologies beyond the protective school environment. The core role of schools is to prepare students to meet the risks and opportunities involved rather than protecting schools and systems.

Recommendation 13: *Restrictions on the use of new technologies in schools should include plans to address the concerns raised by the technology through the Digital Technologies and/or Digital Literacy curricula.*

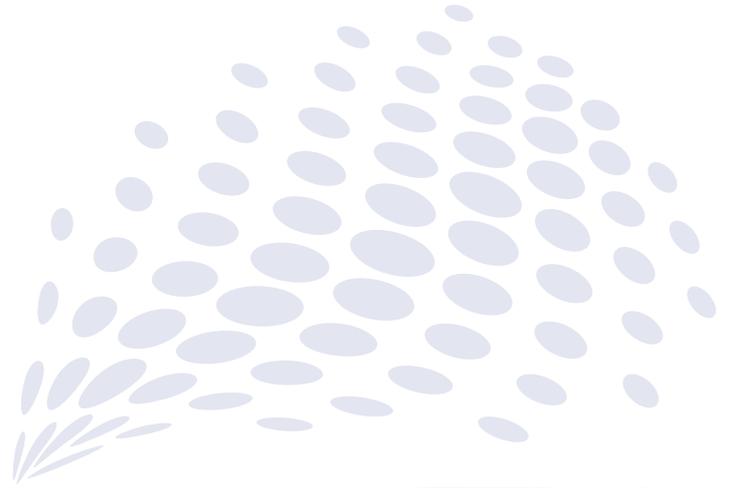
All new technologies introduced into schools must face some initial restrictions as teachers and school systems learn how to first understand and then cope with the risks and disruption such technologies cause. Then, they learn how to use the technologies, if suitable, to support learning and teaching.

This process is often accelerated by newer technologies outpacing previous concerns, with augmented reality glasses, virtual world metaverses and wearable devices such as smart watches the current leading contenders.

Rarely do schools and school systems pre-emptively plan to address new technologies. For example, smart watches can provide very accurate and useful data for health and physical education, but schools would need to have an awareness of this potential to craft suitable learning experiences.

Recommendation 14: *Schools and school systems should develop innovation adoption plans to acknowledge that new technologies are always being introduced. They should systematise reasonable initial restrictions on the new technologies, manage associated disruptions, and transition in a timely manner to acceptable use. Then new technologies should be integrated into school professional learning processes and mainstreamed into schools and school systems with appropriate leadership, systems and technical support.*

08



Challenges and misunderstandings

It's common for school leaders to showcase new technologies as indicators of the successful integration of Digital Technologies within their school. Many schools ostentatiously display robots, drones and 3D printers that have rarely seen regular use by teachers or students.

This can present a false perspective to the school community and prospective students and parents, but, more significantly, mislead school leaders and teachers in their understanding of how effectively their school is addressing computer education and the development of student digital literacy.

Recommendation 15: *Schools and school leaders should focus on demonstrating systemic Digital Technologies learning initiatives rather than showcasing technological devices to parents as indicators of their successful integration of Digital Technologies.*

The focus on technological devices is a significant issue throughout computer education and Digital Literacy education, with acquiring and teaching the latest technological device or application a hallmark of computing education before the introduction of the Digital Technologies curriculum.

The transition for many computing teachers and ICT/Digital Literacy specialists from 'toys to concepts' is difficult. Many lack the foundational skills in programming and computer science concepts, having built their careers around accessing the latest technologies and introducing these to students and schools.

Engaging students by providing them access to new technologies is an important element of digital technologies education, but this now needs to be done in the pursuit of curriculum outcomes and the development of thinking skills, not as an end in itself.

Recommendation 16: *Digital Technologies professional teaching associations should provide increased professional learning focused on concept development rather than technologies.*

Many teachers conflate the use of any digital tool or software with contributing to Digital Technologies education rather than assessing which tools and software are supporting the development of Digital Literacy.

This lack of distinction between these two parts of the curriculum is an ongoing issue. Even the surveyed population of self-identified teachers of Digital Technologies, when asked what software and websites they were using most to teach computer education (Appendix A, Table 14), 30% responded with resources directly related to computer education in the early years of primary and 60% to 70% in the upper primary and high school years.

While Digital Technologies teaching does include the development of Digital Literacy and the use of a wide range of technologies and resources, the responses highlight the ongoing confusion of parallel curricula where tools and websites may be used to address different curricula, or both simultaneously, depending on the context in which they are applied.

Recommendation 17: *Education Services Australia, through the Digital Technologies Hub, should provide a resources search categorisation of either or both the Digital Technologies and Digital Literacies curricula, to assist teachers in understanding the tools and resources that can contribute to addressing their learning outcomes.*

The shift from teaching about how to use digital technologies (ICT) to a computer science focus interrupted ongoing debates over the teaching of computing in a distinct subject versus being integrated throughout the curriculum. While much of computer education was amalgamated into the F–10 Digital Technologies subject, important aspects remained that could and should be addressed in all learning areas, and these were framed into a separate ICT General Capabilities curriculum. This has been revised and renamed Digital Literacy, and included in a suite of complementary curricula collectively known as General Capabilities.

Digital Literacy is developed in all subjects and by all teachers and is distinct but also taught in the Digital Technologies subject, just as numeracy and literacy are developed in all subjects by all teachers but have a special relationship and leadership from the Mathematics and English learning areas.

The complexity arises for teachers in understanding the breadth of the contribution that digital technologies can have for teaching and learning as:

1. educational technologies that form their own digital literacy
2. the digital literacy that they develop in their students through their use of digital technologies in all subjects
3. the more in-depth understanding from specialised studies in Digital Technologies, including developing computational, design and systems thinking skills.

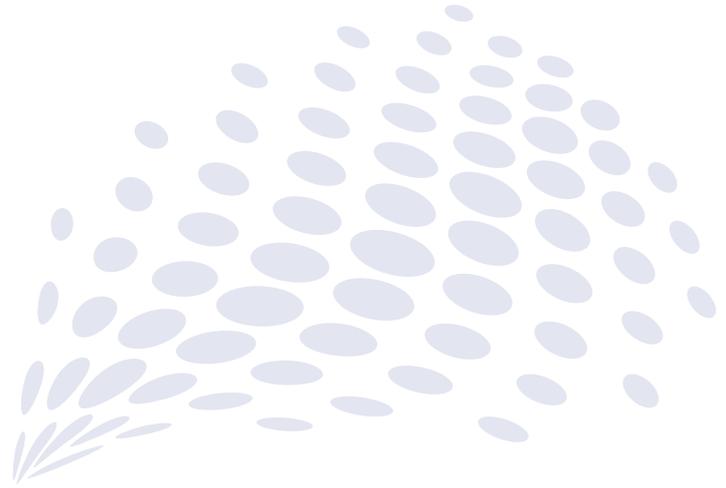
Further complicating Digital Literacy education is that the outcomes for the General Capabilities are not assessed. Consequently, while they are acknowledged as important, they are not generally taught in a systematic manner.

Victoria has largely integrated the Digital Literacy outcomes into its curriculum subjects to address this, but in other states and territories, Digital Literacy education remains problematic. One remediation of this has been in the revision of the Digital Technologies curriculum to include aspects of cyber safety in the Digital Technologies subject to ensure more systematic treatment. However, this results in expectations that cyber safety will be taught in the Digital Technologies subject sub-strand of 'Considering privacy and security' and in two General Capabilities, 'Digital Literacy' and 'Ethical Understanding'.

The resulting curriculum overlap creates the potential for teachers to consider elements of cyber safety as already being addressed. In particular, teachers of other learning areas may assume that cyber safety is addressed in the Digital Technologies subject, although all subjects are responsible for addressing the General Capabilities.

Recommendation 18: *ACARA should highlight where overlap exists between Digital Technologies outcomes and Digital Literacy outcomes, and provide guidance on how this is to be addressed to ensure that what is taught in Digital Technologies is complemented by what is taught in other subjects as they address Digital Literacy.*

09



Coding

Despite the development of the Digital Technologies curriculum, many in education and industry continue to equate the Digital Technologies subject with learning to code. The focus of the Digital Technologies curriculum is teaching students a wide range of fundamental computing concepts, developing their thinking skills and problem-solving capability. Coding is certainly used to assist in this, but primarily as a tool, not as the main outcome of the curriculum, just as learning handwriting is both a tool and an outcome of the English curriculum but not the main outcome.

Within the F–10 curriculum, there are three broad approaches to solution development in Digital Technologies:

- those that explicitly require coding – developing applications, websites, games and AI-based solutions
- those that require automation – incorporating input devices, internet of things (IoT) applications, robotics and drones
- those that require information systems – through collection and representation of data, geospatial data and data security.

While coding is used as a tool in all aspects of Digital Technologies education, it is not the focus. Over the 13 years that the subject is taught, students will learn and use several programming languages to varying degrees. None of these will be learnt comprehensively to the detailed level of specific programming language courses in industry and tertiary studies, but collectively students will explore all the fundamentals common to scripting, procedural and functional programming languages, and query languages, and have an introduction to object-oriented programming in the Year 9 and 10 elective.

Senior secondary computer education courses are generally more comprehensive. They address a single programming language in greater depth and include the use of more complex query language structures.

In the early years of primary schools, the focus of learning programming is on manipulable devices – objects that can be combined in various ways to form simple algorithms that produce various outcomes. These may be robotic and electronic devices or virtualised in applications that are commonly framed as computer games.

This learning sequence progresses through the primary school years from simple to complex block-based programming language solutions that teach core concepts of sequence, selection, iteration and modularity, and then, in secondary school years, to text-based languages that integrate with databases.

No specific languages are mandatory, and if the concepts are being developed and contributing to thinking skills and problem-solving, the outcomes of the curriculum are considered achieved in F–10. The focus on competitive assessment in the senior years results in a greater emphasis on more specifically measurable outcomes.

There is no fixed timing for the shift from manipulables to visual/block-based programming languages, to text-based programming languages, and there's a lack of research as to when this should best occur. The Digital Technologies curriculum does require that some text-based programming is included from Year 7 (defined in a glossary entry on 'general-purpose programming languages').

The visual versus textual coding debate can be an opportunity to explore abstraction (Zagami, 2012), with the selection of different programming tools depending upon the complexity of the computational problem being solved. When this complexity is low, visual programming may be best suited for even the most experienced programmer to easily conceptualise the problem and generate a solution; while for more complex problems that go beyond students' cognitive capacity to visualise the relationships between elements of the computational problem, text-based programming languages may provide the better solution, even for the most inexperienced programmers.

Language fatigue can occur when only a single programming tool is used continuously. There have been reports of the popular Scratch block-based language being used exclusively for up to 10 years in some cases. As occurred with the excessive focus on teaching application software at the turn of the century, students can become disinterested in the study of computer education when it is repetitious, and they form the impression there is nothing interesting left to learn from the subject.

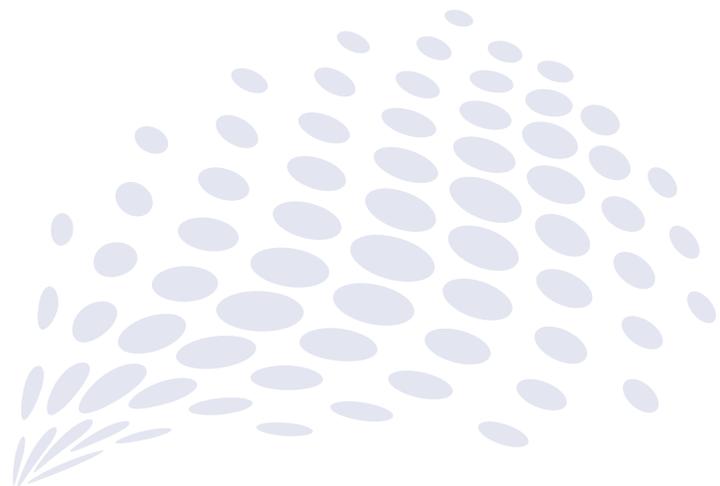
Recommendation 19: *Schools should audit the tools being used to teach Digital Technologies to ensure that students have a variety of experiences and learning contexts within the subject and that no single tool or approach is overused.*

In the Australian Curriculum the type of programming language taught is based on students' age rather than on the capabilities of different languages to support problem-solving in various contexts. This can limit student opportunities to apply their understanding of abstraction and generalisation to the identification of the best programming language tool to fit a given computational problem.

Over the course of 13 years, with many different teachers and learning activities, students will inevitably engage with a wide range of programming language tools and problem contexts, and this provides an opportunity to develop their computational thinking capacity.

Recommendation 20: *ACARA should clarify, through the Technologies 'general-purpose programming language' glossary entry, or a more accessible location in the Digital Technologies curriculum, that while students need to engage with text-based languages in high school, their use is not limited to high school, nor are visual programming languages limited to use in primary school, as each can be used, depending on the concept being taught and the complexity of the problems being solved.*

10



Senior secondary

The transition from visual programming languages in primary school to text-based programming in secondary school is not the only transition barrier in school computing.

The transition from the Digital Technologies curriculum to senior secondary computer education is also significant. Senior secondary courses are focused on assessment. For university pathway courses, this is competitive, and what is taught is generally framed by what can be assessed in a manner that is equitable to all students regardless of the resourcing and quality of teaching available. However, in vocational pathway courses, assessment is generally framed around competencies, subdivided into clearly defined and specified outcomes. Both approaches generally lack overarching collective outcomes such as the thinking skills developed in F–10.

Within F–10, teachers can conduct their own assessment, and if the learning outcomes of the curriculum are achieved, frame their own contexts and learning activities. This enables experienced Digital Technologies teachers to develop units of work that explore concepts in considerable depth – contextualised to the interests of the teachers and students, while less experienced teachers rely upon existing resources to teach the subject. In senior secondary, with more tightly bound learning outcomes linked to standardised assessment, there is less scope for contextualisation, but it remains possible.

Generally, the proportion of senior students that go on to study in computer education-related fields at the tertiary level is low. Only 7% of schools surveyed reported more than 25% of students who were studying computer education electing to undertake computer education-related tertiary studies. Currently only 4.7% of students currently undertaking tertiary studies are doing so in computing fields (Australian Bureau of Statistics [ABS], 2021).

Interest in studying computer education in the senior years is gradually decreasing (Appendix A, Table 10), with 49% of schools reporting numbers staying constant, 31% decreasing and 20% increasing.

Student selection of courses to study in senior high school occurs early in high school, particularly for smaller subjects such as Digital Technologies that are not compulsory to study through to the end of Year 10. Students currently must make decisions on whether to pursue studies of Digital Technologies in Year 8 by selecting Year 9 and 10 Digital Technologies electives. This gives high schools just Year 7 and part of Year 8 to engage and interest students in further study of computer education and computing as a possible career path.

Subject selection decisions at this age are heavily influenced by parents, and parental understanding of computer education subjects and career paths is generally sketchy. They are unlikely to have studied digital technologies in schools, and if they did, it would have been in quite different forms to the current curriculum. In surveyed schools, only 58% had provided any education to parents on any aspect of Digital Technologies, and 16% had surveyed parent attitudes to computer education and 1.5% planned to do so (Appendix A, Table 15).

Recommendation 21: *Schools should survey parents on their understanding of and attitudes to computer education, to identify potential bias and misconceptions.*

Recommendation 22: *ACS should work with professional teaching associations to develop resources for schools to inform students, parents and careers advisers about state senior secondary computer education curricula, national Digital Technologies and Digital Literacy curricula, and associated career pathways in secondary, senior secondary and tertiary studies.*

Recommendation 23: *Schools should provide parents with details of the new Digital Technologies and Digital Literacy curricula and information on associated career pathways in secondary, senior secondary and tertiary studies.*

Complicating matters, there is a lack of curriculum links between what is taught in the F-10 Digital Technologies curriculum and courses in the final years of schooling.

The F-10 Digital Technologies subject aims for students to culminate in being confident, persistent and innovative creators of digital solutions; effective, respectful and cooperative users of digital systems; and critical consumers of information and technologies. Senior secondary courses have the more immediate aims of preparing students for tertiary study and the workforce. They are focused on defined assessment outcomes and currently assume little if any prior knowledge and skills in digital technologies.

This is a disincentive for students to undertake elective Digital Technologies subjects in Years 9 and 10, as they will generally have to relearn this content again in senior courses, and it significantly decreases what could be achieved in senior courses if they extended from what students have achieved in the previous 11 years. Likewise, it is a disincentive for students to select senior secondary computing courses if they have studied Digital Technologies electives, as these will significantly overlap with what students have already accomplished in the Digital Technologies curriculum.

Recommendation 24: *State and territory authorities for the development of senior secondary computing curriculum should develop subjects that build upon the outcomes from the compulsory years of the Digital Technologies curriculum and provide recognition of study of the elective Years 9 and 10 Digital Technologies subjects.*

NATIONAL CONSISTENCY FOR SENIOR SECONDARY STUDENTS

Senior secondary computing courses are not nationally consistent. Some states offer introductory programming courses in senior secondary years. Some also offer introductory information systems courses. However, others only offer advanced digital literacy courses focusing on application use.

These should align better as revisions to senior curricula build upon the F–10 Digital Technologies curriculum and the general trend towards computer science-oriented courses. Yet over the last decade, this has not yet been achieved. Learning areas such as English, mathematics and science (each with four distinct senior secondary subjects) along with HASS (with History and Geography) have nationally consistent senior curricula developed by the Australian Curriculum, Assessment and Reporting Authority (ACARA), but so far there has been insufficient support for a nationally consistent senior secondary computer education curriculum. For students and educators, this can reinforce the sense of a two-tier set of senior subjects, with senior computing not in the top tier.

Recommendation 25: *To guide state and territory curriculum development, ACARA should develop a national senior secondary computer education curriculum with the agreement of all states and territories, as has been achieved for English, Mathematics, Science, and Humanities and Social Sciences.*

SUPPORTING TERTIARY EDUCATION

Spreading the development of core computing concepts – such as sequencing, selection, iteration and modularity – over 13 years significantly changed the approach to computer science education that had been focused on mirroring what was being conducted in semester-long university courses.

The Digital Technologies curriculum, coupled with senior secondary computing subjects, extends over 13 years (approximately 400 weeks/380 hours) and compares to what would be taught in some introductory first-year university computing subjects (approximately 33 weeks/100 hours). The implications for tertiary computing programs are significant. It's expected that students will enter these programs having completed much of what would be taught in their first semester at least.

Traditionally, university computing faculties have strongly resisted attempts to support the transition of students from high school Digital Technologies studies into university programs, preferring to consider all students entering their programs as having no prior knowledge. This will become increasingly difficult to sustain with all students completing at least 9 years of compulsory digital technologies studies, and most having completed 13 years of study.

University mathematics and science faculties have long worked with schools to develop curricula and pathways into their programs, and they have reaped considerable benefit from this cooperation. As a result of these faculties working with, and in many instances leading, school curriculum development, mathematics and science education has achieved a privileged position in senior school education.

These university faculties have had the confidence to require the completion of senior secondary mathematics and science subjects as prerequisites for tertiary study. Consequently, many students undertake studies in these prerequisite courses even without necessarily intending to use them, but not wishing to limit their options.

This, in turn, increases the likelihood of students subsequently deciding to pursue such studies, having achieved the prerequisites. Many consider it a waste to not do so, including students who were considering studying tertiary computing but in choosing to study mathematics and science prerequisites, did not study senior secondary computing courses, and thus had not been encouraged in this tertiary pathway while being encouraged towards science and mathematics pathways.

Recommendation 26: *University computing faculties should proactively work with schools and professional teaching associations on F–12 Digital Technologies curriculum development to guide the development of computer education. They should assign at least one faculty member to the role.*

Recommendation 27: *University computing faculties should implement undergraduate program prerequisites for senior secondary school computer education courses or recognition of prior learning credit for introductory courses where students have completed senior secondary school computer education. Alternatively, university computing faculties should lobby to remove all prerequisites that provide an unfair competitive advantage to particular undergraduate programs.*

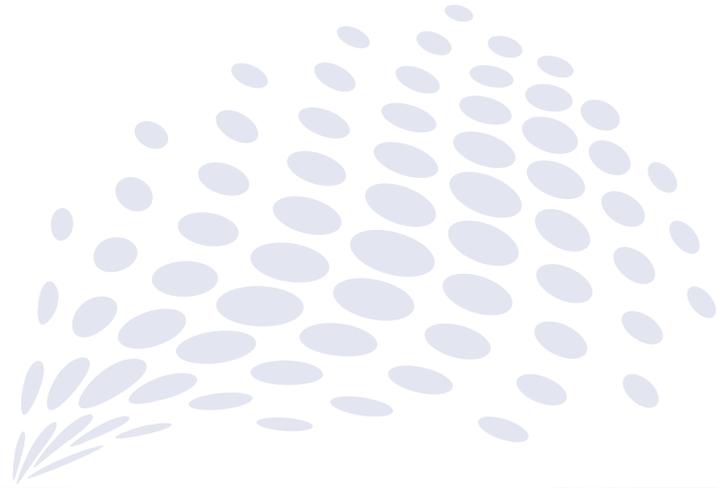
Within the vocational education and training (VET) sector, there is also little coordination between senior secondary schooling and VET. In the 1990s, there was considerable integration, with Certificate III programs embedded within many senior secondary school computer education subjects, including those offering university pathways, but this resulted in competition between the sectors. Many schools established themselves as training providers and cooperation decreased.

There is also the problem of stigma associated with VET pathways. Many independent schools do not support VET courses. Likewise, in some schools, university pathway courses for senior secondary students are characterised as being unsuitable due to the school's demographics. Of the high schools surveyed, 45% offered VET pathways in Digital Technologies-related courses. Of those, 41% were registered training organisations (RTOs) and 59% used an external RTO. Qualifications ranged from Certificate I to Certificate III in Information, Digital Media and Technology.

Recommendation 28: *VET course developers should proactively work with schools and professional teaching associations on F–12 Digital Technologies curriculum development to guide the development of Digital Technologies education in VET.*



11



Thinking skills

The most difficult aspect of F–10 Digital Technologies education for those unfamiliar with it is the teaching and development of thinking skills in students. Bloom’s Taxonomy of educational learning objectives (Bloom, 1956) described a hierarchy of skills culminating in higher-order thinking skills such as the ability to synthesise, evaluate and analyse. Developed from this, specific thinking skills have been identified for various subjects. Digital Technologies focuses on the development of computational thinking, systems thinking, and to a lesser extent, design thinking.

COMPUTATIONAL THINKING

A key aim of the F–10 Digital Technologies curriculum is for students to be able to create digital solutions using computational thinking and its key concepts of abstraction; data collection, representation and interpretation; and specification, algorithms and implementation.

The definition of computational thinking, however, is not fixed. There are many different definitions in use internationally despite over a decade of argument (Sengupta et. al., 2018). The definitions are split between computational thinking as a thought process independent of technology, a problem-solving approach, and the ability to recognise computation.

Without definitional clarity, technology curricula are usually informed by a set of generally accepted computational thinking concepts and skills: abstraction, algorithmic thinking, automation, decomposition, debugging and generalisation (Bocconi et al., 2016). Only abstraction, algorithmic thinking, decomposition and generalisation are considered part of the Australian Curriculum Digital Technologies set of skills.

The Digital Technologies curriculum has amalgamated elements of all the major definitions of computational thinking, framing it as a thinking skill, a problem-solving approach, a way of seeing computation and computational solutions, and as a set of concepts and skills. While this pragmatism is inclusive, it does present inconsistencies. These may not immediately impact the curriculum but will likely have longer-term implications as resources are developed internationally specifically for different approaches to computational thinking.

The Australian Curriculum recognises computational thinking as:

1. ‘A problem-solving method that involves various techniques and strategies that can be implemented by *digital systems*. Techniques and strategies may include organising *data* logically, breaking down problems into parts, defining abstract concepts and *designing* and using algorithms, patterns and models’ (ACARA, 2021, Glossary).
2. ‘Us[ing] the key concepts of abstraction; data collection, representation and interpretation; specification, algorithms and implementation to create digital solutions’ (ACARA, 2021, Aims).
3. ‘[P]rocesses, techniques and digital systems to create solutions to address specific problems, opportunities or needs. Computational thinking is a process of recognising aspects of computation in the world and being able to think logically, algorithmically, recursively and abstractly. Students will also apply procedural techniques and processing skills when creating, communicating and sharing ideas and information, and managing projects’ (ACARA, 2021, Structure).

Recommendation 29: ACARA should clearly define computational thinking in the Australian Curriculum within an international context of competing definitions. This definition should make it clear to educators incorporating international educational resources that such resources may have been framed to support different approaches to computational thinking.

Recommendation 30: ACS, through Technical Committee 3 representation, should provide Australian support to international efforts to reach an agreement on a standard definition of computational thinking.

Recommendation 31: ACARA should rationalise the various descriptions of Computational Thinking contained in the Aims, Structure, and Glossary of the Digital Technologies curriculum to provide a single definition. The definition may be an amalgamation of various approaches to Computational Thinking.

Recommendation 32: ACARA should undertake to map computational thinking concepts and student ability to apply such conceptual understanding to the various Digital Technologies learning outcomes.

SYSTEMS THINKING

Another key aim of the F–10 Digital Technologies curriculum is for students to be able to apply systems thinking to monitor, analyse, predict and shape the interactions within and between information systems, as well as the impact of these systems on individuals, societies, economies and environments.

While clearly defined and used in academia and industry, systems thinking development is poorly supported within the curriculum, and most teachers have no preparation in their own studies in the use or teaching of systems thinking.

Recommendation 33: ACARA should include clear systems thinking opportunities with the Digital Technologies curriculum content descriptions.

Recommendation 34: ACARA should undertake to map systems thinking concepts and student ability to apply such conceptual understanding to the various Digital Technologies learning outcomes.

DESIGN THINKING

Likewise, while Digital Technologies does not specifically have the aim of developing design thinking, it is a subset of the Technologies learning area, which does have this aim. Design thinking is considered a requirement for Digital Technologies processes and production skill development. It is, however, not explicitly taught within the curriculum, and in their own studies many teachers have had no preparation in the use or teaching of design thinking.

Recommendation 35: *ACARA should include clear design thinking opportunities with the Digital Technologies curriculum content descriptions.*

Recommendation 36: *ACARA should undertake to map design thinking concepts, and student ability to apply such conceptual understanding, to the various Digital Technologies learning outcomes.*

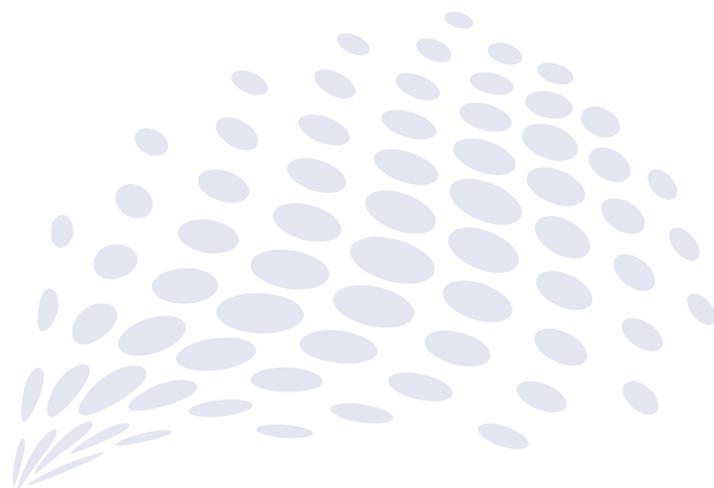
Many Digital Technologies teachers lack recent formal education in computing, and very few have had an opportunity to develop their own computational, systems and design thinking skills (in addition to teaching these skills to students). Therefore, they lack deep understanding of the concepts, the difficulties in learning such concepts, and most significantly, how to apply these thinking skills when addressing digital technologies problems.

The International Society for Information Technology in Education (ISTE, 2021) has developed computational thinking standards for teachers, and there are sufficient resources to develop standards for design thinking (AITSL, 2014) and systems thinking (Rodriguez, 2013).

Recommendation 37: *ACS, in collaboration with Digital Technologies professional teaching associations through the Australian Council for Computers in Education and the Australian Institute for Teaching and School Leadership, should work towards the development of standards to guide teachers' skills in computational, design and systems thinking, and to incorporate the appropriate standards into the Australian Professional Standards for Teachers.*

Recommendation 38: *Education faculties and school systems should provide programs and professional learning for all teachers in computational, design and systems thinking capabilities.*

12



Barriers to implementation

The implementation of the Digital Technologies curriculum is a significant challenge to school systems, schools and teachers. First-order barriers to implementing Digital Technologies include lack of adequate access to technologies, time, training and institutional support. Second-order barriers include teachers' personal and fundamental beliefs regarding the nature of digital technologies, how they should be taught and their place in the curriculum, as well as the teachers' willingness to change (Ertmer, 1999).

Teacher engagement with thinking skills has been considered a third barrier to implementation (Tsai & Chai, 2012), where even once first and second-order barriers have been overcome, teachers' understanding and engagement with the use and teaching of higher-order thinking skills may limit their ability to effectively implement the Digital Technologies curriculum.

There is a high level of agreement from teachers (over 70%) in identifying the barriers to the effective implementation of Digital Technologies. The highest level of agreement (80% strongly or mildly agreed) was that the crowded curriculum is a limitation to Digital Technologies implementation. Before the development of the Australian Curriculum Digital Technologies subject, primary teachers predominantly used digital technologies to support the teaching of other subjects. However, since creating a distinct Digital Technologies subject, some primary school teachers indicate there are difficulties in integrating the subject with other subjects (Redmond et al., 2021).

Within schools and school systems, competing priorities limit opportunities and provide excuses for not effectively implementing the Digital Technologies curriculum, as schools focus on improving literacy and numeracy outcomes to enhance standardised testing performance in national and international measures.

Dealing with student prior knowledge also remains a concern, as inconsistent teaching reduces the capacity of teachers to build upon assumed learning from earlier years. This is, however, improving, and it was inevitable that it would be a barrier during a simultaneous implementation of the curriculum at all year levels.

Teachers also report a lack of relevant professional development, and there is an ongoing need for systematically upskilling the teaching workforce to meet the increased expectations of the curriculum. This is a daunting task, with 152,281 teachers in primary schools, and 143,695 teachers in secondary schools (ABS, 2021) all requiring professional learning in teaching Digital Literacy, and all primary teachers and approximately 20% of secondary teachers requiring professional learning in teaching Digital Technologies. Schools and school systems have made very little attempt or progress in addressing the upskilling of their staff at scale, with most teachers being left to upskill on their own with little or no support.

Recommendation 39: *Schools and school systems should develop appropriate and systematic professional learning support programs to upskill all teachers in the Digital Literacy curriculum and all primary teachers and secondary teachers in the Digital Technologies curriculum.*

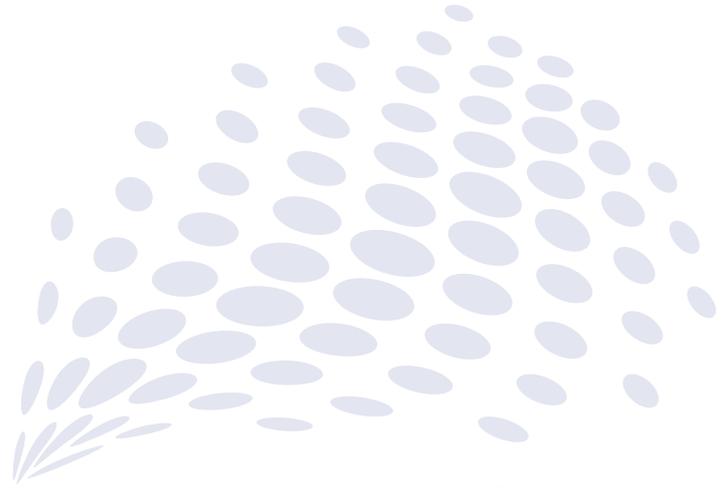
Lack of access to technology to support the teaching of Digital Technologies remains a general barrier. Ongoing maintenance and replacement cycles for outdated equipment is a significant problem in some schools. While there are now extensive supporting educational resources available for most aspects of the Digital Technologies curriculum, many teachers may not know how to access these resources.

Recommendation 40: *Schools and school systems should conduct awareness campaigns for teachers on the resources available to support the teaching of the Digital Literacy and Digital Technologies curricula.*

While there have been federal and state initiatives to provide professional learning opportunities at scale – with massive online open courses, online courses and professional learning support – so far these have only impacted a very small percentage of the teaching workforce.

Recommendation 41: *State and federal education ministers should prioritise funding large systemic professional learning programs to support the teaching workforce to implement the Digital Literacy and Digital Technologies curricula.*

13



Supporting organisations

Each state and territory is responsible for the implementation of the Australian Curriculum and has put in place initiatives to support Digital Technologies. The Australian Government has provided additional support for computer education through several organisations, primarily ACARA, Education Services Australia (ESA), the Australian Education Research Organisation (AERO), the Australian Government Department of Education, Skills and Employment (DESE) and the Australian Institute for Teaching and School Leadership (AITSL).

THE AUSTRALIAN CURRICULUM AND ASSESSMENT AUTHORITY

ACARA produces and revises the Australian Curriculum, which defines what students should learn from the first year of school to Year 10.

While the development of the Digital Technologies curriculum has been largely successful, the revision rate of the curriculum is too slow for the rapid changes occurring in digital technologies.

Artificial intelligence (AI) is a case in point. When the curriculum was developed, the field had languished and was not included in the curriculum, but it is now one of the main fields in digital technologies.

New and emerging technologies are regularly described in various industry reports, with surveyed teachers reporting robotics (56%), 3D printing (46%), cloud computing (30%), virtual reality/augmented reality (29%), drones (27%), IoT (21%), AI (17%) and wearable technology (12%) as emerging and disruptive technologies in schools, along with emerging fields such as esports, quantum computing, digital forensics and bioinformatics.

It is important that the Digital Technologies curriculum remains current. This will engage students with the enthusiasm that emerging technologies can bring and provide opportunities to develop their computational and systems thinking through the exploration of new technologies and their potential impacts.

Recommendation 42: *ACARA should develop mechanisms for increased flexibility in the inclusion of emerging technologies into the Digital Technologies curriculum between revision cycles. This could be achieved by including in each band's content description a statement that involves students exploring preferred futures and identifying and evaluating emerging technologies.*

EDUCATION SERVICES AUSTRALIA

ESA maintains a curated national online repository of teaching resources known as the Digital Technologies Hub (DTHub; ESA, 2021a).

The DTHub has been successful in establishing a single national repository for F–10 Digital Technologies curriculum resources where there would otherwise have been dozens of lesser competing collections. Teachers value the DTHub as a source of high-quality ideas and easy-to-use lesson plans to support the implementation of the Digital Technologies curriculum (dandolopartners, 2021).

ESA's National Digital Learning Resources Network (NDLRN) has been less successful. This is a repository of over 15,000 digital learning resources that were predominately commissioned in the Flash multimedia format and dated rapidly.

ESA has recently embarked on a new strategic plan for 2021–23, which can be found on its website (ESA, 2021a).

Recommendation 43: *Education Services Australia (ESA) should continue to curate quality Digital Technologies education resources and develop more effective mechanisms for teachers, systems, academics and industry to contribute resources through an ongoing peer review process to ensure the currency of resources in line with pillars 3, 4 and 5 in the ESA strategic plan for 2021–23.*

Recommendation 44: *The Digital Technologies Hub provides a basic framework to support school leaders in implementing the Australian Curriculum Digital Technologies subject. However, with the difficulties many schools and school leaders are facing, a greater focus on resources and support for school and system leaders in implementing the curriculum is recommended in line with pillars 1 and 2 in the Education Services Australia strategic plan for 2021–23.*

AUSTRALIAN EDUCATION RESEARCH ORGANISATION

AERO is a new organisation that commissions research on effective teaching and learning practices for teachers and school leaders across Australia. Research is a priority for computer education, as there is limited research available to inform significant curriculum and implementation decisions on a new curriculum subject.

Recommendation 45: *The Australian Education Research Association should identify computer education research as a priority area, given the scarcity of research on which significant curriculum decisions are being made, the impact Digital Technologies education is having on all primary teachers, and the significant impact of the new subject on secondary education with implications for students' further studies in ICT, which is a priority Australian industry.*

AUSTRALIAN GOVERNMENT DEPARTMENT OF EDUCATION, SKILLS AND EMPLOYMENT

DESE supports Australian education through various initiatives outlined in Education strategy for schools (DESE, 2021), with 'School and Early Learning STEM initiatives' supporting computer education.

Previous Coding Across the Curriculum initiatives funded:

1. Digital Technologies massive open online courses (MOOCs) to provide free professional learning for teachers and a National Lending Library to provide new technologies to schools
2. the Digital Technologies in Focus program to provide support for 160 disadvantaged schools to assist them in implementing the Australian Curriculum: Digital Technologies
3. the Australian Digital Technologies Challenges series of free online teaching and learning activities for students in Years 3 to 8
4. the digIT series of summer schools targeting Year 9 and 10 students from under-represented groups to engage them in digital technologies and related careers
5. Digital Literacy School Grants that provided funding to 114 projects supporting innovative ways of implementing the Digital Technologies curriculum in schools.

Current STEM initiatives include \$4.8 million to extend and evaluate the STEM Professionals in Schools program by partnering teachers with STEM professionals to enhance STEM teaching practices and deliver engaging STEM education in Australian schools; and \$1.5 million for the Supporting Artificial Intelligence in Schools initiative, under the Australian Technology and Science Growth Plan, as part of the \$29.9 million Artificial Intelligence Capability Fund measure.

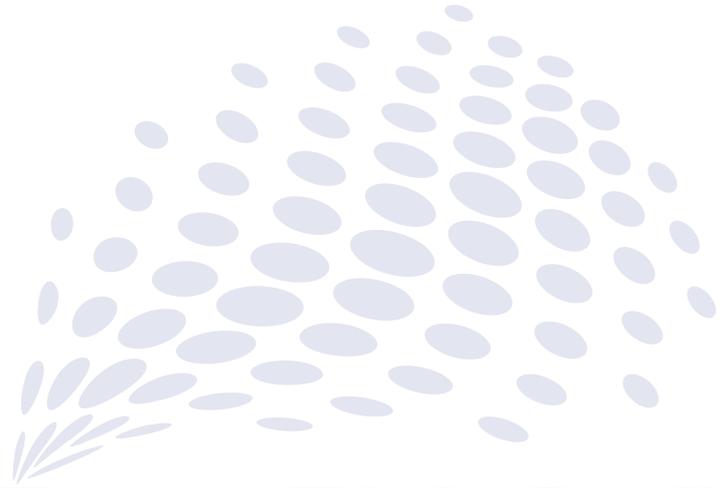
Recommendation 46: Australian Government Department of Education, Skills and Employment should include computer education as an item of national importance.

Recommendation 47: Australian Government Department of Education, Skills and Employment (DESE) should evaluate the implementation of the Australian Curriculum: Digital Technologies and direct support to those aspects of the implementation that do not meet DESE expectations.

THE AUSTRALIAN INSTITUTE FOR TEACHING AND SCHOOL LEADERSHIP

AITSL establishes teacher standards, accredits teacher education programs, and provides policy advice to school leaders.

14



Teacher education

Teacher education faculties and schools in the approximately 40 Australian universities engaged in teacher education are responsible for the preparation of Initial Teacher Education (ITE) students. This includes ensuring they graduate with sufficient digital literacy, thinking skills and digital technologies skills to be able to effectively teach the Australian Curriculum subject of Digital Technologies and senior secondary computing courses.

They also prepare ITE students to teach Digital Literacy – and develop their personal digital literacy, particularly in educational technologies – so they can effectively teach and operate in educational environments.

While education faculties are informed and constrained by the requirements of AITSL and other regulatory bodies, they prioritise areas of the curriculum through their curriculum and staffing decisions. As a result, there are inconsistencies in the quantum and quality of ITE student preparation.

Recommendation 48: *Teacher education faculties should ensure that academics preparing Initial Teacher Education students have sufficient digital literacy to engage and teach ITE students.*

Recommendation 49: *Teacher education faculties should ensure that academics preparing ITE students have sufficient experience with educational technologies to engage ITE students with the use of digital technologies in their teaching practice.*

Recommendation 50: *Teacher education faculties should ensure that academics preparing ITE students to teach Digital Technologies have a sufficient understanding of the curriculum and applied Digital Technologies skills (including programming).*

Recommendation 51: *Teacher education faculties should undertake the recommendations made in the Teaching Teachers for the Future (2013) report and the institution-specific recommendations made by the project officers employed by their faculties.*

Recommendation 52: *Building upon the Teaching Teachers for the Future project, educational faculties – through the Australian Council of Deans of Education, ACS, the Australian Technologies Teaching Education Network, the Australian Council for Computers in Education and the Australian Government Department of Education, Skills and Employment – should support a subsequent national project aimed at benchmarking and extending ITE programs in their development of digital literacy, educational technologies, digital technologies and thinking skills.*

With Digital Technologies now a required subject in all primary schools, all the approximately 6,328 primary qualified teaching graduates (as per ABS statistics) each year would be expected to be capable of teaching Digital Technologies to students from the first year of school to Year 6. With a workforce of 152,281 (2020) primary school teachers in 6,249 primary schools, this represents graduating a single new primary teacher for each of the country's primary schools, with a turnover of 4% of the primary teaching workforce each year. As a result, it will take several decades to upskill the country's teaching workforce to teach Digital Technologies by attrition.

In 2017 (AITSL, 2020), nationally, a total of 695 secondary ITE students were identified as completing undergraduate ITE programs to teach computer education, completing at least one specialisation to teach Digital Technologies to Years 7–10, with 109 completing at least two courses in preparation to teach senior secondary computing subjects. In addition, 593 completed postgraduate ITE programs, with 76 completing at least two courses preparing them to teach senior secondary computing subjects.

This represents an identified annual flow of approximately 1,300 teachers capable of teaching Digital Technologies to Years 7 to 10, with 185 prepared to teach senior secondary computing courses. In context, there were 959 mathematics and 211 physics teachers identified as completing these specialisations.

It should be noted that only 51% of all graduating secondary teachers reported their specialisations, with the remaining 49% being unidentified, but if similar proportions apply, Australia would have a total graduation rate of approximately 2,600 (37% of all secondary teacher graduates) teachers capable of teaching Digital Technologies to Years 7 to 10, with 370 (5% of all secondary teacher graduates) prepared to teach senior secondary computing courses, from a total pool of 6,947 teachers graduating nationally in 2017 to teach in secondary schools.

Again, in context, there were 2,796 secondary schools operating in Australia in 2020 (ABS, 2021), with ITE programs providing fewer than one graduate per school capable of teaching Digital Technologies each year, and substantially fewer graduates capable of teaching senior secondary computing courses.

ITE primary programs predominantly couple the teaching of Digital Technologies with Design and Technologies, and less commonly couple it with Science or Mathematics, or as a STEM or STEAM combination. This contrasts markedly with survey reports that indicate very few surveyed teachers integrate Digital Technologies with Design and Technologies, but this may be an artefact of the survey design, because Design and Technologies was not provided as a selection option (Appendix A, Table 9).

Most ITE programs prepare pre-service teachers to teach Digital Technologies as a distinct subject taught to all students. This was the case for 121 (53 primary and 68 secondary) from a total of 276 courses within ITE programs of 32 Australian higher education institutions (128 primary and 148 secondary) in a recent study (Blannin et al., 2021). Other ITE programs embed it within a more general subject taught to all students (30 primary, 16 secondary and 46 in total); teach it only to Digital Technologies specialists (23 primary, 26 secondary and 49 in total); or teach it as an elective subject (22 primary, 38 secondary and 60 in total; Blannin et al., 2021).

It is not clear the extent to which ITE courses focus on the teaching of computing concepts or on the application of Digital Literacy in the teaching of all learning areas, but in general, Digital Literacy programs would not provide the depth of learning that subject-specific courses provide for the teaching of Digital Technologies. They also would not necessarily provide for sufficient understanding of digital technologies to support teaching and meet AITSL's Australian Professional Standards for Teachers.

Recommendation 53: *The Australian Institute for Teaching and School Leadership (AITSL) should incorporate into ITE accreditation a requirement that ITE programs demonstrate their capacity to prepare students to:*

- 1. teach with digital technologies (as expected by AITSL standards)*
- 2. use digital technologies within all learning areas (including Digital Literacy development)*
- 3. teach the F–10 Digital Technologies subject and/or senior secondary computer education courses.*

These three aspects of ITE preparation should not be conflated, and it should be made clear to what extent each is addressed in ITE programs when they are considered for accreditation. This is in line with AITSL priorities of improved preparation and induction of teachers and leaders as they begin and progress through their careers, and the provision of stronger standards-based support for the development of quality teaching and leadership across Australia’s schools and early childhood settings, and through the career life cycle.

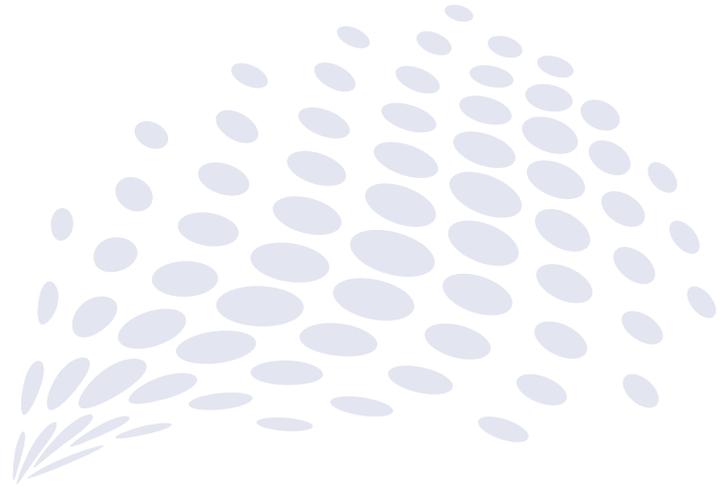
TEACHER STANDARDS

The Australian Professional Standards for Teachers (APST), developed by the AITSL (2018), details expectations of teachers in their use of digital technologies, and it provides some expectations for teachers to develop their own digital literacy.

There are currently, however, no Australian standards for teacher digital literacy beyond those described in the APST. By comparison, many other countries have continued to develop detailed standards not only for teachers in their digital literacy but also for school leaders, as well as standards to guide teachers in developing their own computational thinking (ISTE, 2021). AITSL has developed ICT Elaborations for Graduate Teacher Standards – (AITSL, 2011), but these are no longer published on the AITSL website.

Recommendation 54: *The Australian Institute for Teaching and School Leadership (AITSL) should revise the ICT Elaborations for Graduate Teacher Standards developed through the Teaching Teachers for the Future project to clarify expectations on the digital literacy of Australian teachers beyond that minimally detailed in the Australian Professional Standards for Teachers, with a particular focus on including computational thinking. This is in line with AITSL priorities of building on existing success to consolidate and extend national initiatives and the provision of stronger standards-based support for the development of quality teaching and leadership across Australia’s schools and early childhood settings, and through the career life cycle.*

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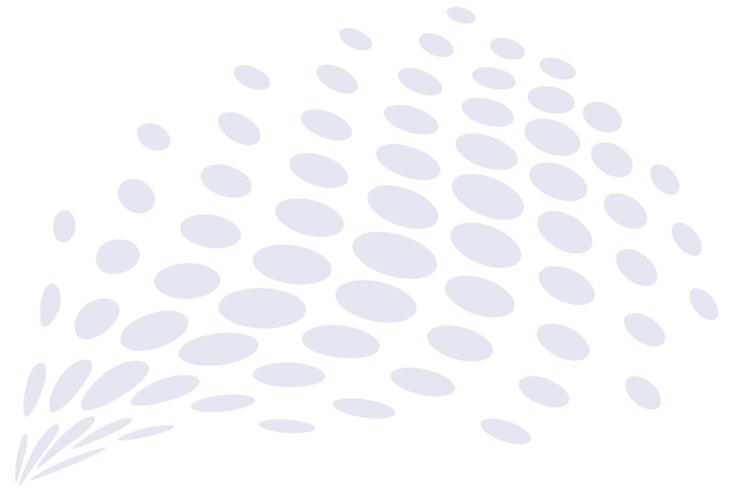


Beyond schools

In addition to state and federal initiatives to support Digital Literacy and Digital Technologies curricula, a range of additional programs provide support to students, teachers, schools and school systems. These include:

- university outreach programs, accelerated and early entry programs
- online academies such as Grok Learning and Code.org
- open source courses such as CSER Digital Technologies MOOC
- competitions such as Young ICT Explorers
- mentoring groups for female students such as the Tech Girls Movement Foundation
- industry mentoring programs such as the CSIRO STEM Professionals in Schools
- Digital Technologies professional teaching associations
- National STEM School Education Resources Toolkit, to assist schools in developing industry partnerships (dandolopartners, 2016).

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Future investigation

While this report is focused on the ACS (2021) response to the 2020/21 Australian Curriculum Review, several important areas remain for future investigation. Primarily, the implementation of senior secondary computing subjects in the final years of schooling needs to be investigated in greater depth to provide a full picture of computer education in Australian schools; state and territory comparisons should be explored in detail, and the equity of access to computer education should be fully investigated.

Recommendation 55: *Further investigation, supported by research, should be conducted into the implementation of senior secondary computing courses in each state and territory, and into the equitable access of Australian students to computer education, including issues of teacher training, schooling sector, regionality, gender, ethnicity and socioeconomic status.*

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APPENDIX A

ACS Computer Education in Australian Schools Survey (2020/2021) results

RATIONALE FOR THE SURVEY

When the new subject of Digital Technologies was endorsed in 2015, many teachers of Foundation to Year 8 students found they were struggling. Those teachers were not taught this subject in their own schooling (since it did not exist) and few were trained to deliver it. They can be labelled a 'cusp generation', learning Digital Technologies themselves as they taught it to their classes.

In 2017, at the State Library of Queensland, ACS hosted a meeting that predicted the need for 12,000 new technology professionals in Queensland by 2022 to meet the skill demand in the workforce. To meet this challenge, it was important schools provided appropriate training within the framework of the Australian Curriculum. A report on the meeting (ACS, 2018) noted:

In particular, primary school teachers are generalists in nature. They teach a range of disciplines, from maths and science, to English, history, sport and art. For many primary-trained teachers, the P-10 Digital Technologies Curriculum is completely new and is not necessarily something they have current skills or training in. Nor may they have the expertise they will need to teach the specialised content of the Digital Technologies subject.

In addition, a report from New South Wales (Curran et al., 2019) asked:

What resources need to be in place to support the teaching of computational thinking and coding in NSW and to what extent do we already have them?

Do we have sufficient understanding of the extent to which students are achieving proficiency in computational thinking, algorithmic thinking and familiarity with a range of contemporary technologies?

There were more worrying trends in a national survey by the Design and Technology Teachers' Association of Australia (DATTA, 2019). It predicted that by 2025 all schools would be using unqualified teachers to deliver technology education and half of schools would reduce teaching in this area due to the lack of suitable staff.

In August 2020, the Information and Communications Technology Educators Committee of the Australian Computer Society (ACS) saw a series of anecdotal reports which indicated that many senior secondary Digital Solutions courses in Queensland schools would not be offered in 2021 because of a lack of qualified teachers and low student enrolments.

This is a crucial course, contributing to university entrance and focused on creating with code, application and data solutions, digital innovation and digital impacts. Seeing this course diminish presented an early warning of serious impacts on the whole digital economy.

So, to get a better picture of how Digital Technologies is being implemented in Australian schools five years after it became part of the core Australian Curriculum, the ICT Educators Committee resolved to develop and distribute a survey. The COVID-19 pandemic delayed the project, but with the review of the curriculum coming up (ACARA, 2020b), we resolved to push ahead in the final term of 2020, with a further extension to 19 February 2021. The results of that survey are presented here.

POTENTIAL BIAS

The ICT Educators Committee noted that respondents to the survey may have been those with positive stories, and this may have affected the outcomes. Similarly, the Committee may have had a negative stance due to the reasons above, which we have striven to avoid in reporting the results.

It was obviously not a good time to circulate a survey to schools. Many schools had pivoted to online teaching during the pandemic, and many teachers had been subject to public health lockdowns. Staff were exhausted, and schools tended to focus on core activities. The initial public consultation period for the curriculum review was February to March 2021, so there was pressure to collect the data in time for it to be analysed prior to this. Luckily the review time line was amended just before Christmas 2020, and this allowed the extension of the data collection period.

In the survey results, 95% of respondents claimed they were aware of the difference between the Digital Technologies subject and ICT capabilities, while their estimate of the proportion of other teachers who understood the difference was 29%. This is worryingly low.

For the benefit of the reader, ICT as a general capability relates to student capacity to communicate, create and investigate while applying social and ethical protocols and managing and operating computers. The emphasis in ICT is on practical computer use. This has been in the Australian Curriculum since 2010 and is expected to be taught in all subjects.

Digital Technologies is a relatively new subject, focusing on creating digital solutions. It was only approved by the Education Council in 2015, so it is noteworthy that the bulk of teachers have failed to appreciate its introduction and distinctive nature.

SURVEY FINDINGS

The first task was to evaluate the sample of responding schools and determine the extent to which they represented the nation.

Table 1: Distribution of responding schools

Student Year	Number of responses	Total number of schools nationally	State/territory	Number of responses	Total number of schools in state
Combined schools (P/K/F–Year 10/12)	60	1,727	Australian Capital Territory	5	147
Primary (Years P/K/F–6/7)	112	6,434	New South Wales	41	3,361
Junior secondary (Years 7/8–10)	13	1,824	Northern Territory	1	202
Secondary (Years 7/8 –12)	111		Queensland	86	1,884
Senior secondary (Years 11/12)	11		South Australia	58	781
			Tasmania	17	279
TOTAL	307		Victoria	53	2,712
			Western Australia	45	1,206

The representativeness of the sample differed by state and territory, with $\chi^2 (7, n = 243) = 131.4, p = .000$. Australian Capital Territory, New South Wales, Northern Territory and Victoria were under-represented. Queensland, South Australia, Western Australia and Tasmania were over-represented.

Table 2: School categories

School category	Number of responses	Total number of schools nationally
Government/public	148	6,659
Independent	71	1,088
Catholic	80	1,756
Other	2	

With respect to school categories, the sample was under-representative of government schools $\chi^2 (3, N = 243) = 71.3, p = .000$.

TYPES OF DIGITAL TECHNOLOGIES CURRICULA

While the Australian Curriculum identifies Digital Technologies as a separate subject in the Technologies area, this is not followed by all state/territory jurisdictions. Therefore, it was appropriate to ask about the variation in terminology.

Respondents could pick more than one curriculum, so some schools are teaching a mainstream Digital Technologies subject (ACARA/national or state/territory version) alongside a VET/IB/Year 12 option. Through this report, we refer to 'Digital Technologies' to encompass all these curricula. The key take-away is that 98% of respondents say their school is teaching a mainstream Digital Technologies subject. This would accord with suspected respondent bias, that only schools with a positive view of the subject have responded. It would seem that very few schools where Digital Technologies is not taught have responded to the survey.

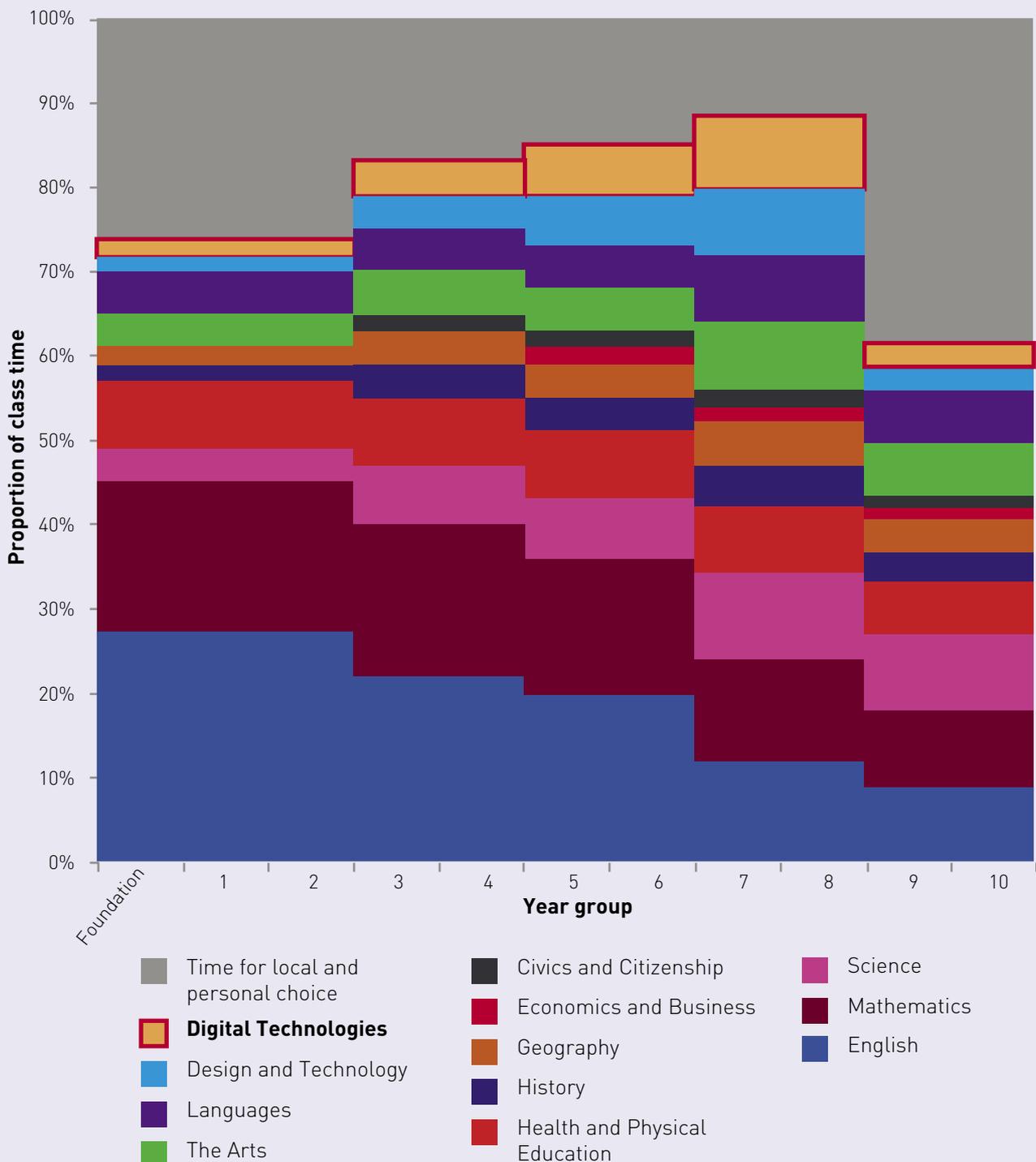
Table 3: Variations of Digital Technologies curricula

Which Digital Technologies/IT curriculum is taught at your school?	n	%
Digital Technologies ACARA national curriculum	169	55%
Digital Technologies state/territory curriculum	122	40%
International Baccalaureate (IB)	10	3%
Vocational education and training (VET) – Years 10, 11, 12 only	52	17%
Other (e.g. Steiner, QCAA Digital Solutions, SACE Digital Technologies)	14	5%

TIME SPENT LEARNING DIGITAL TECHNOLOGIES

In the design of the Australian Curriculum, a certain amount of design time was allocated to each learning area and subject. As the following figure shows, the design time for Digital Technologies starts with half an hour per week in Foundation to Year 2, then grows to just over two hours per week in Years 7 and 8. It becomes an optional subject in Years 9 and 10, and senior secondary specialism subjects take over for Years 11 and 12. It should be noted that although the Australian Curriculum expected 10% or more of contact time to remain free for other activities, general experience suggests the content has taken most teachers and schools more than the design time.

Figure 1: Design time for Australian Curriculum subjects



By weighting the central time in each interval by the number of responses, it was possible to find an average teaching duration for Digital Technologies in the sampled schools. Table 4 broadly indicates that where Digital Technologies is taught, the time devoted to it in class is compatible with the Australian Curriculum design time. This shows many schools have found it possible to do the subject justice.

Table 4: Hours per week for teaching Digital Technologies (or ICT or Information Technology)

Student Year	Australian Curriculum design time	Average teaching time from survey
P/K/F–Year 2	0.5	1.1
Years 3–4	1.1	1.4
Years 5–6	1.6	1.7
Years 7–8	2.1	1.9
Years 9–10	1.1	2.5
Years 11–12	N/A	3.1

REPORTING TO PARENTS/GUARDIANS

Nationally, 79% of schools report student progress on Digital Technologies to parents in the Foundation to Year 8 range, where the subject is specified for all students. This rises from 73% for students in the lower years (Foundation to Year 2) and becomes 84% for students in Year 7 to 8 (the last years for which the subject is specified as a required subject). In Years 9 to 12, this subject is an elective or optional subject, and reporting rates are therefore higher, at 86% for Years 9 to 10 and 82% for Years 11 to 12.

Table 5: Reporting of Digital Technologies to parents by state/territory

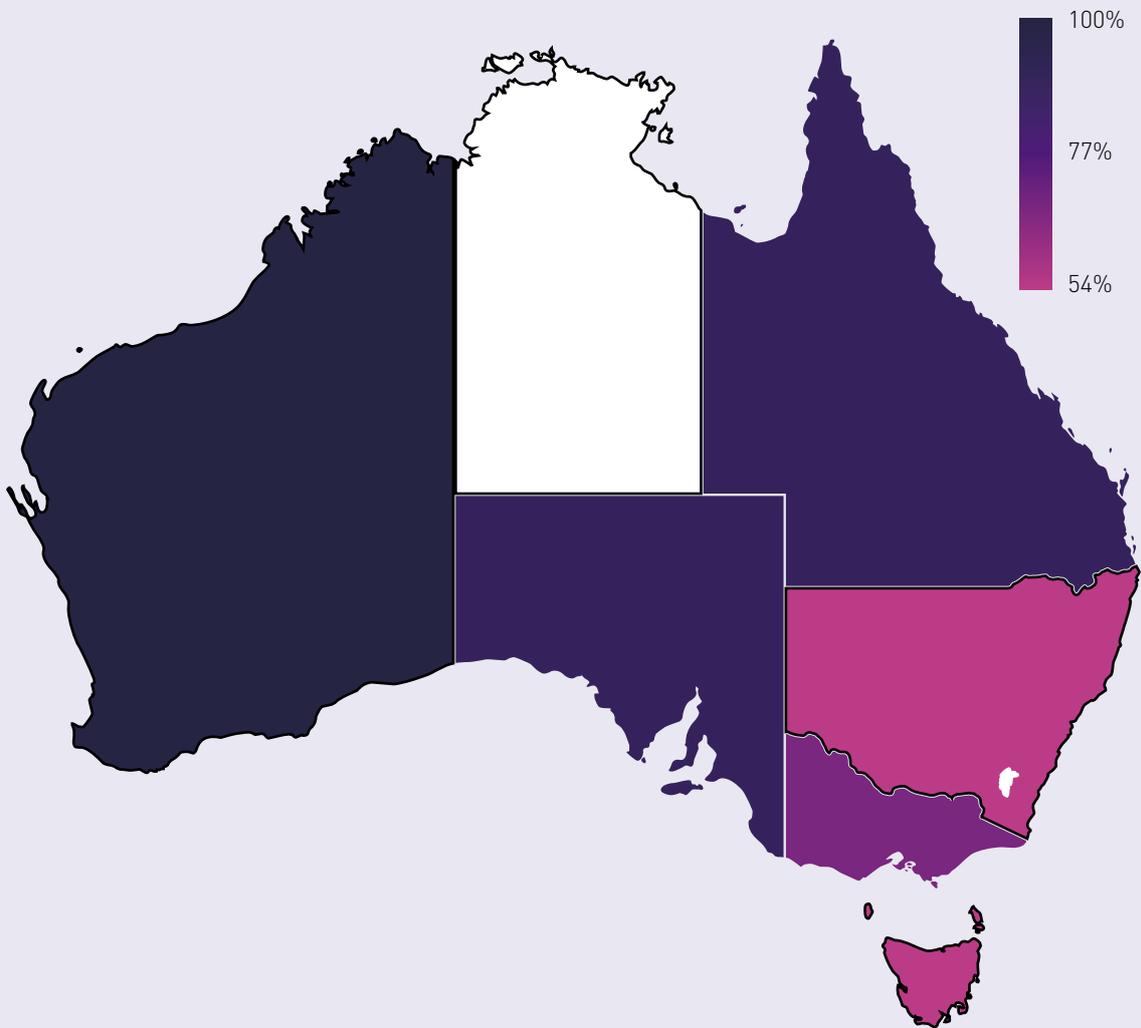
State/territory	Responses to this question	Currently reporting to parents/guardians (%)	Likely to change in next two years (%)	Not sure (%)
Australian Capital Territory	15	Too little data to report		
New South Wales	80	54%	15%	31%
Northern Territory	3	Too little data to report		
Queensland	205	86%	9%	5%
South Australia	142	85%	3%	12%
Tasmania	52	56%	17%	27%
Victoria	99	66%	16%	18%
Western Australia	106	95%	4%	1%

Table 5 clearly shows how actual implementation of the Digital Technologies subject varies greatly around the nation. Five states/territories have more than 80% compliance in reporting student progress to parents/guardians, and in two years it is expected seven jurisdictions will have 82% compliance or more.

However, only about half the schools in Tasmania and New South Wales are currently fully implementing the subject (as measured by reporting to parents/guardians). This is expected to reach 73% and 69% respectively by 2022. Part of the under-reporting to parents in New South Wales can be explained by the inclusion of Digital Technologies in the Science and Technology course syllabus (NSW Government Education Standards Authority, 2021) for students in F-6 (primary schools), and therefore reporting may occur in the Science area instead.

Figure 2: Map of compliance with reporting requirements

States/territories currently reporting student progress with Digital Technologies to parents/guardians (%)



Note: Northern Territory had too little data to report.

We also analysed the reporting of student achievement in Digital Technologies by school sector.

Table 6: Reporting of Digital Technologies to parents by school sector

School sector	Responses to this question	Currently reporting to parents/guardians (%)	Likely to change in next two years (%)	Not sure (%)
Government/public	31	55%	16%	29%
Independent	25	76%	20%	4%
Catholic	22	68%	18%	14%

Note: South Australian schools are excluded from these results due to data collection agreements.

This shows independent schools have a greater degree of reporting student achievement in Digital Technologies than Catholic or government schools.

DEVICES

Less than half (46%) of the schools reported running a bring-your-own-device (BYOD) program. Those that do operate such a program gave details on the student year groups where it operates. The percentages in the table relate to the percentage of all respondents.

Table 7: In which Years does BYOD operate, and with which kind of device?

Student year	Tablet	Laptop	Desktop	Mobile phone	No BYOD
P/K/F-Year 2	59%	22%	18%	0%	0%
Years 3-4	43%	39%	17%	0%	1%
Years 5-6	37%	45%	17%	0%	0%
Years 7-8	13%	60%	23%	4%	0%
Years 9-10	11%	59%	25%	4%	0%
Years 11-12	9%	59%	25%	5%	1%

Table 7 shows that BYOD policies are broadly spread, with tablets being replaced by laptop computers as students get older. There seems to be some allowance for mobile phones in high school or secondary school, but this is a very small proportion of the sample.

The survey also asked if 'mobile phones are currently banned in your school?' In total, 68% of respondents stated that they were banned in all years of schooling, while 25% said there were no such bans in place. Of the 7% of responses about partial bans, these were about divided evenly between primary years (2.4%) and high school/secondary years (2.8%).

INTEGRATION

There are opposing views on how Digital Technologies should be taught in schools. On one hand, as a new subject, it can be a struggle to achieve recognition if it is taught within another learning area. In fact, to do so can blur the distinctive character of Digital Technologies (creating digital solutions) from ICT (using computers). On the other hand, it can be argued that as few teachers have been trained to teach this new subject, a gentle modification of existing practices might be the best way to upskill them.

The survey asked: 'In your school, is the Digital Technologies/IT curriculum (state or national) taught and assessed as a separate subject, or is it integrated into other subjects?'

The responses were segregated by year group as seen in Table 8 below.

Table 8: The extent to which Digital Technologies is integrated or taught separately

Student year	Separate subject	Integrated into other subjects	Not taught at this year level
P/K/F-Year 2	39%	49%	12%
Years 3-4	47%	49%	4%
Years 5-6	50%	48%	2%
Years 7-8	69%	25%	5%
Years 9-10	76%	18%	5%
Years 11-12	72%	8%	21%

In primary years (Foundation to Year 6) there is a fairly even split between integrated teaching and discrete lessons for the new subject. We can see Digital Technologies is mostly a separate subject in high schools.

Where Digital Technologies is integrated into the teaching of other subjects, Science is the main choice. This is likely driven by the inclusion of Digital Technologies in the Science learning area for NSW schools. Other subject integration was described by respondents as follows:

Table 9: Integration of Digital Technologies teaching (283 schools)

Subject into which Digital Technologies is integrated	Percentage of responses	Subject into which Digital Technologies is integrated	Percentage of responses
Science	22%	The Arts (Media Arts, Visual Arts, Music etc.)	14%
Mathematics	19%	Health and Physical Education	5%
Humanities	15%	Languages	5%
English	15%	Other	5%

In the 'Other' category were Design and Technology, Engineering Design and STEAM (Science, Technologies, Engineering, Art and Mathematics). Some responses indicated the lack of awareness about Digital Technologies versus ICT.

SENIOR SECONDARY STUDENTS

From the previous analysis, we know that there were 168 responding schools with Year 11 and 12 students. Of those, 55% had no students enrolled in vocational education and training (VET) qualifications in the ICT training package.

Of those schools that were running VET courses in Digital Technologies/ICT/IT, 41% were a registered training organisation, and 59% used an external RTO. The qualifications offered ranged from Certificate I to Certificate III in Information, Digital Media and Technology.

Schools commented on the proportion of senior students who go on to study Digital Technologies/IT – related fields at tertiary level. Ninety-three per cent of respondents to this question said this was less than 25% of students or were unsure. Only in 7% of schools had more than a quarter of senior students go on to study the subject at tertiary level.

We also wanted to know what trends there might be in student interest in Digital Technologies.

Table 10: Trends in student interest in Digital Technologies/IT subjects or courses in Years 11 and 12

Staying fairly constant	49%
Decreasing	31%
Increasing	20%

It was good to see that in many schools, interest was staying fairly constant. However, in 31% of schools, interest was decreasing and there were few schools with a rising trend. This overall negative perception of Digital Technologies needs to be carefully considered and addressed.

STAFF EXPERTISE

The survey asked approximately what proportion of Digital Technologies/IT teachers are teaching outside their area of expertise (without formal qualifications in that subject). The response was collated by student year group, seen below in Table 10.

Table 11: Proportion of teachers of Digital Technologies working outside their area of expertise (109 to 136 schools responded, according to year group)

Student year	< 25%	25%–50%	51% – 75%	> 75%	Not applicable (Digital Technologies may not be taught)
P/K/F–Year 2	16%	4%	6%	52%	23%
Years 3–4	16%	6%	5%	52%	21%
Years 5–6	17%	9%	5%	49%	21%
Years 7–8	34%	21%	10%	24%	13%
Years 9–10	54%	14%	5%	15%	13%
Years 11–12	51%	7%	2%	10%	29%

As might be expected in the lower age groups, most teachers have no specific Digital Technologies training. As students grow older, they are increasingly taught by more skilled Digital Technologies teachers.

We also asked about teacher self-rated expertise and passion.

Table 12: Teachers' ratings of their expertise in and passion for Digital Technologies (106 to 132 responses according to student year group)

Student year	Self-rated teacher expertise in Digital Technologies				Self-rated teacher passion for Digital Technologies			
	Low	Moderate	Proficient	Not sure	Low/not passionate	Moderately passionate	Very passionate	Not sure
P/K/F-Year 2	21%	48%	26%	5%	16%	40%	29%	15%
Years 3-4	20%	41%	37%	2%	13%	40%	35%	12%
Years 5-6	17%	31%	50%	2%	8%	32%	49%	11%
Years 7-8	11%	31%	52%	6%	7%	44%	44%	5%
Years 9-10	3%	28%	65%	4%	2%	26%	68%	4%
Years 11-12	2%	20%	69%	10%	3%	17%	74%	7%

Teachers were quite upbeat about their expertise with Digital Technologies. For all student year groups, self-rated expertise was moderate or proficient for 75% or more teachers, rising with ages taught. Similarly, passion was reported by 69% of teachers for younger students taught, rising to 94% of those teaching Year 9 to 10 students.

Schools were asked about the Digital Technologies qualifications of teachers involved in delivering the subject. For each student year group, they were asked how many of the teachers had either an industry certificate (for instance, a Microsoft accreditation), a Certificate (level I, II or III), a Diploma, or a bachelor's or master's degree.

Table 13: Digital Technology qualifications of teachers of Digital Technologies by student age-group taught (85 to 135 responses depending upon student age group)

Student year	Industry certificate	Certificate	Diploma	Bachelor	Master	N/A
P/K/F-Year 2	1%	9%	3%	26%	6%	55%
Years 3-4	5%	9%	2%	25%	6%	53%
Years 5-6	5%	10%	3%	27%	9%	47%
Years 7-8	7%	9%	7%	58%	10%	8%
Years 9-10	7%	10%	9%	59%	10%	5%
Years 11-12	10%	10%	10%	50%	13%	8%

More than half (51%) of teachers delivering the Digital Technologies subject to students in Foundation to Year 6 had no qualification in this topic. Digital Technology qualifications in high schools and senior secondary were better, with 66% of teachers having a bachelor's or master's degree in the subject. It could be argued there is a need for each primary school to have at least one specialist teacher of Digital Technologies.

SOFTWARE PROGRAMS AND TOOLS FOR DIGITAL TECHNOLOGIES

The survey asked respondents to:

List three software programs/tools (or websites) students use most in their learning of Digital Technologies/IT over the entire year.

This question was analysed according to student year group.

We also wanted to know what trends there might be in student interest in Digital Technologies.

Table 14: Proportion of 10 most popular tools and websites used for Digital Technologies

Student year	Number strictly relevant to Digital Technologies	Number suited to all subjects (ICT)	Percentage of tools and websites strictly relevant to Digital Technologies/ Information Technology
P/K/F-Year 2	3	7	30%
Years 3-4	4	7	36%
Years 5-6	6	4	60%
Years 7-8	7	3	70%
Years 9-10	6	4	60%

More details on this are provided below, under 'Websites and tools nominated for teaching Digital Technologies'.

Only three of the top 10 tools nominated for Foundation to Year 2 were strictly relevant to learning in the Digital Technologies area. It is worrying that so many of the computer tools mentioned are instead suited to all subjects across the curriculum and represent the general capability of ICT.

In Year 3 to 4, Makers Empire is used for fashioning 3D printed objects. This was classified in both categories. At this, and all successive year levels, office suites (including word processors, spreadsheets and presentation applications) from Microsoft and Google dominated the rankings. These are general purpose software applications suitable for writing essays, presenting findings from internet searches and so on. They relate to the general ICT capability.

For Years 5 to 6, Scratch, Minecraft, Code.org and robotics form the core of relevant tools and websites for Digital Technologies.

In Years 7 to 8, Grok Academy and Python appear in the top 10. Grok is worthy of special mention, as this originated from the University of Sydney with a \$10 million Australian Government grant to provide professional learning for teachers of Digital Technologies. It appears that the funding was not renewed.

Digital Technologies is an option in Years 9 to 10, and therefore one might expect fewer students to be involved, but with more specialist teachers. Hardware like the Arduino microcontrollers are included in the top 10 list in this band, along with the Unity 3D gaming/virtual reality modelling system.

The middle range was Years 5 to 6, with 60% of the top 10 tools strictly relevant to Digital Technologies.

The data providing this snapshot was investigated more fully, going beyond the 10 most popular tools to classify all those listed. This involved deeper investigation of more unusual tools and websites. This involved some subjective judgements. For instance, how to classify 'Literacy Learning Apps' and 'Khan Academy'? The former are clearly associated with the English learning area, while the latter is famous for providing videos on a host of topics. However, the Khan Academy videos on programming/coding and other Digital Technologies content are very well known, so this website was classified as strictly relevant to the subject. Animation tools were not judged as strictly relevant to Digital Technologies, but the programming language Python was.

In this fuller analysis of nominated tools and websites, 123 items were assessed as strictly relevant to Digital Technologies, out of the total of 245. This implies 50.2% of the nominations were relevant to the subject, somewhat less than the proportion identified in the top 10. This process provided justification for the top-10 methodology, showing it is somewhat conservative.

COMMENTS FROM RESPONDENTS

The survey asked if there was any additional information that you would like to provide for this survey. A selection of comments is provided below.

Although I am employed to support the integration of IT/Digital Technologies, it is always an uphill battle as teachers feel pressure to fit so much into the curriculum. They value what I can provide, but they are feeling so pressured that they don't always provide the space necessary.

This comment illustrates the need to rewrite all areas of the curriculum to explicitly include subject-appropriate computer applications throughout, instead of overlaying generic computer skills as an ICT general capability.

The Digital Technologies curriculum is very heavy on jargon which makes it really hard for teachers with no formal expertise in that area to teach comfortably – it does in fact almost scare them away from teaching it. It would be good to have a curriculum in plain language (all key terms explained) and have links to places where teachers can find more information before they have to teach something.

This illustrates the 'cusp generation' aspects of the current teaching workforce. The 'jargon' is explained in the glossary of the curriculum document, but the curriculum is not easily accessible to many teachers who were not taught this subject when they were students at school themselves.

IT is still seen as a TOOL to help other curriculums, not a specialist subject area in itself. IT resources are often used more as babysitting tools and as a means to an end, rather than students being explicitly taught Digital Technology/IT skills.

This reinforces our finding that teachers and schools are largely failing to comprehend the difference between the general capability of ICT and the new Digital Technologies subject.

There are not enough teachers coming out of university to teach Digital Tech and Solutions. If our current teacher leaves, we won't be able to offer Digital Solutions at our school.

The training pipeline for a new skill such as this is about 7 years long (3 years for a bachelor's degree in IT, 2 for a master's in teaching, one year to become fully registered as a professional teacher and one year of professional experience). It has already been established Australia lacks IT professionals, and very few transition into the Master of Teaching because IT careers are far more lucrative and do not require the additional years of training.

There is a drastic shortfall in teachers who are being trained in coding. We have embraced teaching coding in the Technology Mandatory syllabus but have had to train ourselves. Very grateful to the team at ACARA and Grok Learning for their support.'

This echoes the UK findings by Sentance and Csizmadia (2016), who reported teachers' lack of subject knowledge was the greatest challenge faced when implementing this aspect of the computing curriculum. In the UK, teachers adopted these strategies to manage the situation:

1. unplugged type activities
2. contextualising activities
3. collaborative learning
4. developing computational thinking
5. scaffolding programming tasks.

The survey asked about information provided to parents. For schools including Year 11 and 12 students, the responses listed in Table 15 were received.

Table 15: School-parent interactions about Digital Technologies

Has the school surveyed parents/guardians regarding their attitudes to the Digital Technologies/IT curriculum in the last two years?	Yes	20
	No	108
Are there plans to survey parents/guardians regarding their attitudes to the Digital Technologies/IT curriculum?	Yes	16
	No	92
Does the school educate parents/guardians about any aspect of Digital Technologies/IT?	Yes	75
	No	54

As can be seen, schools had not engaged with parents regarding their attitudes to the Digital Technologies subject, but a majority had provided parents with information about it. This comment therefore resonates with the survey findings:

Parents/carers need to be more educated on ICT careers, as well as students and staff.

Two final comments expressed concern about non-teacher support for the new Digital Technologies subject:

The most difficult aspect of implementing IT in a school is the tiny number of hours we get of tech support. Our TSSP [Technical Support to Schools Program] hours have been halved over the past five years as student numbers have dropped, even though we have even more tech devices and tech issues in the school than ever before. There needs to be significantly more funding to keep schools up to date with the latest technology, and with a tech support person to keep it working.

Schools need to be funded for technology software and hardware.

The TSSP (Technical Support to Schools Program) in Victoria ‘provides specialist technicians to deliver onsite scheduled support for school and Department information and communication technology initiatives’. Every school is assigned a Service Delivery Manager and a weekly allocation of technical support hours.

The respondent expectation is that such support should be provided on a per device basis, rather than a per capita basis. While this is understandable, data on the number of devices may not be as easily available to central administrators as the numbers of enrolled students.

The final comment about school funding for information infrastructure embraces an important policy debate. Many public and commercial concerns provide laptops for staff, because they are widely recognised as tools of the trade. In addition, it has been speculated this equipment enhances productivity – the staff member can work from home (even when sick) and may choose to work longer hours in that comfortable environment (Rash, 2019). In addition, the staff member can in theory be contacted at any time – office attendance is not needed for an electronic memo to be circulated by email.

Could this logic extend to students? Insofar as students appear on the government balance sheet as costs rather than suppliers, one would say not. From an administrative point of view, the provision of digital technology to schools increases costs, and therefore requires justification. The Australian Curriculum is pivoting to require these tools to support basic education – but the pre-2021 version could largely be taught without them.

WEBSITES AND TOOLS NOMINATED FOR TEACHING DIGITAL TECHNOLOGIES

Table 16: The 10 most popular tools and websites used for Digital Technologies in F-Year 2

Tool and description	Incidence	Strictly relevant to Digital Technologies	Suited to all subjects (ICT)
Bee-Bot	17	✓	
ScratchJr	16	✓	
Seesaw	14		✓
Microsoft Office	8		✓
Reading Eggs	8		✓
Book Creator	7		✓
Code.org	6	✓	
ABCya!	3		✓
Canvas	3		✓
Google Suite	3		✓

Summary of word cloud analyses

Note: Total = 151.

Also mentioned were:

Apple Keynote, Blue-Bot, Google Classroom, Google Slides, LightBot, Literacy Planet, Makers Empire, Mathletics, Mathseeds, Matific, Microsoft Teams, OneNote, Osmo, Pages, Paint, PowerPoint, Typing Club, and Typing Tournament.

Table 17: The 10 most popular tools and websites used for Digital Technologies in Years 3–4

Tool and description	Incidence	Strictly relevant to Digital Technologies	Suited to all subjects (ICT)
Microsoft Office 365	29		✓
Scratch	16	✓	
Code.org	9	✓	
Google Suite	9		✓
Google Classroom	8		✓
Minecraft	8	✓	
Makers Empire	6	✓	✓
Mathletics	5		✓
Seesaw	4		✓
Book Creator	3		✓

Note: Total = 171.

Also mentioned were:

ABC Education, Adobe, Apple iMovie, Apple Keynote, Apple Pages, Apps, AR Makr, BBC Micro:bit, Bee-Bot, Canvas, Chrome Books, codeSpark Academy, Codey Rocky, Connect, Cool Math Games, CoSpaces Edu, Dash and Dot, Edison Programmable Robot, Flipgrid, GAFE, Google Docs, Google Sites, Grok Academy, Hopscotch, Hour of Code, Interland, internet, internet safety website, iPad apps for literacy and numeracy, Kodu, The Learning Place, Literacy Planet, Literacy-Learning Apps, MakeCode, Makey Makey, Mathigon, MathsOnline, Matific, Lego Mindstorms EV3 robots, OneNote Class Notebook, Padlet, Paint 3D, PicCollage, Pivot Professional Learning, Prodigy Education, QR codes, Reading Eggs, Reading Eggspress, Renaissance Accelerated Reader, Schoolbox, Showbie, Spelling City, Sphero, Tinkercad, Typing Tournament Online, Typing.com, TypingClub, and YouTube.

Table 18: The 10 most popular tools and websites used for Digital Technologies in Years 5– 6

Tool and description	Incidence	Strictly relevant to Digital Technologies	Suited to all subjects (ICT)
Microsoft Office	49		✓
Scratch	24	✓	
Minecraft	15	✓	
Google For Education apps	14		✓
Code.org	11	✓	
Tynker	9	✓	
Lego EV3 Mindstorms	8	✓	
BBC Micro:bit	7	✓	
Seesaw	7		✓
Google Classroom	6		✓

Note: Total = 245; 123 were strictly relevant to Digital Technologies (= 50%).

Also mentioned were:

Adobe, Alice 2, Apple iMovie, Apple Keynote, Apple Pages, AppShed, Audacity, BBC Bitesize, Bee-Bot, Bitsbox.com, Book Creator, Canvas, Chrome Books, Dash and Dot, Dash apps, digital printer, DoInk Suite, drones, Edison Programmable Robot, EdWare, eSmart Digital Licence, Essential Assessment, Explain EDU, Flipaclip, GAFE, GameMaker Studio, Google Classroom, Google G-Suite, Google Sites, Grok Academy, Hour of Code, Interland, internet, iPad apps for literacy and numeracy, Khan Academy, Kodu Game Lab, Learning Place, Literacy Learning Apps, Make Code, Makers Empire, Makey Makey, Mathletics, Maths Online, Microsoft 365 programs, Movie Maker, OneNote Class Notebook, Python, Reading Eggs, Reading Eggspress, ReadTheory, Renaissance Accelerated Reader, Schoolbox, SculptGL, Sphero, Studyladder, Swift Playgrounds, Typing Tournament, VEX Robotics, virtual reality headsets, Vocabulary.com, and YouTube.

Table 19: The 10 most popular tools and websites used for Digital Technologies in Years 7–8

Tool and description	Incidence	Strictly relevant to Digital Technologies	Suited to all subjects (ICT)
Microsoft Office	57		✓
Grok Learning	26	✓	
Scratch	22	✓	
Adobe Creative Suite	16		✓
Google Suite	15		✓
BBC Micro:bit	14	✓	
Python	14	✓	
Lego EV3 Mindstorms	12	✓	
Code.org (App Lab)	9	✓	
Minecraft	8	✓	

Note: Total = 321.

Also mentioned were:

aca.edu.au, Adobe Animate, Adobe Premiere Pro, Apple Keynote, Apple Pages, Apple resources, AppShed, Arduino, assorted coding websites, Audacity, AutoDesk CAD, BBC Bitesize, Blender, Blockly Games, Brackets, CAD, Cambridge HOTmaths, Canvas, ClickView, Cloud Stop Motion, Code with Mu, Codecademy, Connect (WA Department of Education LMS), Construct 3, CoSpaces Edu, CSS, Daymap, Education Perfect, Fusion 360, Game Maker, GIMP, Godot Engine, Google For Education apps, Google Classroom, Hacking with Swift, JavaScript, Khan Academy, Kodu, Komodo Edit, learning management system, Learning Place, library research tools, MakeCode Editor, Mathspace for Students, mBlock, Metaverse Studio, MicroPython, Microsoft Access, Microsoft Teams, My Computer Brain, Notepad, OneNote Class Notebook, online coding, Padlet, Photoshop, PI System Learning, Processing, PyCharm, Replit, robotics coding platform, Schoolbox, Scupltris, Sentral, SEQTA myEdOnline, SketchUp, Sphero, Stile, Swift Playgrounds, TASS, Thinkable, Tinker Learning, Tinkercad, Tynker, TypingClub, Unity, Visual Studio, we write our own, web technologies (HTML, web-based applications), Wix, Xcode, YouTube, and Zoom.

Table 20: The 10 most popular tools and websites used for Digital Technologies in Years 9–10

Tool and description	Incidence	Strictly relevant to Digital Technologies	Suited to all subjects (ICT)
Microsoft Office	66		✓
Python	29	✓	
Adobe Creative Suite and Dreamweaver	27		✓
Grok Learning	22	✓	
Google Suite	14		✓
Lego EV3 Mindstorms	13	✓	
Arduino	12	✓	
Unity	12	✓	
Canvas	6		✓
Code.org	5	✓	

Note: Total = 338.

Also mentioned were:

apps.diagrams.net, 3ds Max, Academy of Interactive Game Programming, Adafruit Circuit Playground Express, Adobe Animate, Adobe Illustrator, Adobe Photoshop, Adobe Premiere Rush, app development, App Lab +, Apple Design Resources, Apple Swift, assorted coding websites, Autodesk AutoCAD, Autodesk Maya, BBC Bitesize, BBC Micro:bit, Blender, CAD, Cambridge HOTmaths, Cisco cybersecurity course, ClickView, Code Academy, Code with Mu, CodeCombat, CodeHS, Connect (WA Department of Education LMS), Construct 2 and 3, CoSpaces Edu, databases, Daymap, Education Perfect, Fusion 360, FutureBASIC, Gamefoot, Game Maker, Gimp, Google Apps For Education, Hacking with Swift, Hour of Code, HTML, interactive Flash websites, JavaScript, Kahoot!, Khan Academy Computer Programming, Komodo Edit, Learning Management System, The Learning Place, library research tools, MakeCode Arcade, MAMP, Minecraft, MIT App Inventor, Notepad, online coding, PHP, Proto.io, Python Editor for Micro:bit, Python Tkinter, Python with Spike Prime, Raspberry Pi, Raspbian, Replit, robotics, Schoolbox, Scratch, Sentral, SQL, SQL Lite, Stile, TASS, Tello EDU, TextEdit, Tinkercad, Visual Studio, Visual Studio, Vortals, W3Schools, web-based applications, Xcode 13, YouTube, and Zoom.

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APPENDIX B

Recommendations grouped by organisation

AUSTRALIAN COMPUTER SOCIETY

Recommendation 8: Industry (through ACS) should provide guidance to schools and government on benchmarks based on industry-wide norms for computer education infrastructure investment, update cycles and support staffing.

Recommendation 10: Industry (through ACS) should provide guidelines on the expected qualifications for school technical support staff, ranging from junior IT support technicians to CIO leadership positions.

Recommendation 11: Industry (through ACS) should provide or support the development of professional training frameworks for qualification of school-based IT professionals.

Recommendation 12: Industry (through ACS) should provide professional pathway advice and encouragement for ACS members to enter school-based IT positions.

Recommendation 22: ACS should work with professional teaching associations to develop resources for schools to inform students, parents and careers advisers about state senior secondary computer education curricula, national Digital Technologies and Digital Literacy curricula, and associated career pathways in secondary, senior secondary and tertiary studies.

Recommendation 30: ACS, through Technical Committee 3 representation, should provide Australian support to international efforts to reach an agreement on a standard definition of computational thinking.

Recommendation 52: Building upon the Teaching Teachers for the Future project, educational faculties – through the Australian Council of Deans of Education, ACS, the Australian Technologies Teaching Education Network, the Australian Council for Computers in Education and the Australian Government Department of Education, Skills and Employment – should support a subsequent national project aimed at benchmarking and extending ITE programs in their development of digital literacy, educational technologies, digital technologies and thinking skills.

Recommendation 55: Further investigation, supported by research, should be conducted into the implementation of senior secondary computing courses in each state and territory, and into the equitable access of Australian students to computer education, including issues of teacher training, schooling sector, regionality, gender, ethnicity and socioeconomic status.

SCHOOLS

Recommendation 1: High schools and universities should introduce measures to assist students in transitioning from an outcomes-based education in schools to increasingly competency-based education in tertiary studies.

Recommendation 3: Schools and school systems should provide increased support for Digital Technologies teachers to obtain formal training and qualifications in Digital Technologies, with the aim of at least one teacher in every primary school having formal qualification in the teaching of Digital Technologies, all secondary Digital Technologies teachers having at least some formal training in a programming language, and all senior secondary Digital Technologies teachers having formal tertiary qualifications in a Digital Technologies field.

Recommendation 5: Government school systems and schools should use Digital Technologies initiatives and school achievement awards to signal to principals and teachers the importance of implementing Digital Technologies within their schools.

Recommendation 7: Schools should assess student Digital Literacy outcomes and reporting provided to parents. This should be coupled with parental awareness programs covering the elements of Digital Literacy that have been addressed during each year. This will inform the community of the general integration and academic use of digital technologies by teachers and the degree to which Digital Literacy outcomes are addressing cyber safety concerns.

Recommendation 9: Schools and school systems should implement annual equipment, software and network audits in line with industry-wide norms, to ensure frontline teachers have the requisite resources to effectively teach computer education subjects and the Digital Literacy curriculum.

Recommendation 13: Restrictions on the use of new technologies in schools should include plans to address the concerns raised by the technology through the Digital Technologies and/or Digital Literacy curricula.

Recommendation 14: Schools and school systems should develop innovation adoption plans to acknowledge that new technologies are always being introduced. They should systematise reasonable initial restrictions on the new technologies, manage associated disruptions, and transition in a timely manner to acceptable use. Then new technologies should be integrated into school professional learning processes and mainstreamed into schools and school systems with appropriate leadership, systems and technical support.

Recommendation 15: Schools and school leaders should focus on demonstrating systemic Digital Technologies learning initiatives rather than showcasing technological devices to parents as indicators of their successful integration of Digital Technologies.

Recommendation 19: Schools should audit the tools being used to teach Digital Technologies to ensure that students have a variety of experiences and learning contexts within the subject and that no single tool or approach is overused.

Recommendation 21: Schools should survey parents on their understanding of and attitudes to computer education, to identify potential bias and misconceptions.

Recommendation 23: Schools should provide parents with details of the new Digital Technologies and Digital Literacy curricula and information on associated career pathways in secondary, senior secondary and tertiary studies.

Recommendation 39: Schools and school systems should develop appropriate and systematic professional learning support programs to upskill all teachers in the Digital Literacy curriculum and all primary teachers and secondary teachers in the Digital Technologies curriculum.

Recommendation 40: Schools and school systems should conduct awareness campaigns for teachers on the resources available to support the teaching of the Digital Literacy and Digital Technologies curricula.

STATE EDUCATION SYSTEMS

Recommendation 3: Schools and school systems should provide increased support for Digital Technologies teachers to obtain formal training and qualifications in Digital Technologies, with the aim of at least one teacher in every primary school having formal qualification in the teaching of Digital Technologies, all secondary Digital Technologies teachers having at least some formal training in a programming language, and all senior secondary Digital Technologies teachers having formal tertiary qualifications in a Digital Technologies field.

Recommendation 4: States and territories should rigorously report to parents on student outcomes in the Digital Technologies subject, to provide a key initial indicator of their success in implementing the subject in their schools.

Recommendation 5: Government school systems and schools should use Digital Technologies initiatives and school achievement awards to signal to principals and teachers the importance of implementing Digital Technologies within their schools.

Recommendation 9: Schools and school systems should implement annual equipment, software and network audits in line with industry-wide norms, to ensure frontline teachers have the requisite resources to effectively teach computer education subjects and the Digital Literacy curriculum.

Recommendation 14: Schools and school systems should develop innovation adoption plans to acknowledge that new technologies are always being introduced. They should systematise reasonable initial restrictions on the new technologies, manage associated disruptions, and transition in a timely manner to acceptable use. Then new technologies should be integrated into school professional learning processes and mainstreamed into schools and school systems with appropriate leadership, systems and technical support.

Recommendation 24: State and territory authorities for the development of senior secondary computing curriculum should develop subjects that build upon the outcomes from the compulsory years of the Digital Technologies curriculum and provide recognition of study of the elective Years 9 and 10 Digital Technologies subjects.

Recommendation 37: ACS, in collaboration with Digital Technologies professional teaching associations through the Australian Council for Computers in Education and the Australian Institute for Teaching and School Leadership, should work towards the development of standards to guide teachers' skills in computational, design and systems thinking, and to incorporate the appropriate standards into the Australian Professional Standards for Teachers.

Recommendation 38: Education faculties and school systems should provide programs and professional learning for all teachers in computational, design and systems thinking capabilities.

Recommendation 39: Schools and school systems should develop appropriate and systematic professional learning support programs to upskill all teachers in the Digital Literacy curriculum and all primary teachers and secondary teachers in the Digital Technologies curriculum.

Recommendation 40: Schools and school systems should conduct awareness campaigns for teachers on the resources available to support the teaching of the Digital Literacy and Digital Technologies curricula.

Recommendation 41: State and federal education ministers should prioritise funding large systemic professional learning programs to support the teaching workforce to implement the Digital Literacy and Digital Technologies curricula.

PARENTS

Recommendation 4: States and territories should rigorously report to parents on student outcomes in the Digital Technologies subject, to provide a key initial indicator of their success in implementing the subject in their schools.

Recommendation 7: Schools should assess student Digital Literacy outcomes and reporting provided to parents. This should be coupled with parental awareness programs covering the elements of Digital Literacy that have been addressed during each year. This will inform the community of the general integration and academic use of digital technologies by teachers and the degree to which Digital Literacy outcomes are addressing cyber safety concerns.

Recommendation 15: Schools and school leaders should focus on demonstrating systemic Digital Technologies learning initiatives rather than showcasing technological devices to parents as indicators of their successful integration of Digital Technologies.

Recommendation 21: Schools should survey parents on their understanding of and attitudes to computer education, to identify potential bias and misconceptions.

Recommendation 23: Schools should provide parents with details of the new Digital Technologies and Digital Literacy curricula and information on associated career pathways in secondary, senior secondary and tertiary studies.

TEACHER EDUCATION

Recommendation 38: Education faculties and school systems should provide programs and professional learning for all teachers in computational, design and systems thinking capabilities.

Recommendation 48: Teacher education faculties should ensure that academics preparing ITE students have sufficient digital literacy to engage and teach ITE students.

Recommendation 49: Teacher education faculties should ensure that academics preparing ITE students have sufficient experience with educational technologies to engage ITE students with the use of digital technologies in their teaching practice.

Recommendation 50: Teacher education faculties should ensure that academics preparing ITE students to teach Digital Technologies have a sufficient understanding of the curriculum and applied Digital Technologies skills (including programming).

Recommendation 51: Teacher education faculties should undertake the recommendations made in the Teaching Teachers for the Future (2013) report and the institution-specific recommendations made by the project officers employed by their faculties.

Recommendation 52: Building upon the Teaching Teachers for the Future project, educational faculties – through the Australian Council of Deans of Education, ACS, the Australian Technologies Teaching Education Network, the Australian Council for Computers in Education and the Australian Government Department of Education, Skills and Employment – should support a subsequent national project aimed at benchmarking and extending ITE programs in their development of digital literacy, educational technologies, digital technologies and thinking skills.

UNIVERSITIES AND VOCATIONAL EDUCATION AND TRAINING

Recommendation 1: High schools and universities should introduce measures to assist digital technologies students in transitioning from an outcomes-based education in schools to increasingly competency-based education in tertiary digital technologies studies.

Recommendation 26: University computing faculties should proactively work with schools and professional teaching associations on F–12 Digital Technologies curriculum development to guide the development of computer education. They should assign at least one faculty member to the role.

Recommendation 27: University computing faculties should implement undergraduate program prerequisites for senior secondary school computer education courses or recognition of prior learning credit for introductory courses where students have completed senior secondary school computer education. Alternatively, university computing faculties should lobby to remove all prerequisites that provide an unfair competitive advantage to particular undergraduate programs.

Recommendation 28: VET course developers should proactively work with schools and professional teaching associations on F–12 Digital Technologies curriculum development to guide the development of Digital Technologies education in VET.

AUSTRALIAN GOVERNMENT DEPARTMENT OF EDUCATION, SKILLS AND EMPLOYMENT

Recommendation 6: Australian Government Department of Education, Skills and Employment should address the low rate of government schools reporting on Digital Technologies outcomes to parents nationally (55%), as this indicates that they need additional support and incentives through federal funding arrangements to meet their agreed obligations to the Australian Curriculum.

Recommendation 41: State and federal education ministers should prioritise funding large systemic professional learning programs to support the teaching workforce to implement the Digital Literacy and Digital Technologies curricula.

Recommendation 46: Australian Government Department of Education, Skills and Employment should include computer education as an item of national importance.

Recommendation 47: Australian Government Department of Education, Skills and Employment (DESE) should evaluate the implementation of the Australian Curriculum: Digital Technologies and direct support to those aspects of the implementation that do not meet DESE expectations.

Recommendation 52: Building upon the Teaching Teachers for the Future project, educational faculties – through the Australian Council of Deans of Education, ACS, the Australian Technologies Teaching Education Network, the Australian Council for Computers in Education and the Australian Government Department of Education, Skills and Employment – should support a subsequent national project aimed at benchmarking and extending ITE programs in their development of digital literacy, educational technologies, digital technologies and thinking skills.

DIGITAL TECHNOLOGIES PROFESSIONAL TEACHING ASSOCIATIONS

Recommendation 16: Digital Technologies professional teaching associations should provide increased professional learning focused on concept development rather than technologies.

Recommendation 37: ACS, in collaboration with Digital Technologies professional teaching associations through the Australian Council for Computers in Education and the Australian Institute for Teaching and School Leadership, should work towards the development of standards to guide teachers' skills in computational, design and systems thinking, and to incorporate the appropriate standards into the Australian Professional Standards for Teachers.

Recommendation 52: Building upon the Teaching Teachers for the Future project, educational faculties – through the Australian Council of Deans of Education, ACS, the Australian Technologies Teaching Education Network, the Australian Council for Computers in Education and the Australian Government Department of Education, Skills and Employment – should support a subsequent national project aimed at benchmarking and extending ITE programs in their development of digital literacy, educational technologies, digital technologies and thinking skills.

THE AUSTRALIAN CURRICULUM AND ASSESSMENT AUTHORITY

Recommendation 2: ACARA should develop processes to assess Digital Technologies thinking skills, either directly or through a formalised secondary process derived from content description outcomes.

Recommendation 18: ACARA should highlight where overlap exists between Digital Technologies outcomes and Digital Literacy outcomes, and provide guidance on how this is to be addressed to ensure that what is taught in Digital Technologies is complemented by what is taught in other subjects as they address Digital Literacy.

Recommendation 20: ACARA should clarify, through the Technologies 'general-purpose programming language' glossary entry or a more accessible location in the Digital Technologies curriculum, that while students need to engage with text-based languages in high school, their use is not limited to high school, nor are visual programming languages limited to use in primary school, as each can be used, depending on the concept being taught and the complexity of the problems being solved.

Recommendation 25: To guide state and territory curriculum development, ACARA should develop a national senior secondary computer education curriculum with the agreement of all states and territories, as has been achieved for English, Mathematics, Science, and Humanities and Social Sciences.

Recommendation 29: ACARA should clearly define computational thinking in the Australian Curriculum within an international context of competing definitions, so educators incorporating international educational resources understand that such resources may have been framed to support different approaches to computational thinking.

Recommendation 31: ACARA should rationalise the various descriptions of Computational Thinking contained in the Aims, Structure, and Glossary of the Digital Technologies curriculum to provide a single definition. The definition may be an amalgamation of various approaches to Computational Thinking.

Recommendation 32: ACARA should undertake to map computational thinking concepts and student ability to apply such conceptual understanding to the various Digital Technologies learning outcomes.

Recommendation 33: ACARA should include clear systems thinking opportunities with the Digital Technologies curriculum content descriptions.

Recommendation 34: ACARA should undertake to map systems thinking concepts and student ability to apply such conceptual understanding to the various Digital Technologies learning outcomes.

Recommendation 35: ACARA should include clear design thinking opportunities with the Digital Technologies curriculum content descriptions.

Recommendation 36: ACARA should undertake to map design thinking concepts, and student ability to apply such conceptual understanding, to the various Digital Technologies learning outcomes.

Recommendation 42: ACARA should develop mechanisms for increased flexibility in the inclusion of emerging technologies into the Digital Technologies curriculum between revision cycles. This could be achieved by including in each band's content description a statement that involves students exploring preferred futures and identifying and evaluating emerging technologies.

EDUCATION SERVICES AUSTRALIA

Recommendation 17: Education Services Australia, through the Digital Technologies Hub, should provide a resources search categorisation of either or both the Digital Technologies and Digital Literacies curricula, to assist teachers in understanding the tools and resources that can contribute to addressing their learning outcomes.

Recommendation 43: Education Services Australia (ESA) should continue to curate quality Digital Technologies education resources and develop more effective mechanisms for teachers, systems, academics and industry to contribute resources through an ongoing peer review process to ensure the currency of resources in line with pillars 3, 4 and 5 in the ESA strategic plan for 2021–23.

Recommendation 44: The Digital Technologies Hub provides a basic framework to support school leaders in implementing the Australian Curriculum Digital Technologies subject. However, with the difficulties many schools and school leaders are facing, a greater focus on resources and support for school and system leaders in implementing the curriculum is recommended in line with pillars 1 and 2 in the Education Services Australia strategic plan for 2021–23.

AUSTRALIAN INSTITUTE FOR TEACHING AND SCHOOL LEADERSHIP

Recommendation 37: ACS, in collaboration with Digital Technologies professional teaching associations through the Australian Council for Computers in Education and the Australian Institute for Teaching and School Leadership, should work towards the development of standards to guide teachers' skills in computational, design and systems thinking, and to incorporate the appropriate standards into the Australian Professional Standards for Teachers.

Recommendation 53: The Australian Institute for Teaching and School Leadership (AITSL) should incorporate into ITE accreditation a requirement that ITE programs demonstrate their capacity to prepare students to:

1. teach with digital technologies (as expected by AITSL standards)
2. use digital technologies within all learning areas (including Digital Literacy development)
3. teach the F-10 Digital Technologies subject and/or senior secondary computer education courses.

These three aspects of ITE preparation should not be conflated, and it should be made clear to what extent each is addressed in ITE programs when they are considered for accreditation. This is in line with AITSL priorities of improved preparation and induction of teachers and leaders as they begin and progress through their careers, and the provision of stronger standards-based support for the development of quality teaching and leadership across Australia's schools and early childhood settings, and through the career life cycle.

Recommendation 54: The Australian Institute for Teaching and School Leadership (AITSL) should revise the ICT Elaborations for Graduate Teacher Standards developed through the Teaching Teachers for the Future project to clarify expectations on the digital literacy of Australian teachers beyond that minimally detailed in the Australian Professional Standards for Teachers, with a particular focus on including computational thinking. This is in line with AITSL priorities of building on existing success to consolidate and extend national initiatives and the provision of stronger standards-based support for the development of quality teaching and leadership across Australia's schools and early childhood settings, and through the career life cycle.

THE AUSTRALIAN EDUCATION RESEARCH ORGANISATION

Recommendation 45: The Australian Education Research Association should identify computer education research as a priority area, given the scarcity of research on which significant curriculum decisions are being made, the impact Digital Technologies education is having on all primary teachers, and the significant impact of the new subject on secondary education with implications for students' further studies in ICT, which is a priority Australian industry.

Recommendation 55: Further investigation, supported by research, should be conducted into the implementation of senior secondary computing courses in each state and territory, and into the equitable access of Australian students to computer education, including issues of teacher training, schooling sector, regionality, gender, ethnicity and socioeconomic status.





ABOUT THE AUSTRALIAN COMPUTER SOCIETY

ACS is the professional association for Australia's technology sector. We represent technology professionals across industry, government, and education. Our aim is to grow the nation's digital skills and capacity.

ACS is here to support this strong demand by helping technology professionals:

Plan your career

Assess and profile your current skills, understand your competencies, get recognised as a Certified Professional and map your career plan.

Learn new skills online

Gain new skills across cyber security, cloud tech, AI, machine learning and more, with over 8000 flexible online videos and courses.

Grow your tech network

Meet the right people – network with other tech professionals as well as leaders from some of the biggest local and global organisations.

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Stay informed on industry trends and emerging technologies with over 200 events, masterclasses, research projects and case studies.

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Join mentoring programs designed to accelerate your career growth. ACS mentors are leaders who are here to help guide you.

Protect yourself

Stay protected with comprehensive liability insurance.

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On behalf of tech professionals ACS engages with media and policy makers on the issues affecting the technology sector, along with providing a range of resources to educators and industry to boost the nation's digital capabilities and competitiveness.

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