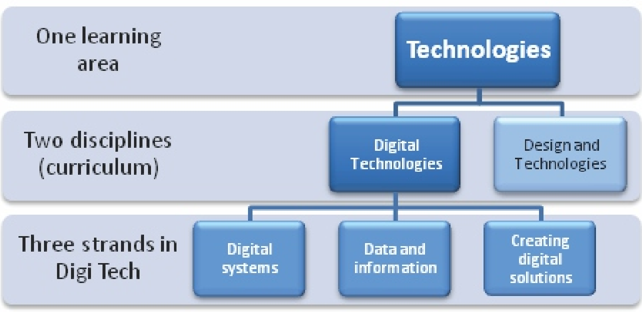
THINK BEFORE YOU CODE:
Digital Technologies in the Victorian Curriculum

Paula Christopherson

Introducing the curriculum

Digital Technologies (Digi Tech) is one of two disciplines within the Technologies learning area, with the other being Design and Technologies. The Digi Tech curriculum is new, with its conceptual roots in computer science. In essence, Digi Tech involves students creating digital solutions through the use of information systems and specific ways of thinking. It is about solving problems through the creation of digital solutions that require an understanding of computation principles and practices. Figure 1 shows the structure of the Technologies learning area and the strands in the Digi Tech curriculum.

Figure 1: Structure of Digital Technologies within the Technologies learning area



The study has five aims (VCAA, 2017c) and these should be the key reference points when developing teaching and learning programs. These programs should focus on students:

- designing, creating, managing and evaluating solutions that are innovative (non-routine) and sustainable
- applying computational thinking concepts
- confidently using digital systems to acquire, communicate and create data, information and solutions
- applying social, ethical, legal and technical protocols when communicating, collaborating and creating information and solutions
- applying systems thinking to monitor, analyse, predict and shape interactions between people, the environment, data and digital systems.

Key messages about Digi Tech

There are several important messages that schools should consider when implementing the Digital Technologies curriculum.

Mandate

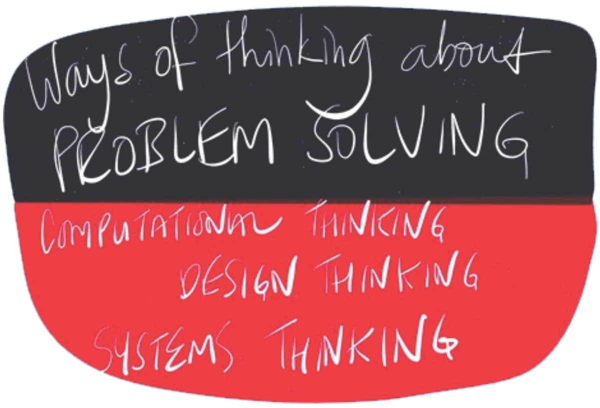
All government and Catholic schools are required to provide students with the opportunities to demonstrate the standards in Digi Tech from Foundation to Level 10. Offering the highest band (Levels 9 and 10) differentiates Victoria from all other states and territories, where the band is optional. Schools are expected to have commenced the implementation of the curriculum this year.

Ways of thinking

Digi Tech is as much about using different ways of thinking about problem-solving as it is about using different digital systems. The curriculum requires students to apply computational, design and systems thinking to create digital solutions, as shown in Figure 2.

Up to 50 per cent of the curriculum can be learned 'unplugged', meaning not using a digital device. This is a clear

Figure 2: The Digital Technologies curriculum involves applying a set of thinking skills. Image courtesy of Paul Clapton-Caputo, Department for Education and Childhood Development, SA.



point of differentiation from ICT, which is dependent on the use of digital devices to perform tasks such as communicating, acquiring and creating data and information.

Nomenclature

Digi Tech is not a new name for ICT or eLearning despite the fact that some learning areas refer to digital devices used by students as digital technologies. Developing ICT capabilities mean students becoming effective users (or consumers) of ICT to support their learning in all fields of endeavour. In this instance, students use solutions developed by other people to create and communicate information. Typically within the Victorian Curriculum explicit references to ICT are embedded in the content descriptions for some learning areas. For example, at Level 6, English, students learn how to 'use a range of software, including word processing programs, to create, edit and publish written and multimodal texts' (VCAA, 2017a).

This contrasts with the Digi Tech curriculum that focuses on students becoming confident *developers* (or creators) of digital solutions. For example, at Levels 5 and 6 students learn to 'develop digital solutions as simple visual programs' (VCAA, 2017b). In Digi Tech students are creating their own solutions rather than using others. They might be instructing a robotic device to 'collect' objects or creating a grammar game or creating a friend-matching app.

Unpacking the strands

While the content of the curriculum has been organised around three strands, there is an interconnection between these. There needs to be respect for the integrity of each content description within a strand as well as an understanding of how they all fit together when solving problems.

Digital systems

This strand focuses on the hardware and software that when combined form digital systems. Digital systems can be networked to support the transmission of data and information across a connected set of digital systems. The curriculum also examines information systems that comprise digital systems, data, processes and people. Student learning across the Digital systems strand progresses from exploring and using digital systems, through to a study of how digital systems form networks, culminating in the study of how data is protected, moved and controlled at Levels 9 and 10. Examples of digital systems and peripherals include notebooks, laptops, mobile phones, robotic devices, digital probes and speakers.

Data and information

This strand focuses on four key areas, namely:

- how data is accessed and checked for its validity
- how data is presented in order to improve the communication of its message
- ways in which data is represented digitally to enable processing and storage, such as in binary form
- creating ideas and information for sharing online.

Aspects of this strand have the closest connections to some other learning areas, particularly with respect to the quality and presentation of data, so many school programs would already be addressing some of this content. Figure 3 teases out some of the content areas in this strand, using colour coding to indicate the band at which content is covered.

Creating digital solutions

This strand provides the content for the processes involved in creating digital solutions, namely analyse, design, develop and evaluate. These processes differ in name from the Australian Digital Technologies Curriculum; however, the content descriptions are almost exactly the same. The Australian Curriculum has five processes. See Table 1 for a comparison of processes between the two curriculum documents.

Analysis involves identifying the individual elements of a problem and considering the cause-and-effect connections between these elements. It also involves stating what the solution needs to be able to do (functional requirements) and the characteristics the solution should possess (non-functional requirements).

Design involves writing the set of instructions for how the solution is going to be created and documenting how the solution will look—it is about 'how', whereas analysis is about 'what'. The set of instructions (procedures and decisions) is called an algorithm.

Figure 3: Mindmap of key content in the Data and information strand

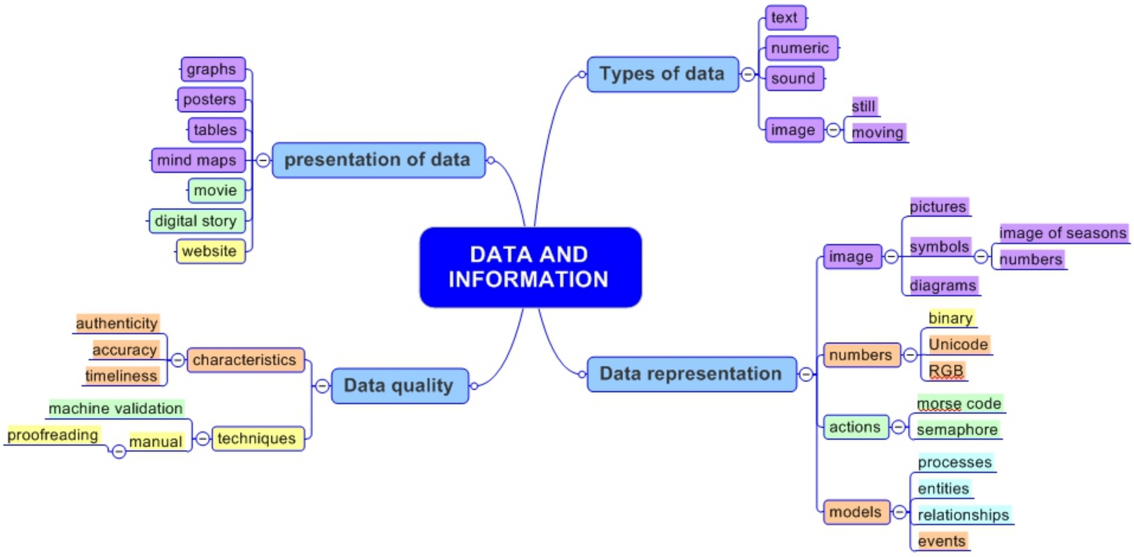


Table 1: Comparison of processes for creating digital solutions

Victorian Curriculum processes	Australian Curriculum processes
Analysis	Investigating and defining
Design	Generating and designing
Development	Producing and implementing
Evaluation	Evaluating
	Collaborating and managing

Developing is the process of bringing the set of instructions to life, typically through the use of a programming language. This is usually referred to as 'coding'. The development process is about enacting the design. While most of the development process is achieved through coding, it also involves using application software, such as the Microsoft and Adobe suites, to support the creation of solutions. Over the bands, students progress from using block-based (image) languages that have no syntax, such as Kodu and Scratch (Levels 3 to 6), to procedural/scripting languages, such as python and Ruby (at Levels 7 and 8), and object-oriented languages, such as Scala at Levels 9 and 10.

Evaluation involves considering if the solutions developed by the students and others are 'fit for purpose'. Students progress from evaluating solutions that meet specific personal needs (Levels F to 2) through to considering the risks associated with their solutions, if implemented, and their levels of sustainability and innovativeness (Levels 9 and 10).

Ways of thinking

A defining feature of a computer-science based curriculum is the particular ways of thinking about problem-solving that involves computation. In the Digi Tech curriculum the driving force is computational thinking, in combination with design thinking and systems thinking. The weighting given to each of these ways of thinking will vary depending on the process and the nature of the problem. These skills take practise, and teachers should be always on the lookout to find opportunities in all learning areas to develop these capabilities.

Computational thinking

There are many definitions of this term but as a generalisation computational thinking (CT) involves representing human knowledge in a way that can be transformed into solutions using digital systems. It is a hybrid of thinking—a multifaceted way of approaching problem-solving, as shown in Figure 4.

Figure 4: Computational thinking is at the heart of the Digi Tech curriculum. Image courtesy of Paul Clapton-Caputo, Department for Education and Childhood Development, SA.

Some aspects of CT include:

- identifying patterns—it is about finding similarities within and between problems, and data. It involves identifying repetition so you can remove it, as well as identifying errors that do not fit patterns
- precision—this is the hallmark of algorithms (a set of procedures and decisions required to solve a problem). The quality of a solution is as good as the instructions. There is no room for second guessing, so sequence and syntax are essential. It is similar to a recipe or a knitting pattern—if you miss or reorder a step you are likely not to create what was intended. See Figure 5 for an example of a knitting pattern, which is an example of an algorithm

Row
4. K
5. Repeat row 3
6. K
7. Repeat row 3 (repeat row 3 once more for larger size)
8–13. K 5 (6–7) rows
14. K to last 6 stiches, k2tog, k1, k2tog, k1 (2nd circ) k1, k2tog, k1, k2tog, k to end

Figure 5: Extract of a knitting pattern (Lewis,2008)

For a solution to work correctly every step in its development must be logically scheduled and expressed in the correct form. Students begin writing algorithms from the F to 2 band. Algorithms can be described in many ways, one of which is using flowcharts to visualise the algorithm, as shown in Figure 6. This flowchart shows the steps and decisions (formulation rules) to make the present participle of a verb. Try the process with the word 'bake'

- decomposing—the process of breaking down a task or problem into smaller, manageable parts. This allows separating elements within a problem according to their type. It is about chunking to help make problems more clearly understood
- logical thinking—it is about using reasoning to come to a conclusion, based on an analysis of facts. For example, in English you could ask students to explain what they think a character will do next in a novel, or explain the character's actions in the story so far. In Digi Tech students would use logical thinking to predict the behaviour of simple programs
- abstract thinking—this is the process of simplifying a complex problem to define its main ideas. This is achieved by focusing on the important things and ignoring irrelevant details. It is about filtering in order to concentrate on what is important. Abstraction is typically applied when analysing problems, as you need to distil facts in order to arrive at the main ideas; however, when writing algorithms, it is necessary to ensure that all steps and decisions are recorded logically and precisely.

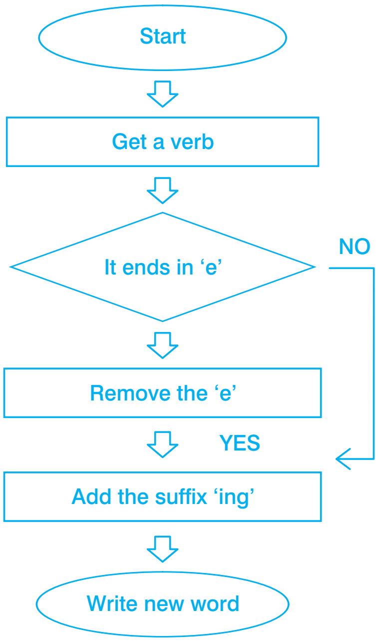


Figure 6: Formulation rule for making a present participle of a verb using a flowchart (Izu & Weerasinghe, 2015, p. 17)

Design thinking

This type of thinking is more than creative thinking. It involves devising a strategy in order to:

- understand design problems
- generate and visualise ideas
- analyse and evaluate ideas for further development.

Designing thinking goes beyond imagination. It requires the creation of a solution and its innovation (or implementation). In a school setting the innovation step is rarely achieved, but should not be ignored as an aspiration. **Note:** The Digital Technologies curriculum does not require students to implement their solutions.

Ideation is the creative process that underpins design thinking.

According to Nijstad, De Cruc, Rietzschel & Baas (2010), creativity is typically defined as 'the production of ideas, problem solutions and products that are both novel (original) and appropriate (feasible, potentially useful)' (p. 35).

Creativity typically involves both divergent (creative) thinking and convergent (critical) thinking. It involves generating ideas that need to be assessed in order to select the preferred option that in turn will be further developed into a solution. This requires flexibility of thought as well as persistence in systematically striving to achieve an appropriate new or novel solution.

Time is required to develop the design-thinking subsets; time to generate ideas without passing judgment on their merits, and time to filter these ideas using criteria to determine the preferred idea. Students need time to incubate their ideas, but there are many competing demands on time in schools, sometimes leading to short cuts in teaching and learning.

We need to be careful of not falling into the trap of assuming that creativity is just innate—that we cannot help students become flexible thinkers, hence creative ones. Unfortunately non-creative behaviour is learned. From the age of seven or eight years children become more socially aware and lean towards conformity. This is often coupled with a teaching regime that is less tolerant of differences and is fast-paced. Creative thinking techniques must be explicitly taught if students are to move from creating routine solutions to simple problems to non-routine solutions to complex problems. This does not happen just by osmosis. The Harvard Graduate School of Education's See / Think /Wonder thinking routine is used in many schools, and it provides a simple, but effective construct for students to question routine behaviours.

Systems thinking

Systems thinking is very important as we live in a global society and economy supported by networked information systems. Systems thinking involves taking a holistic approach to identifying and solving problems where the parts and components of systems are interrelated (VCAA, 2017c). It is important to understand that in a networked society and economy, the output produced from one system might become the input into another system, hence the accuracy and security of transmitted data and information is very important. It is also vital to consider the users of the systems, making sure that the solution is useful and user-friendly, and that the users feel confident that the data they provide to a system is secure. For example, there is a strong interconnectedness between a banking system and Centrelink—if incorrect data is supplied to Centrelink, then it is possible that direct debits into a bank account will also be wrong. Where appropriate, these types of considerations should influence the design of a solution, such as security measures, the ability to validate the reasonableness of data, and the options provided in the solution to opt-in or opt-out of services.

Curriculum connections

This curriculum requires space within a school's timetable, and there are many competing demands for spots on this timetable. School leaders must consider how best to preserve the integrity of the curriculum as well as make meaningful connections to other learning areas so efficiencies and effectiveness outcomes are achieved. Authenticity of problem-solving is core to this curriculum, so where ever possible, students should be attempting to create digital solutions to real problems.

Types of connections

When scouring the Victorian Curriculum consider if there are connections based on:

- common concepts, such as methods of inquiry and design
- common words, such as 'create' and 'ethics'
- contexts, such as settings or applications that provide a meaningful environment for student learning, such as exploring eating habits (Health and Physical Education) and migration data in History.

Conceptual connections

Conceptual connections usually share common words and a common intent. There is a core of common knowledge and skills between relevant learning areas; however, there are differences that reflect the nature of each learning area. When commonalities are identified, then efficiencies should be gained because the core knowledge and skills do not have to be taught for each learning area. However, what is important is that the teaching and learning is nuanced to accommodate each learning area's perspective. Similarities and differences are shown in Table 2, which compares the types of inquiry for History and Science.

Table 2: Similarities and differences between the types of inquiry in History and Science

Learning Area	Inquiry processes				
History	Questioning	Researching	Analysing	Evaluating and Reflecting	Communicating
Science	Questioning and predicting	Planning and conducting	Processing and analysing	Evaluating	Communicating

Word connections

Some learning areas share common words in the content descriptions that have a shared intent. In other instances a word may not be common; however, it has a common intention. Table 3 identifies some common and non-common words that share similar intents. In these instances, teaching and learning programs can embrace these connections and minimise the duplication of teaching efforts and potential student disengagement.

These connections provide opportunities for students to use real data for a real purpose that leads to real learning.

Conclusion

The Digital Technologies curriculum is a rich source for teaching and learning programs that challenge students to be flexible and systematic thinkers. There are aspects of the curriculum that will also challenge teachers, and this is acknowledged through the increasingly available online resources, such as those published on ESA's Digital Technologies Hub and the Victorian Curriculum's website, as well as professional learning programs. The challenges are not insurmountable so start implementing the curriculum even if you start small. You and your students will be rewarded.

Table 3: Making connections based on words with shared intents at Levels 3 and 4

	Digital Technologies	Media Arts	Science
Content description	Collect, access and present different types of data using simple software to create information and solve problems	Use media technologies to create time and space through the manipulation of images, sounds and text when telling stories	Represent and communicate observations, ideas and findings to show patterns and relationships using formal and informal scientific language
Common word; same intent	Create • information • solutions	Create • stories	
Non-common word; same intent			Represent and communicate: • ideas • findings (create)
Non-common words; same intent	Simple software	Media technologies	
	Types of data	Images, sounds and text	

Context connections

In many instances there are settings or environments in other learning areas that suit the development and application of Digi Tech knowledge and skills. For example, for the Data and information strand at Levels 5 and 6 there are many meaningful opportunities for units of work that have connections to other learning areas such as:

- Economics and business, where students could collect data about the types of resources found in the school and make conclusions about the effects on the environment and sustainability
- Science, where students could record, represent and analyse the melting and freezing times of different types of liquids
- Geography, where students could collect data about specific countries, representing the data in graphic form looking for patterns and drawing conclusions.

References

Izu, C. & Weerasinghe, A. (2015), Using flowcharts to introduce computational thinking in primary schools, *Journal of Digital Learning and Teaching Victoria, 2*(1), pp.

Lewis, J. (2008) Seamless mini christmas stocking v. 2, Ravelry, retrieved from https://www.ravelry.com/patterns/library/seamless-mini-christmas-stocking-v-2

Nijstad, B., De Cruc, C., Rietzschel, E., & Baas, M. (2010), The dual pathway to creativity model: Creative ideation as a function of flexibility and persistence, *European Review of Social Psychology*, *21*(1), pp. 34-77.

VCAA (2017a), *Victorian Curriculum Foundation-10, English*, http://victoriancurriculum.vcaa.vic.edu.au/english/curriculum/f-10?layout=3#level=6

VCAA (2017b), *Victorian Curriculum Foundation-10, Digital Technologies*, http://victoriancurriculum.vcaa.vic.edu.au/technologies/digital-technologies/curriculum/f-10#level=5-6

VCAA (2017c), Rationale and aims, *Victorian Curriculum Foundation-10, Digital Technologies*, http://victoriancurriculum.vcaa.vic.edu.au/technologies/digital-technologies/introduction/rationale-and-aims