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ACS response to the 2020/21 Australian Curriculum Review

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The importance of Digital Technologies

The endorsement of the Digital Technologies curriculum in 2015 was a critical moment for Australian education. With so many jobs of the future requiring high technical skills, it was imperative that the Australian education system prepare students for that future, and the new National Curriculum was designed to meet those needs.

Critically, it broadly recognised that the ability to use computers was not the same as the ability to engage with computers. Many parents think their children are technical wunderkinds because they know the ins and outs of using computers and mobile devices, simply because they grew up with those devices. But use of and engagement with technology are not the same things.

The history of tertiary enrolments in IT courses in Australia is instructive: familiarity with technology does not automatically equate to a higher chance to pursue a technology career. The capacity to practically use technology (what are referred to as 'ICT skills' or 'digital literacy') is not the same as actual creative engagement with technology (the focus of Digital Technologies education). The former is a valuable life skill, applicable in a broad range of fields; the latter leads to careers in technology.

Australia is desperately in need of people who choose careers in technology. In the next five years alone the nation will need 156,000 new technology workers (ACS, 2020), and we're currently nowhere near filling that quota domestically. In 2019, for example, there were less than 7,000 IT degree course completions nationally by domestic students.

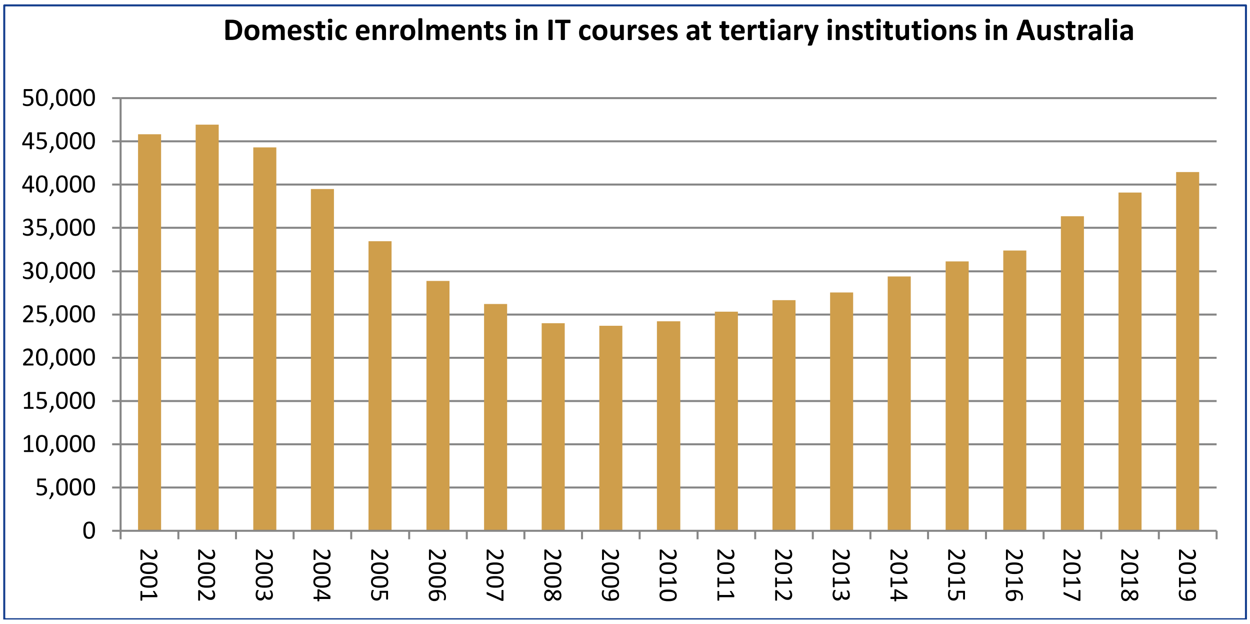


Figure 1: Domestic enrolments in IT courses at tertiary institutions in Australia (source: Department of Education uCube.)

Although more children were growing up with technology skills, between 2001 and 2010 we saw a sharp decline in the number of students pursuing technology careers through tertiary education. Fortunately, there has been an uptick since (to just over 41,000 enrolments in 2019), but the numbers are still below their peak. It's impossible to say yet what kind of impact the Digital Technologies curriculum has had on these numbers, since the program is only six years old and has had teething issues, especially with getting teachers and other educators up to speed on the curriculum.

A look at the proposed 2021 changes to the Curriculum

On 29 April 2021, ACARA published a set of proposed changes to the current Curriculum. In general (with a few exceptions) the ACS ICT Educators Committee believes that these are excellent changes and additions to the curriculum, refining its focus, clearing up wording and defining a better education pathway for students of Digital Technologies.

Appendix 1 presents a quick breakdown of notes by Content Descriptor, but more broadly the Educator's Committee had the following notes on the proposed changes:

1. The separation of Foundation material from 1-2 is a welcome improvement.
2. Moving binary from Year 7-8 to 5-6 is also welcome, indicative of the seriousness in which the subject is regarded.
3. In Years 7-8, AC9TDI8P12 confounds project management with online publication. These topics should be separated, since they're very different disciplines.
4. 42% of the Content Descriptors appear to show an improvement in clarity and focus (see Appendix 1).
5. The number of Content Descriptors for Digital Technologies has grown by 65% (from 43 to 71), reflecting advances in the field. Will this require more classroom time? A review of the total Digital Technologies design time may be in order.
6. The term "user stories" appears through the proposal. It occurs in about ten of the proposed Content Descriptors. Without a Glossary, it may be difficult to interpret this critical term.
7. There may be some tension between the lack of teacher Digital Technologies skills and the use of sometimes broad language designed to make the curriculum future-proof. The use of more explicit and direct language will probably help teachers to identify what should be taught.
8. School administrators and teachers already confuse the ICT general capability with the Digital Technologies subject. Renaming the former to Digital Literacy may perpetuate this confusion.
9. "Creative commons" has entered Digital Literacies. This is a welcome change which provides a suitable counterpoint to the prior emphasis on protecting the rights of intellectual property owners.
10. Programming/coding has declined from 14% to 8% of Content Descriptors, which is in contrast to the increasing interest in this topic overseas. Although visual, general purpose and object-oriented programming/coding are included, there is no mention of non-deterministic programming. Given recent government funding initiatives, artificial intelligence/machine learning[1] and quantum computing might well be included in the Year 9-10 curriculum.

Based on these responses and the results of the ACS Computer Education in Australian Schools Survey (2020/2021) (attached here as Appendix 2), ACS has a set of five recommendations for ACARA to consider during this review. Some of these relate to the proposals of the Curriculum Review, but others are more general in nature and deserve attention from the Australian Government Department for Education and all similar State/Territory departments.

[1] See Machine Learning for Kids (IBM) at https://machinelearningforkids.co.uk

Recommendations

Recommendation 1: Make Digital Technologies part of the core curriculum in all schools

With jobs related to digital technologies being critical to the future of the nation as well as being highly in demand for graduating students, we would recommend that Digital Technologies' place in the core curriculum be implemented in all schools.

We also believe that the guidelines for schools should be made more explicit and less open to interpretation by state education systems and schools. Students should be engaging with Digital Technologies in each year level for at least one term (or equivalent).

Although outside the direct scope of this review, we would also recommend the inclusion of Digital Technologies in NAPLAN testing. This can encourage uptake and engagement in the subject by schools, teachers, students and parents alike. ICT literacy has been a part of the National Assessment Program since 2002[2] with samples of Year 6 and Year 10 students participating. This sampling could be switched to Digital Technologies, and by 2024 could be included in the more general biannual assessment program.

Recommendation 2: Encourage teacher training in Digital Technologies

While we recognise that teacher training is outside the purview of ACARA and the National Curriculum, we believe the organisation can help, both by providing guidance on self-training and lesson plans as well as encouraging schools and government bodies to upskill teachers to meet the requirements of the subject.

More than anything when it comes to Digital Technologies, training of teachers is a huge challenge. For new teachers, this needs to be addressed at the tertiary teacher training level otherwise this problem will continue. There is an urgent need to attract teachers to train as Digital Technologies teachers and to train teachers already in schools who lack knowledge and understanding of this area.

There are teachers in schools who have no knowledge of Digital Technologies yet are delivering the curriculum. At the classroom level, the curriculum is then adjusted (unit plans) to what the teacher knows or is comfortable teaching from the plethora of concepts included in the Australian Curriculum. We are short-changing the students, and in the long run the ICT/ Digital Technologies -related industries.

Recommendation 3: Clarify and communicate Digital Technologies and digital literacies

As we noted above, one of the critical problems in the curriculum is the distinction between the general capability of using computers (ICT/digital literacy) and the creative use of digital tools for building digital solutions (Digital Technologies). This is emphasised by the results of the survey in Appendix 2 that show many teachers are using tools like office suites and image editors in Digital Technologies education rather than coding and creation tools.

The slow take up and reporting on the new Digital Technologies subject can be partly ascribed to this confusion. In the survey report, the subject is integrated into other subjects in about half of Australian primary schools. Teachers in such schools are therefore blending both ICT/digital literacy and also Digital Technologies into other subjects. Principals in these schools should be able to answer questions like:

[2] https://www.nap.edu.au/nap-sample-assessments/ict-literacy

- How much class time is allocated to the Digital Technologies subject through the year?
- What is the consistent method by which student learning achievement in Digital Technologies is monitored and reported across the school?
- Do you publish the proportion of students in each year group that attain a satisfactory level of learning achievement in Digital Technologies each year?

For educational leaders, principals and teachers to effectively deliver the subject, they need to have the distinction between ICT/digital literacies and the Digital Technologies subject clarified and communicated. This communication should include parents, where the similar proposed terminologies can cause misunderstanding.

Other countries have solved this issue by writing appropriate software tools into each subject curriculum and eliminating the ICT/digital literacy capability. This is beginning to happen in Australia (see for instance AC9M2SP03 – specifying dynamic geometric software in Mathematics). Another approach is to see that digital technology fundamentally changes the curriculum (for instance, to what extent are positive Google Translate skills embedded in the Languages?). However, Australia is not yet at this point.

Recommendation 4: A clearer focus on computational thinking including coding

The key concept in the Digital Technologies Curriculum is ‘creating digital solutions’. Computational thinking is fundamental to the subject. Computational thinking is defined as a “process of recognising aspects of computation in the world and being able to think logically, algorithmically, recursively and abstractly”. The way digital solutions are to be created in the subject is through “using combinations of readily available hardware and software applications, and/or specific instructions provided through programming”. It is quite clear from this language that coding or programming is just one of the methods students can employ.

To put programming/coding into context in the Australian Curriculum, it is useful to establish the format used. For each age range there is a description, a list of content descriptors (with elaborations) and the assessable achievement standards. Table 1 shows the proportion of content descriptors in each age range where programming or coding is mentioned.

Table 1: Proportion of coding in the Australian Digital Technologies subject

Student Years	Total Content Descriptors	Content Descriptors including programming or coding	% of coding in the subject
F - Year 2	6	0	0%
Years 3-4	7	1	14%
Years 5-6	9	2	22%
Years 7-8	10	1.5	15%
Years 9-10 (optional)	11	1.5	14%

Programming/coding is first mentioned with respect to visual programming in a content descriptor (AC9TDI4P04) in the elaborations for Years 3 and 4 and in the achievement standards. Visual programming is a way of coding using coloured shapes on the screen. This recurs in Years 5 and 6 (AC9TDI6P05)

By Years 7 and 8, general-purpose programming/coding languages are mentioned in the description, and this occurs for the first time in content descriptors (AC9TDI8P09) at this level. “Use of a programming language” is also mentioned in the Achievement Standards, so students are to be assessed on their programming skills for the first time once they reach this age (high school). In Years 9 and 10 (where Digital Technologies becomes an optional subject), we now see object-oriented programming/coding in the description, in two content descriptors (AC9TDI10P09), and in the achievement standards.

Overall, the curriculum design has students progressing through the core F-8 Digital Technologies subject by visual coding in Years 3-6 and only undertaking general purpose programming/coding in Years 7 and 8.

In other countries, we see a different perspective on computer education in schools. In Singapore, for example, coding classes for primary school students were mandatory from the start of 2020 (Tan, 2019). The initiative aims to develop an early appreciation of computational thinking and coding concepts—through simple visual programming.

For Australia, we believe there is an increased need for a foundation on computational thinking and coding at all levels, especially the upper junior, middle, and senior school curriculum. As of now, it still shows a greater emphasis on teaching computational and programming/coding concepts in the higher junior school years. However, this decreases in the middle and senior school. We believe it should be similar across all stages.

The Australian Digital Technologies Curriculum also highlights, via the content descriptors for each stage, a mismatch where teachers in the junior school who are not trained in programming have more to deliver in this aspect compared to the specialist Digital Technologies teachers in the senior school who have a lesser requirement to do so, yet are required to be highly trained in this.

Recommendation 5: The inclusion of emerging and disruptive technologies in the curriculum

Digital Technologies is arguably the most rapidly evolving field in education today. We would recommend more regular reviews of the curriculum, with a focus on integrating new and disruptive technology in the platform.

For example, a current focus can include smartphones, artificial intelligence (AI), virtual or augmented reality (VR/AR), the internet of things (IoT), blockchain technology, eCommerce and collaboration platforms. All Australian students should at least have awareness of these.
The ACS has identified the following areas as important technological advances which should be debated and monitored:

- Blockchain
- Artificial intelligence
- Cyber security
- Quantum communications and computing
- Cloud-based services

In our recent survey of schools (Appendix 2), when asked “What emerging/disruptive technologies are utilised in the teaching of Digital Technologies/IT in your school?” there were relatively few responses. Robots are popular (56% of schools) but blockchain was only mentioned in 1% of schools.

It is clear that more could be done in schools to embrace these innovations which are becoming economically more important year on year. The low uptake of non-deterministic computing (artificial intelligence and quantum computing) is of particular concern.

Table 2: Emerging and disruptive technologies in schools

Emerging/disruptive technology	Count	% (of 307 survey responses)
Robotics	172	56%
3D printing	140	46%
Cloud computing	91	30%
Virtual reality/augmented reality	88	29%
Drones	83	27%
The internet of things	66	21%
Artificial intelligence	53	17%
Wearable technology	36	12%
None/not applicable	22	7%
Blockchain	4	1%

Conclusion

Based on the anecdotal experience of teachers as well as the results of a nationwide survey of schools, it's clear that the Digital Technologies curriculum is having a positive impact, but there's still a way to go with respect to refining the curriculum and implementing it.

In particular, the distinction between *using computers* (digital literacy) and *creating with technology* (Digital Technologies) needs to be more clearly defined in the curriculum, which would clear up some of the confusion and improve the implementation of Digital Technologies curricula nationwide.

There are other areas to address, of course. Teacher training and availability; student perception and equipment are all issues that need to be looked at – but we can start with the curriculum in this review, and give Digital Technologies the kind of clarity and consistency that most other subjects enjoy.

Appendix 1: A breakdown review of the proposed changes to Content Descriptors in the Australian Curriculum – Digital Technologies

Year Range	***OLD***	***Proposed***		***Difference***
F-2	Recognise and explore digital systems (hardware and software components) for a purpose (ACTDIK001)	F	Recognise and explore digital systems (hardware and software) and how they can be used to solve simple problems (AC9TDIFK01)	Better: more nuanced for Foundation students.
		1-2	Identify and explore digital systems and their components for a purpose (AC9TDI2K01)	
F-2	Recognise and explore patterns in data and represent data as pictures, symbols and diagrams (ACTDIK002)	F	Represent data as objects, pictures and symbols (AC9TDIFK02)	Better: useful F/1-2 distinction and more direct language.
		1-2	Represent data as pictures, symbols, numbers and words (AC9TDI2K02)	
F-2	Collect, explore and sort data, and use digital systems to present the data creatively (ACTDIP003)	<moved to Maths - Statistics>		Better: eliminates duplication.
F-2	Follow, describe and represent a sequence of steps and decisions (algorithms) needed to solve simple problems (ACTDIP004)	F	<nil>	Worse: F students can benefit from using a Beebot or similar to plan a sequence. 'Investigate' is a vaguer term.
		1-2	Investigate simple problems for known users that can be solved with digital systems (AC9TDI2P01)	
F-2	Explore how people safely use common information systems to meet information, communication and recreation needs (ACTDIP005)	F	<nil>	About the same: but "explore" might be better than "discuss", since the latter can be done without computer use.
		1-2	Discuss how existing digital systems satisfy known user needs (AC9TDI2P03)	
F-2	Create and organise ideas and information using information systems independently and with others, and share these with known people in safe online environments (ACTDIP006)	F	<nil>	Better: taking F students away from online communications is probably a good idea. More explicit language in 1-2 is better.
		1-2	Create and locate content and communicate with others using common tools and their basic functionality (AC9TDI2P04)	

Year Range	*OLD*	*Proposed*	*Difference*
		Share information with known people following agreed behaviours, supervised by trusted adults (AC9TDI2P05)	
F	<nil>	Identify some data that are personal and owned by them (AC9TDIFP01)	Better: a good inclusion.
1-2	<nil>	Access their school account with a recorded username and password to access their own information (AC9TDI2P06)	Better: a good inclusion.
1-2	<nil>	Discuss that some websites and apps store their personal data online (AC9TDI2P07)	Better: a good inclusion.
3-4	Identify and explore a range of digital systems with peripheral devices for different purposes, and transmit different types of data (ACTDIK007)	Explore and describe a range of digital systems and their peripherals for a variety of purposes (AC9TDI4K01) Explore transmitting different types of data between digital systems (AC9TDI4K02)	Better: clearer.
3-4	Recognise different types of data and explore how the same data can be represented in different ways (ACTDIK008)	Recognise different types of data and explore how the same data can be represented differently depending on the purpose (AC9TDI4K03)	Better: refined language clarifies the Content Descriptor.
3-4	Collect, access and present different types of data using simple software to create information and solve problems (ACTDIP009)	<moved to Maths - Statistics>	About the same.
3-4	Define simple problems, and describe and follow a sequence of steps and decisions (algorithms) needed to solve them (ACTDIP010)	Define problems with given design criteria and by co-creating user stories (AC9TDI4P01) Follow and describe algorithms involving sequencing, comparison operators (branching), and iteration (AC9TDI4P02) Generate, communicate and compare designs (AC9TDI4P03)	About the same. Suggest AC9TDI4P03 replace “designs” with “algorithm designs”.
3-4	Implement simple digital solutions as visual programs with algorithms involving branching (decisions) and user input (ACTDIP011)	Implement simple algorithms as visual programs involving control structures, variables and user input (AC9TDI4P04)	Better.

Year Range	*OLD*	*Proposed*	*Difference*
3-4	Explain how student solutions and existing information systems meet common personal, school or community needs (ACTDIP012)	Discuss how existing and student solutions satisfy the design criteria and user stories (AC9TDI4P05)	Worse: discussing is not as good as doing. Eliminating the ethical dimension avoids overlap with ICT/DL.
3-4	Plan, create and communicate ideas and information independently and with others, applying agreed ethical and social protocols (ACTDIP013)	Create, locate and edit content and communicate with others selecting and using common tools and their core functionality and following agreed conventions to name files (AC9TDI4P06)	Better.
		Share information and collaborate with others demonstrating agreed behaviours, guided by trusted adults (AC9TDI4P07)	
3-4	<nil>	Access their school account using a memorised password and explain why it should be easy to remember, but hard for others to guess (AC9TDI4P08)	Better.
3-4	<nil>	Identify what personal data is stored and shared in their online accounts and discuss any associated risks (AC9TDI4P09)	Better.
5-6	Examine the main components of common digital systems and how they may connect together to form networks to transmit data (ACTDIK014)	Investigate the main internal components of common digital systems and their function (AC9TDI6K01)	Better: clearer.
		Examine how digital systems form networks to transmit data (AC9TDI6K02)	
5-6	Examine how whole numbers are used to represent all data in digital systems (ACTDIK015)	Explain how digital systems represent all data using numbers (AC9TDI6K03)	Better: clearly introduces binary.
		Explore how data can be represented by off and on states (zeros and ones in binary) (AC9TDI6K04)	
5-6	Acquire, store and validate different types of data, and use a range of software to interpret and visualise data to create information (ACTDIP016)	<moved to Maths - Statistics>	Worse: what about non-numerical data (e.g. text and visual/video)?

Year Range	*OLD*	*Proposed*	*Difference*
5-6	Define problems in terms of data and functional requirements drawing on previously solved problems (ACTDIP017)	Define problems using given or co-developed design criteria and by creating user stories (AC9TDI6P01)	About the same: the continuing limitation to stories could be restricting.
5-6	Design a user interface for a digital system (ACTDIP018)	Design a user interface for a digital system (AC9TDI6P03)	About the same.
5-6	Design, modify and follow simple algorithms involving sequences of steps, branching, and iteration (repetition) (ACTDIP019)	Design algorithms involving multiple alternatives (branching) and iteration (AC9TDI6P02)	About the same. Suggest AC9TDI6P04 replace “designs” with “algorithm designs”.
		Generate, modify, communicate and evaluate designs (AC9TDI6P04)	
5-6	Implement digital solutions as simple visual programs involving branching, iteration (repetition), and user input (ACTDIP020)	Implement algorithms as visual programs involving control structures, variables and user input (AC9TDI6P05)	About the same: replacing “digital solutions” with algorithms and programs is a good move.
5-6	Explain how student solutions and existing information systems are sustainable and meet current and future local community needs (ACTDIP021)	Evaluate existing and student solutions against the design criteria and user stories and their broader community impact (AC9TDI6P06)	Better.
5-6	Plan, create and communicate ideas and information, including collaboratively online, applying agreed ethical, social and technical protocols (ACTDIP022)	Create, locate and edit content for, and communicate with, a specific audience, selecting appropriate tools and using their advanced functionality and storage conventions (AC9TDI6P07)	About the same.
		Share information, plan and collaborate with others demonstrating ethical and agreed behaviours, supported by trusted adults (AC9TDI6P08)	
5-6	<nil>	Access multiple personal accounts using unique passphrases and explain the risks of password re-use (AC9TDI6P09)	Better: might help to introduce password managers.
5-6	<nil>	Explain the creation and permanence of their digital footprint and consider privacy when collecting user data (AC9TDI6P10)	Better: a good inclusion.

Year Range	*OLD*	*Proposed*	*Difference*
7-8	Investigate how data is transmitted and secured in wired, wireless and mobile networks, and how the specifications affect performance (ACTDIK023)	Explain how hardware specifications affect performance and select appropriate hardware for particular tasks and workloads (AC9TDI8K01) Investigate how data is transmitted and secured in wired and wireless networks including the internet (AC9TDI8K02)	Better: differentiating between local and network hardware/performance helps be more explicit about what is to be taught.
7-8	Investigate how digital systems represent text, image and audio data in binary (ACTDIK024)	Investigate how digital systems represent text, image and audio data using integers (AC9TDI8K03) Explain how and why digital systems represent integers in binary (AC9TDI8K04)	Better: more explicit.
7-8	Acquire data from a range of sources and evaluate authenticity, accuracy and timeliness (ACTDIP025)	Acquire, store and validate data from a range of sources using software, including spreadsheets and databases (AC9TDI8P01)	About the same.
7-8	Analyse and visualise data using a range of software to create information and use structured data to model objects or events (ACTDIP026)	Analyse and visualise data using a range of software, including spreadsheets and databases, to draw conclusions and make predictions by identifying trends (AC9TDI8P02) Model and query the attributes of objects and events using structured data (AC9TDI8P03)	Better: the inclusion of predictions is useful.
7-8	Define and decompose real-world problems taking into account functional requirements and economic, environmental, social, technical and usability constraints (ACTDIP027)	Define and decompose real-world problems with design criteria and by creating user stories (AC9TDI8P04)	About the same.
7-8	Design the user experience of a digital system, generating, evaluating and communicating alternative designs (ACTDIP028)	Design the user experience of a digital system (AC9TDI8P07)	Better.
7-8	Design algorithms represented diagrammatically and in English, and trace algorithms to predict output for a given input and to identify errors (ACTDIP029)	Design algorithms involving nested control structures and represent them using flowcharts and pseudocode (AC9TDI8P05) Trace algorithms to predict output for a given input and to identify errors (AC9TDI8P06)	Better: more explicit

Year Range	***OLD***	***Proposed***	***Difference***
7-8	Implement and modify programs with user interfaces involving branching, iteration and functions in a general-purpose programming language (ACTDIP030)	Implement algorithms and modify and debug programs involving control structures and functions in a general-purpose programming language (AC9TDI8P09)	About the same.
7-8	Evaluate how student solutions and existing information systems meet needs, are innovative, and take account of future risks and sustainability (ACTDIP031)	Evaluate existing and student solutions against the design criteria, user stories and possible future impact (AC9TDI8P10)	About the same.
7-8	Plan and manage projects that create and communicate ideas and information collaboratively online, taking safety and social contexts into account (ACTDIP032)	Create, locate and edit content for, and communicate with, a specific audience, selecting from a range of tools and using their advanced functionality and storage conventions (AC9TDI8P11)	Worse: project management would be better standing alone as a separate Content Descriptor.
		Share information publicly online and plan, manage and collaborate on simple agile projects, demonstrating agreed behaviours (AC9TDI8P12)	
7-8	<nil>	Explain how multi-factor authentication protects an account when the password is compromised and identify phishing and malware threats (AC9TDI8P13)	
7-8	<nil>	Investigate and manage the data existing systems and student solutions collect that contributes to a digital footprint and assess if the data is essential to their purpose (AC9TDI8P14)	
9-10	Investigate the role of hardware and software in managing, controlling and securing the movement of and access to data in networked digital systems (ACTDIK034)	Investigate how hardware and software manage, control and secure access to data in networked digital systems (AC9TDI10K01)	About the same.

Year Range	***OLD***	***Proposed***	***Difference***
9-10	Analyse simple compression of data and how content data are separated from presentation (ACTDIK035)	Represent documents online as content (text), structure (markup) and presentation (styling) and explain why such representations are important (AC9TDI10K02)	Better: more explicit.
		Investigate simple data compression techniques (AC9TDI10K03)	
9-10	Develop techniques for acquiring, storing and validating quantitative and qualitative data from a range of sources, considering privacy and security requirements (ACTDIP036)	Develop techniques to acquire, store and validate data from a range of sources using software, including spreadsheets and databases (AC9TDI10P01)	About the same.
9-10	Analyse and visualise data to create information and address complex problems, and model processes, entities and their relationships using structured data (ACTDIP037)	Analyse and visualise data interactively using a range of software, including spreadsheets and databases, to draw conclusions and make predictions by identifying trends and outliers (AC9TDI10P02)	Better: explicit mentioning of spreadsheets and databases as examples.
		Model and query entities and their relationships using structured data (AC9TDI10P03)	
9-10	Define and decompose real-world problems precisely, taking into account functional and non-functional requirements and including interviewing stakeholders to identify needs (ACTDIP038)	Define and decompose real-world problems with design criteria and by interviewing stakeholders to create user stories (AC9TDI10P04)	About the same.
9-10	Design the user experience of a digital system by evaluating alternative designs against criteria including functionality, accessibility, usability, and aesthetics (ACTDIP039)	Design and prototype the user experience of a digital system (AC9TDI10P07)	Better: shorter, clearer.
9-10	Design algorithms represented diagrammatically and in structured English and validate algorithms and programs through tracing and test cases (ACTDIP040)	Design algorithms involving logical operators and represent them as flowcharts and pseudocode (AC9TDI10P05)	Better: more explicit.
		Validate algorithms and programs by comparing their output against a range of test cases (AC9TDI10P06)	

Year Range	*OLD*	*Proposed*	*Difference*
		Generate, modify, communicate and critically evaluate alternative designs (AC9TDI10P08)	
9-10	Implement modular programs, applying selected algorithms and data structures including using an object-oriented programming language (ACTDIP041)	Implement, modify and debug modular programs, applying selected algorithms and data structures, including in an object-oriented programming language (AC9TDI10P09)	About the same.
9-10	Evaluate critically how student solutions and existing information systems and policies, take account of future risks and sustainability and provide opportunities for innovation and enterprise (ACTDIP042)	Evaluate existing and student solutions against the design criteria, user stories, possible future impact and opportunities for enterprise (AC9TDI10P10)	About the same.
9-10	Create interactive solutions for sharing ideas and information online, taking into account safety, social contexts and legal responsibilities (ACTDIP043)	Create, locate and edit interactive content for a diverse audience (AC9TDI10P11)	Better.
9-10	Plan and manage projects using an iterative and collaborative approach, identifying risks and considering safety and sustainability (ACTDIP044)	Plan, manage and document individual and collaborative agile projects accounting for risks and responsibilities (AC9TDI10P12)	Better: since project management has its own mention here, why not eliminate it from AC9TDI8P12? Or make the Year 7-8 CD precede this one without the burden of 'share information publicly online'?
9-10	<nil>	Describe cyber security threats and mitigation, including using multi-factor authentication and password managers (AC9TDI10P13)	Better: good inclusion.
9-10	<nil>	Apply the Australian Privacy Principles to critique and manage the data that existing systems and student solutions collect that contribute to a digital footprint (AC9TDI10P14)	Better: good inclusion.

Appendix 2: 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, ACS hosted a meeting at the State Library of Queensland which 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 (ACS, 2018) on the meeting 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 them 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 focussed 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 – March 2021, so there was pressure to collect the data in order for it to be analysed prior to this. Luckily the review timeline 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, focussing 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[3]
Combined Schools (P/K/F - Year 10/12)	60	1727
Primary (Years P/K/F - 6/7)	112	6434
Junior Secondary (Years 7/8 - 10)	13	1824
Secondary (Years 7/8 - 12)	111	
Senior Secondary (Years 11/12)	11	
TOTAL	307	

State/Territory	Number of responses	Total number of schools in state[4]
Australian Capital Territory	5	147
New South Wales	41	3361
Northern Territory	1	202
Queensland	86	1884
South Australia	58	781
Tasmania	17	279
Victoria	53	2712
Western Australia	45	1206

The representativeness of the sample differed by state and territory, with X^2 (7, n=243) = 131.4, p = .000. ACT, NSW, NT & VIC were under-represented. QLD, SA, WA and TAS were over-represented.

Table 2: School categories

School category	Number of responses	Nationally
Government/public	148	6659
Independent	71	1088
Catholic	80	1756
Other	2	

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

[3] https://asl.acara.edu.au/ (May, 2020)

[4] https://www.abs.gov.au/statistics/people/education/schools/latest-release#data-download (2019)

Types of Digital Technologies curricula

While the Australian Curriculum identifies Digital Technologies as a separate subject in the Technology 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. 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. Through this report, we refer to 'Digital Technologies' to encompass all of these curricula.

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	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.

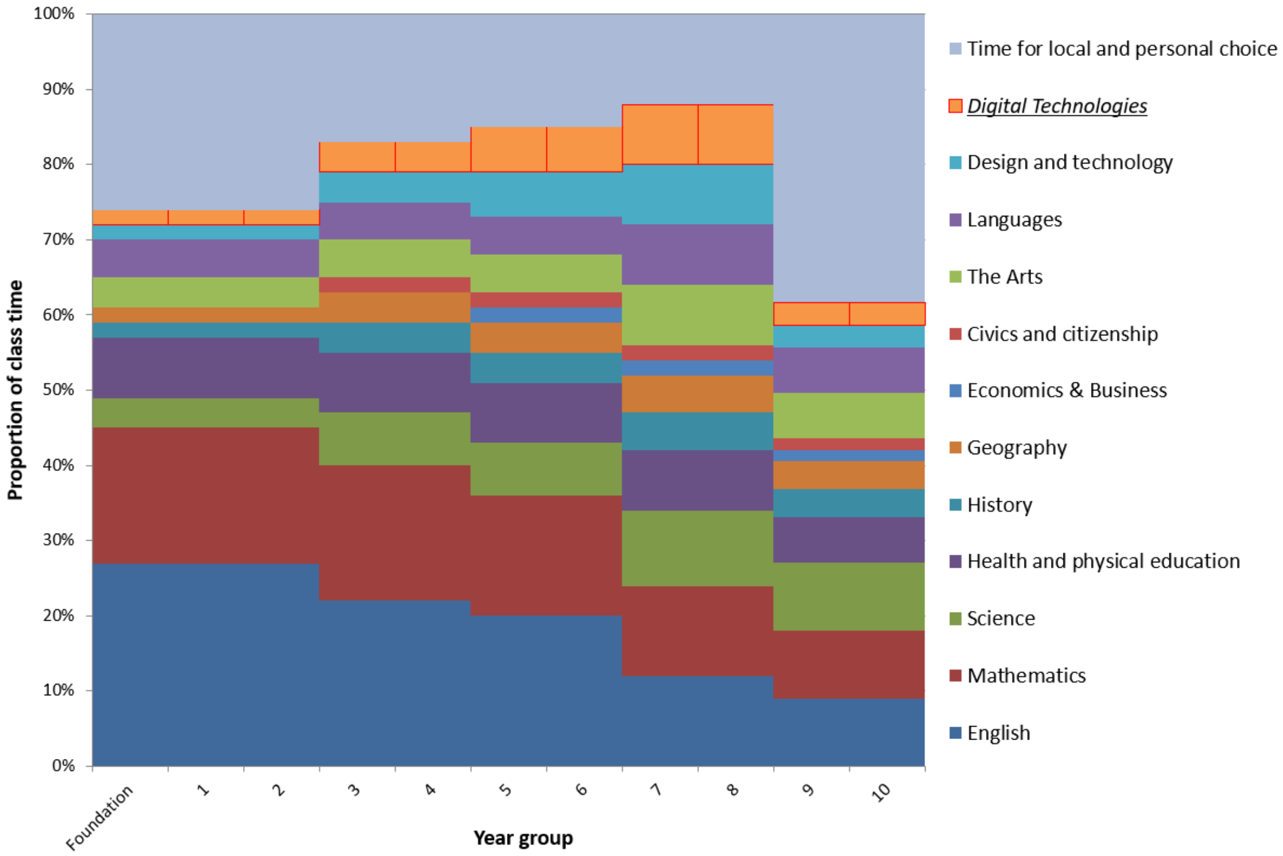


Figure 1: Design time for Australian Curriculum subjects[5]

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

[5] http://education.qld.gov.au/curriculum/framework/p-12/docs/time-allocations.pdf

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 7-8 (the last years for which the subject is specified as a required subject). In Years 9-12 this subject is an elective or optional subject, and reporting rates are therefore higher at 86% for Years 9-10 and 82% for Years 11-12.

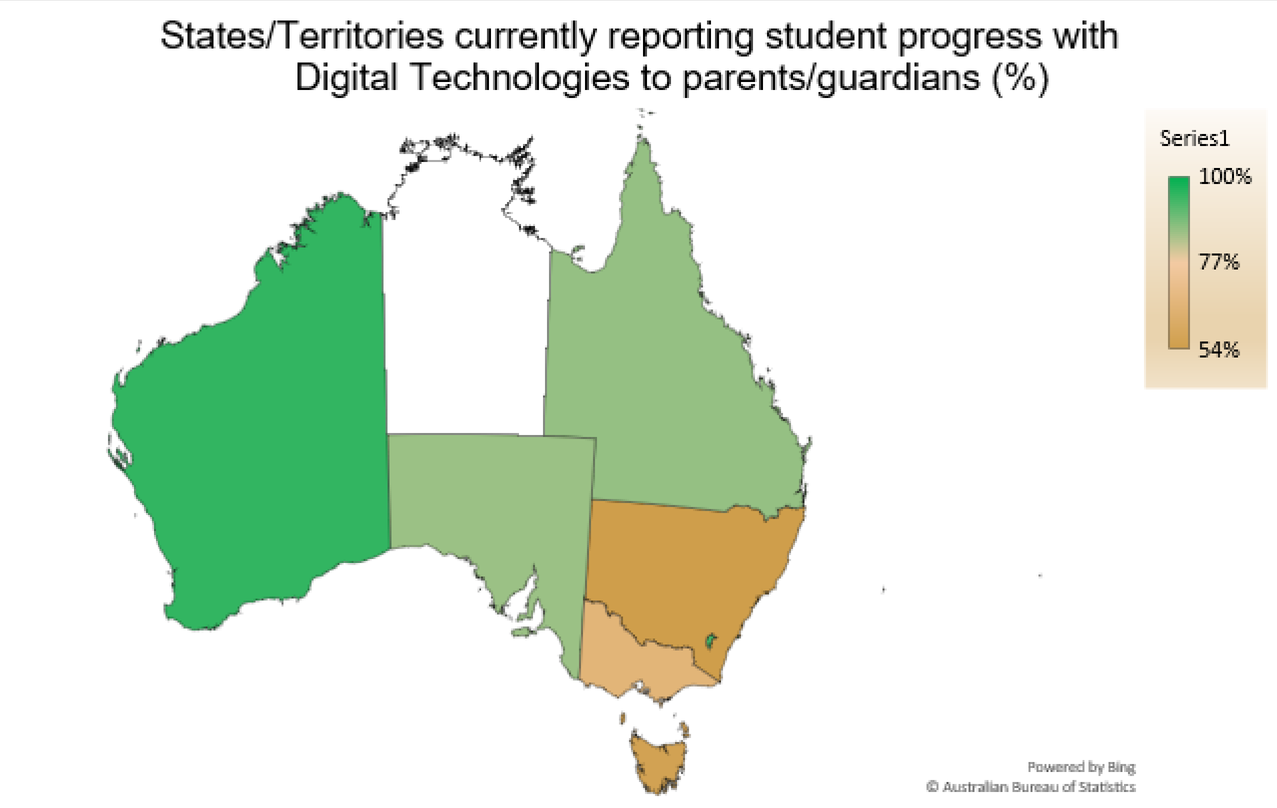
Table 5: Reporting of Digital Technologies to parents by state/territory

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[6] for students in F-6 (Primary schools), and therefore reporting may occur in the Science area instead.

[6] https://educationstandards.nsw.edu.au/wps/portal/nesa/k-10/learning-areas/science



NT – too little data to report

Figure 2: Map of compliance with reporting requirements.

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 2 years (%)	Not sure (%)
Government/public	31	55%	16%	29%
Independent	25	76%	20%	4%
Catholic	22	68%	18%	14%

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/Secondary schools, 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/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 some other 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 few teachers have been trained to teach this new subject, so 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 taught as 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 New South Wales 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
Science	22%
Maths	19%
Humanities	15%
English	15%
Arts (Media Arts, Visual Arts, Music etc)	14%
Health & Physical Education/Sport	5%
Languages	5%
Other	5%

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

Senior secondary students

From the previous analysis, we know that there were 168 responding schools with Years 11 and 12 students. Of those, 55% had no students enrolled in Vocational Education and Training qualifications in the ICT training package.

For those schools 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 that go on to study Digital Technologies/IT related fields at tertiary level. 93% of respondents to this question said this was less than 25% of students, or were unsure. Only in 7% of schools did 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, in few schools, there was 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: How did teachers rate their expertise and passion for Digital Technologies? (106 to 132 responses according to student Year group)

	Self-rated teacher expertise				Teacher passion for Digital Technologies			
Student Year	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 up-beat 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 for passion, this was 69% for younger students taught, rising to 94% for those teaching Year 9-10 students.

Schools were asked about the Digital Technologies qualifications of teachers involved in delivering the subject. For each age 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, a Bachelor 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 F-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 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.

Table 14: Proportion of ten 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
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 used for teaching Digital Technologies'.

Only three of the top ten 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 suited to all subjects across the curriculum, and represent the general capability of ICT instead.

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

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

In Years 7-8 Grok Learning and Python appear in the top ten. Grok is worthy of special mention, since this originated from the University of Sydney with a $10m 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 9-10, and therefore one might expect fewer students to be involved, but with more specialist teachers. Hardware like the Arduino micro-controllers are added to the top ten list, along with the Unity 3D gaming/virtual reality modelling system.

The mid-range was Years 5-6 with 60% of the top ten tools strictly relevant to Digital Technologies.

The data providing this snapshot was investigated more fully, going beyond the ten 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 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 ten. This process provided justification for the top-ten methodology, showing it is somewhat on the conservative side.

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 re-write 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 baby sitting 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 seven years long (three years for a Bachelor's degree in IT, two for a Masters 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, so very few transition into the Master of Teaching because IT careers are far more lucrative without 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 Sentence and Csizmadia (2016), who reported teachers' lack of subject knowledge was the greatest challenge faced when implementing this aspect of the computing curriculum. In that country, 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

		Count
Has the school surveyed parents/guardians regarding their attitudes to the Digital Technologies/IT curriculum in the last 2 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 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.[7]

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, such data 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, since 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

[7] https://www2.education.vic.gov.au/pal/ict-support-schools/policy

environment[8]. 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 e-mail.

Can 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 requiring these tools to support basic education – but much of the pre-2021 version could largely be taught without them.

[8] https://au.pcmag.com/lenovo-thinkpad-x1-extreme/61790/higher-end-laptops-can-save-your-company-money and https://www.cfocentre.com.au/working-from-home/

Websites and tools nominated for teaching Digital Technologies (summary of word cloud analyses)

Table 16: Ten most popular tools and websites used for Digital Technologies in F-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		✓

Total = 151

Also mentioned:

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

Table 17: Ten most popular tools and websites used for Digital Technologies in 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		✓

Total - 171

Also mentioned:

ABC Education, Adobe, Apple Pages, Apps, AR Makr, BBC Micro:bit, Beebots, 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 Learning, Hopscotch, Hour of Code, iMovie, Interland, internet, internet safety website, iPad Apps for Literacy and Numeracy, KeyNote, Kodu, Literacy Planet, Literacy-Learning Apps, MakeCode, Makey Makey, Mathigon, MathsOnline, Matific, Lego Mindstorms EV3 robots, OneNote Class Notebooks, Padlet, Paint 3D, PicCollage, Pivot Professional Learning, Prodigy Education, QR-codes, Reading Eggs, Reading Eggspress, Renaissance Accelerated Reader, Schoolbox, Showbie, Spelling City, Sphero, The Learning Place, Tinkercad, Typing Tournament Online, Typing.com, TypingClub, YouTube.

Table 18: Ten most popular tools and websites used for Digital Technologies in 5-6

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

Total = 245

123 were strictly relevant to Digital Technologies (= 50%)

Also mentioned:

Adobe, Alice 2, all Microsoft 365 programs (Teams) , Apple iMovie, Apple Keynote, Apple Pages, AppShed, Audacity, BBC Bitesize, Beebot, 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 Learning, 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, Movie Maker, OneNote Class Notebooks, Python, Reading Eggs, Reading Eggspress, ReadTheory, Renaissance Accelerated Reader, Schoolbox, SculptGL, Sphero, Studyladder, Swift Playgrounds, Typing Tournament, VEX Robotics, virtual reality headsets, Vocabulary.com, YouTube.

Table 19: Ten most popular tools and websites used for Digital Technologies in 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:bits	14	✓	
Python	14	✓	
Lego EV3 Mindstorms	12	✓	
Code.org (App Lab)	9	✓	
Minecraft	8	✓	

Total = 321

Also mentioned:

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, CAD, Cambridge HOTmaths, Canvas LMS, ClickView, Cloud Stop Motion, Code with Mu, Codecademy, Connect (WA Dept of Ed. LMS), Construct 3, CoSpaces Edu, CSS, Daymap, Education Perfect, Fusion 360, Game Maker, GIMP, Godot Engine, Google Apps For Education, Google Classroom, Hacking with Swift, HTML + CSS using Brackets, 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, Thunkable, Tinker Learning, Tinkercad, Tynker, TypingClub, Unity, Visual Studio, we write our own, web technologies (HTML, web-based applications, Wix, Xcode, YouTube, Zoom.

Table 20: Ten most popular tools and websites used for Digital Technologies in 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	✓	

Total = 338

Also mentioned:

apps.diagrams.net, 3Ds Max, Academy of Interactive Game Programming, Adafruit Circuit Playground Express, Adobe Animate, Adobe Illustrator, 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 Dept of Ed. LMS), Construct 2 and 3, CoSpaces Edu, databases, Daymap, Education Perfect, Fusion 360, FutureBASIC, Gamefroot, 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, library research tools, MakeCode Arcade, MAMP, Minecraft, MIT App Inventor, Notepad, online coding, Photoshop, 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, The Learning Place, Tinkercad, Visual Studio, Visual Studio, Vortals, W3Schools, web-based applications, Xcode 13, YouTube, Zoom.

Appendix 3: References

Australian Computer Society [ACS] (2018). *ICT Education in Queensland: Challenges and Solutions.* https://researchbank.swinburne.edu.au/file/a0c379b2-5ad2-423e-9b21-6639a2ec6ed5/1/2018-Keane-ICT_Education_in_Queensland.pdf or available from the ICT Educators Resource Centre at www.acs.org.au

Australian Computer Society [ACS] (2020). *Australia's Digital Pulse 2020.* https://www.acs.org.au/insightsandpublications/reports-publications/digital-pulse-2020.html

Australian Curriculum, Assessment and Reporting Authority [ACARA] (2016). *Foundation – Year 10 curriculum.* https://www.acara.edu.au/curriculum/foundation-year-10

Australian Curriculum, Assessment and Reporting Authority [ACARA] (2020a). *Monitoring the effectiveness of the Foundation-Year 10 Australian Curriculum 2019*. Author.

Australian Curriculum, Assessment and Reporting Authority [ACARA] (2020b). *Review of the Australian Curriculum.* Author. https://acara.edu.au/curriculum/curriculum-review.

Curran, J.R, Schulz, K.A and Hogan, A (2019). *Coding and computational thinking: what is the evidence?* Australian Computing Academy for the State of New South Wales (Department of Education), as part of the Education for a Changing World initiative.

Design and Technology Teachers' Association of Australia [DATTA] (2019). *Technologies Teacher Shortage Survey: National Overview 2019*.

Sentance, S., Csizmadia, A. *Computing in the curriculum: Challenges and strategies from a teacher's perspective*. Educ Inf Technol 22, 469–495 (2017). https://doi.org/10.1007/s10639-016-9482-0

Tan, Z. (2019). *Singapore makes coding classes mandatory for primary school students, starting 2020*. KrASIA. https://kr-asia.com/singapore-makes-coding-classes-mandatory-for-primary-school-students-starting-2020

Williams, O. (2020). *The coding crisis in UK schools*. New Statesman (3rd February) https://www.newstatesman.com/spotlight/skills/2020/02/coding-crisis-uk-schools