Development paper: revising the technology learning area to strengthen digital technologies in the New Zealand Curriculum

Proof of concept, development, and testing

Contents

Overview of the development

Background

The work to revise the technology learning area to strengthen digital technologies in the New Zealand Curriculum began in 2016. A group was established to develop a design approach[1] that described the objective of the work and the governing principles and rationale for the design, and included impact and stakeholder analysis. The design recommended the development of key conceptual learning progressions for digital technologies in a manner that would easily sit beside the current technology learning area achievement objectives.

This paper describes the second and third phases of the work to develop learning progressions for digital technologies within the technology learning area. The three phases of the development project are described in Figure 1.

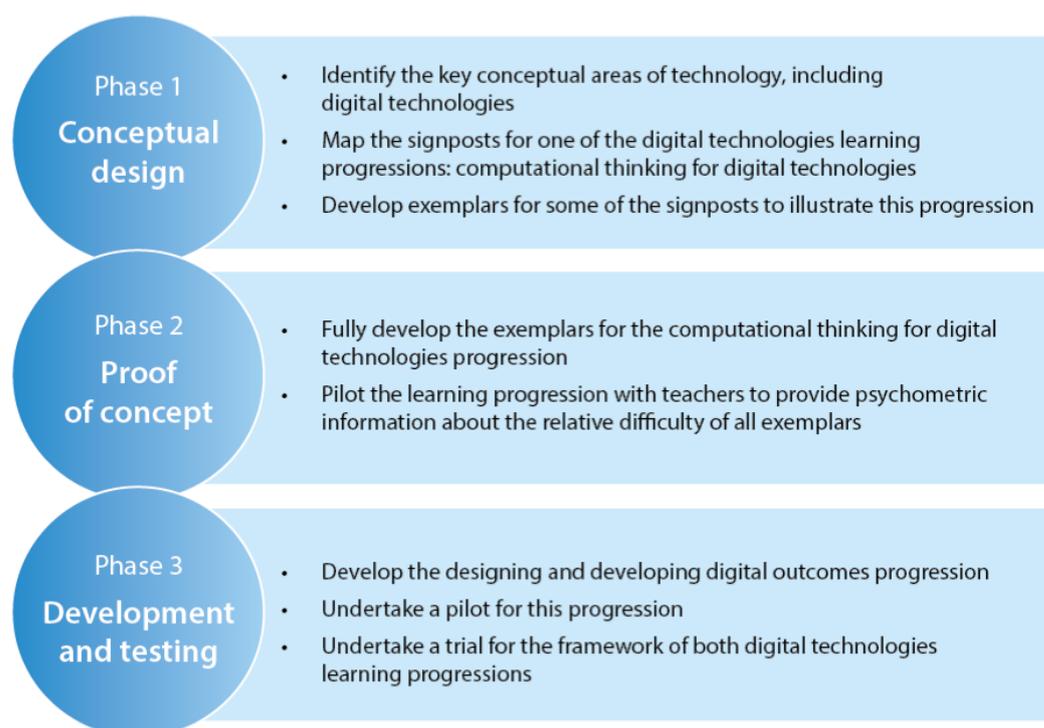| Phase 1 Conceptual design | • Identify the key conceptual areas of technology, including digital technologies
 • Map the signposts for one of the digital technologies learning progressions: computational thinking for digital technologies
 • Develop exemplars for some of the signposts to illustrate this progression |
| Phase 2 Proof of concept | • Fully develop the exemplars for the computational thinking for digital technologies progression
 • Pilot the learning progression with teachers to provide psychometric information about the relative difficulty of all exemplars |
| Phase 3 Development and testing | • Develop the designing and developing digital outcomes progression
 • Undertake a pilot for this progression
 • Undertake a trial for the framework of both digital technologies learning progressions |

Figure 1: Phases of the technology learning progressions development

The first phase of the project was carried out in 2016 and involved conceptual design. The key conceptual areas of technology were identified and included two aspects of digital technologies: computational thinking for digital technologies (CT) and designing and developing digital outcomes (DDDO). Signposts for the progression of students' skills and knowledge in computational thinking were mapped, and some exemplars were developed to illustrate this progression. Further information on the first phase of the project and additional background to the project can be found in the working paper entitled *Introduction of Digital Technologies into the NZC: Phase 1 proposed design.*

The focus of the second phase of the project was the completion of the CT progression with associated piloting to obtain psychometric information. The third phase of the project included the

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[1] The group included Robyn Baker, Mary Chamberlain (Evaluation Associates), Tim Bell (University of Canterbury), and Geoff Gibbs and Pam Streeter for the Ministry of Education.

development of the DDDO progression, the piloting of this progression to obtain psychometric information, and a trial of the framework of both digital technologies learning progressions.

The Ministry of Education commissioned Education Technology Ltd to carry out phases two and three of the project. This was a continuation of the work Education Technology had completed during phase one.

The process and timelines for phases 2 and 3

The design team for phases two and three included people with a variety of expertise. Dr Gill Thomas and Sue Douglas (Education Technology Ltd) provided leadership and oversight. Caitlin Duncan (University of Canterbury) and Julie McMahon (NZACDITT President) provided subject-matter expertise in digital technologies and worked as developers. Melinda Stevenson (Francis Douglas Memorial College), Catherine Johnson (The Mind Lab), and John Creighton (Burnside High School) assisted with development. Gerard McManus (Hobsonville Point Secondary School) and Tracey Henderson (University of Canterbury) provided further subject-matter expertise and assisted with exemplar review. Elliot Lawes (NZCER) carried out psychometric analysis and provided psychometric advice. Professor Tim Bell (University of Canterbury) acted as a critical friend to the project and provided expert review. The developers worked with students from several schools to obtain student work samples.

Tables 1 and 2 provide an overview of phases 2 and 3 of the development.

Table 1: Phase 2 timeline and outcomes

Mapping signposts for the CT progression 22 March	Outcomes: • Signpost descriptors drafted • Signposts mapped for levels 6–8 of the NZC • Alignment of the progression with NCEA described
Technology working group meeting 26 April	Outcomes: • Revised learning area statement for the technology learning area • Refinement of the proposed positioning of digital technologies within technology and the NZC
Exemplar development 27 March–1 May	Outcomes: • 17 exemplars drafted for the five signposts of the CT progression • Student work samples obtained • Exemplars reviewed
Exploratory trials 8–12 May	Outcomes: • Initial information on the relative sophistication of exemplars • Information about whether the exemplars are being interpreted as intended and whether teachers regard the learning tasks and student responses as authentic • Qualitative questions for the online trial piloted
Exemplar refinement 15–26 May	Outcomes: • Exemplars updated to address issues identified in the exploratory trial • Signpost 4 and 5 exemplars amended to make the complexity of the tasks and student responses clearer
Online trial, including psychometric analysis 29 May–23 June	Outcomes: • Information on the relative sophistication of exemplars • Teachers' feedback on the authenticity and transferability of the exemplars and the extent to which they illustrate rich teaching and learning
Exemplar refinement 26 June–14 July	Outcomes: • Signpost descriptors for the progression revised • Information about students' use of the NZC key competencies in the learning tasks added to each exemplar • Integration with other learning areas highlighted in the exemplars, where possible • Minor changes made to a small number of exemplars to address issues identified in the online trial
Design and style of exemplars 17–28 July	Outcomes: • All exemplars edited and styled • Exemplars prepared for publication

Table 2: Phase 3 timeline and outcomes

Mapping signposts for the DDDO progression 1–2 May	Outcomes: - Signposts mapped - Signpost descriptors drafted - Signposts mapped for levels 6–8 of the NZC - Alignment of the progression with NCEA described
Exemplar development 2 June–14 July	Outcomes: 12 exemplars drafted for the first three signposts of the DDDO progression - Student work samples obtained - Exemplars reviewed
Exploratory trials 24–28 July	Outcomes: - Information about whether the exemplars are being interpreted as intended and whether teachers regard the learning tasks and student responses as authentic - Initial information on the relative sophistication of exemplars
Exemplar refinement 31 July–11 August	Outcomes: Three exemplars updated to address issues identified in the exploratory trial
Online trial, including psychometric analysis 14 August–8 September	Outcomes: - Information on the relative sophistication of exemplars - Teachers' feedback on the authenticity and transferability of the exemplars and the extent to which they illustrate rich teaching and learning - Need to clarify the focus of the progression identified
Exemplar refinement 11 September–13 October	Outcomes: - Advice sought from the technology working group and critical friends on the focus of the progression - All exemplars revised to strengthen the focus on the use of digital technologies and address issues identified in the online trial - Decision to repeat the online trial due to the extent of exemplar revisions. Some CT exemplars included for psychometric comparison
Combined online trial, including psychometric analysis 24 October–15 November	Outcomes: - Information on the relative sophistication of the DDDO exemplars and their alignment with the sophistication of the CT exemplars - CT online trial results confirmed with additional analysis - Teachers' feedback on the authenticity and transferability of the exemplars and the extent to which they illustrate rich teaching and learning
Exemplar refinement 16–17 November	Outcomes: Exemplars updated to address issues identified in the combined trial
Design and style of the exemplars 20–22 November	Outcomes: - All exemplars edited - Exemplars prepared for publication

Positioning digital technologies within technology and the New Zealand Curriculum

A working group was established to consult on the changes proposed in phase one to the technology learning area of the New Zealand Curriculum (NZC). The group included six practising teachers and three subject-matter experts with expertise in the broader technology area (areas other than digital technologies). Several professional associations were represented: the New Zealand Graphics and Technology Teachers Association (NZGTTA), the Home Economics and Technology Teachers Association (HETTANZ), and Technology Education New Zealand (TENZ).

The group met on 26 April for a working meeting. They revised the statement for the technology learning area and refined the proposed positioning of digital technologies within technology and the NZC. The essence statement was updated after the meeting to reflect the suggested changes and circulated to the group for their feedback.

The revised technology learning area statement was finalised following the Ministry of Education's consultation process. It is included below along with associated diagrams.

Revised learning area statement

What is technology about?

Kaua e rangiruatia te hāpai o te hoe;

e kore tō tātou waka e ū ki uta.

Technology is intervention by design. It uses intellectual and practical resources to create technological outcomes, which expand human possibilities by addressing needs and realising opportunities.

Design is characterised by innovation and adaptation and is at the heart of technological practice. It is informed by critical and creative thinking and specific design processes. Effective and ethical design respects the unique relationship that New Zealanders have with their physical environment and embraces the significance of Māori culture and world views in its practice and innovation.

Technology makes enterprising use of knowledge, skills and practices for exploration and communication, some specific to areas within technology and some from other disciplines. These include digitally-aided design, programming, software development, various forms of technological modeling, and visual literacy – the ability to make sense of images and the ability to make images that make sense.

Why study technology?

With its focus on design thinking, technology education supports students to be innovative, reflective and critical in designing new models, products, software, systems and tools to benefit people while taking account of their impact on cultural, ethical, environmental and economic conditions.

The aim is for students to develop broad technological knowledge, practices and dispositions that will equip them to participate in society as informed citizens and provide a platform for technology-related careers. Students learn that technology is the result of human activity by exploring stories and experiences from their heritage, from Aotearoa New Zealand's rich cultural environment, and from contemporary examples of technology. As they learn in technology, students draw on and further develop the key competencies.

Learning area structure

The technology learning area has three strands: Technological Practice, Technological Knowledge, and Nature of Technology. These three strands are embedded within each of five technological areas:

- computational thinking for digital technologies
- designing and developing digital outcomes
- designing and developing materials outcomes
- designing and developing processed outcomes
- design and visual communication.

The following diagram illustrates the structure of the learning area.
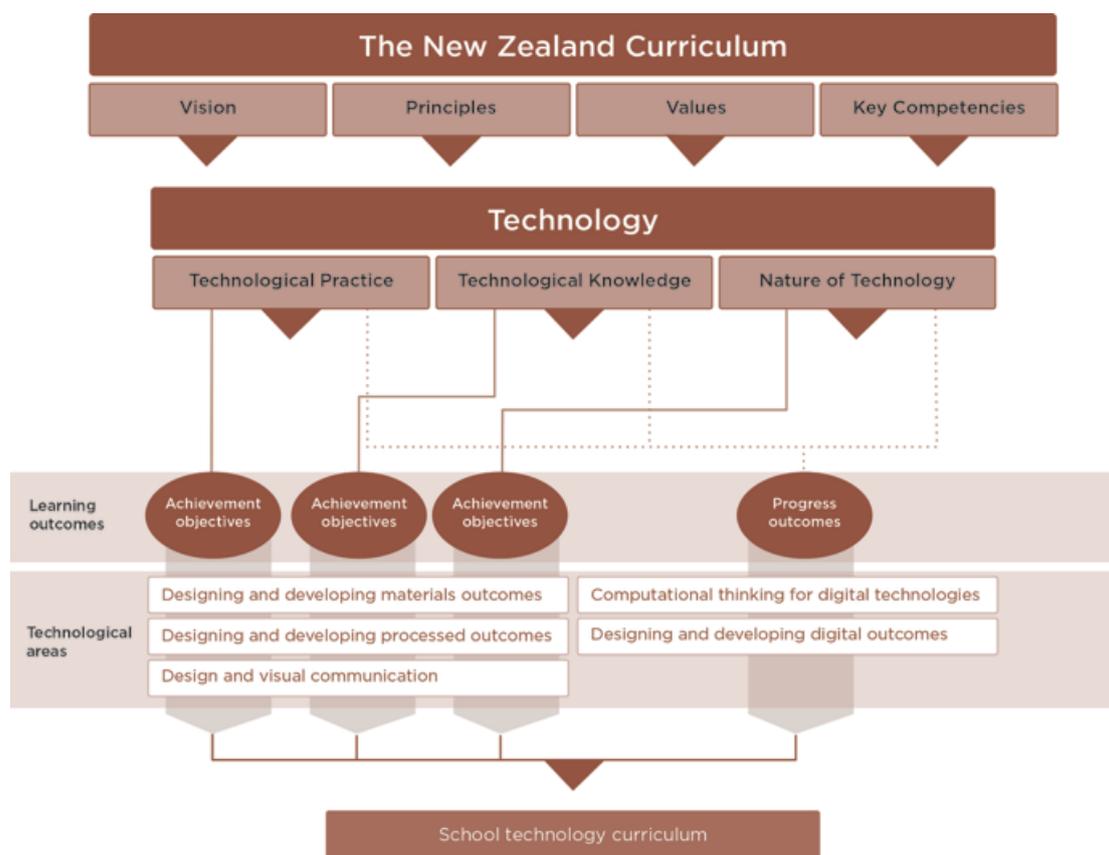
As the diagram shows, the three strands provide the organising structure for achievement objectives used in three of the technological areas (Designing and developing materials outcomes, Designing and developing processed outcomes, Design and visual communication), and they underpin progress outcomes for the other two areas (Computational thinking for digital technologies, Designing and developing digital outcomes).

Strands

Although the three strands are described separately below, in reality they are almost always integrated in teaching and learning programmes.

In **Technological Practice**, students examine the practice of others and undertake their own. They develop a range of outcomes, including concepts, plans, briefs, technological models, and fully realised products or systems. Students investigate issues and existing outcomes and use the understandings gained, together with design principles and approaches, to inform their own practice. They also learn to consider ethics, legal requirements, protocols, codes of practice, and the needs of and potential impacts on stakeholders and the environment.

Students develop **Technological Knowledge** particular to technological enterprises and environments and in relation to how and why things work. They learn how functional modeling is used to evaluate design ideas and how prototyping is used to evaluate the fitness for purpose of systems and products as they are developed. An understanding of material properties, uses and development is essential to understanding how and why products work the way they do. Similarly, an understanding of the constituent parts of systems and how these work together is essential to understanding how and why systems operate in the way they do.

For the **Nature of Technology,** students develop an understanding of technology as a discipline and of how it differs from other disciplines. They learn to critique the impact of technology on societies and the environment and to explore how developments and outcomes are valued by different peoples in different times. As they do so, they come to appreciate the socially embedded nature of technology and become increasingly able to engage with current and historical issues and to explore future scenarios.

Technological areas

The technological areas provide contexts for learning. At primary school, teachers will generally take a cross-curricular approach, with students learning in the technological areas as part of a topic or theme that encompasses several curriculum learning areas. This approach can also be applied in years 9 and 10, before students begin to specialise in particular technological areas.

Digital technologies

The first two of the five technological areas focus on developing students' capability to create digital technologies for specific purposes. In years 1–8, these two areas are usually implemented within other curriculum learning areas, integrating technology outcomes with the learning area outcomes. These two areas also significantly contribute to students developing the knowledge and skills they need as digital citizens and as users of digital technologies across the curriculum. They also provide opportunities to further develop their key competencies.

By the end of year 10, students' digital technological knowledge and skills enable them to follow a predetermined process to design, develop, store, test and evaluate digital content to address a given issue. Throughout this process, students take into account immediate social and end-user considerations. They can independently decompose a computational problem into an algorithm that they use to create a program incorporating inputs, outputs, sequence, selection and iteration. They understand the role of systems in managing digital devices, security and application software, and they are able to apply file management conventions using a range of storage devices.

By the end of year 13, students who have specialised in digital technologies will design and develop fit-for-purpose digital outcomes, drawing on their knowledge of a range of digital applications and systems and taking into account a synthesis of social, ethical and end-user considerations. They understand how areas of computer science such as network communication protocols and artificial intelligence are underpinned by algorithms, data representation and programming, and they analyse

how these are synthesised in real world applications. They use accepted software engineering methodologies to design, develop, document and test complex computer programs.

Computational thinking for digital technologies

Computational thinking enables students to express problems and formulate solutions in ways that means a computer (an information processing agent) can be used to solve them.

In this area, students develop algorithmic thinking skills and an understanding of the computer science principles that underpin all digital technologies. They become aware of what is and isn't possible with computing, allowing them to make judgments and informed decisions as citizens of the digital world.

Students learn core programming concepts and how to take advantage of the capabilities of computers, so that they can become creators of digital technologies, not just users. They develop an understanding of how computer data is stored, how all the information within a computer system is presented using digits, and the impact that different data representations have on the nature and use of this information.

Designing and developing digital outcomes

In this area, students understand that digital applications and systems are created for humans by humans. They develop increasingly sophisticated understandings and skills for designing and producing quality, fit-for-purpose, digital outcomes. They develop their understanding of the technologies people need in order to locate, analyse, evaluate and present digital information efficiently, effectively and ethically.

Students become more expert in manipulating and combining data, using information management tools to create an outcome. They become aware of the unique intellectual property issues that arise in digital systems, particularly with approaches to copyright and patents. They also develop understandings of how to build, install, and maintain computers, networks and systems so that they are secure and efficient.

Students develop knowledge and skills in using different technologies to create digital content for the web, interactive digital platforms and print. They construct digital media outcomes that integrate media types and incorporate original content. They also learn how electronic components and techniques are used to design digital devices and integrated to assemble and test an electronic environment.

Designing and developing materials outcomes

In this area, students develop knowledge and skills that enable them to form, transform and work with resistant materials, textiles and fashion. This allows them to create both conceptual and prototypic technological outcomes that solve problems and satisfy needs and opportunities. They develop knowledge about the systems, structures, machines and techniques used in manufacturing products, and they use manufacturing and quality assurance processes to produce prototypes and batches of a product.

Students' thinking becomes more and more reflective, critical and creative as they assess and critique materials outcomes in terms of quality of design, fitness for purpose, and impact and influence on society and the environment. Students become increasingly skilled in applying their knowledge of design principles to create innovative outcomes that realise opportunities and solve real-world problems.

Designing and developing processed outcomes

In this area, students develop knowledge of the materials and ingredients used to formulate food, chemical and biotechnological products. They form, transform and manipulate materials or ingredients to develop conceptual, prototypic and final technological outcomes that will meet the needs of an increasingly complex society.

Students engage in a range of processes related to food technology, biotechnology, chemical technology and agricultural technologies. They explore the impact of different economic and cultural concepts on the development of processed products, including their application in product preservation, packaging and storage. They also develop understandings of the systems, processes and techniques used in manufacturing products and gain experience from using these, along with related quality assurance procedures, to produce prototypes or multiple copies of a product.

Students demonstrate increasingly critical, reflective and creative thinking as they evaluate and critique technological outcomes in terms of the quality of their design, their fitness for purpose and their wider impacts. They become more and more skilled in applying their knowledge of design principles to create desired, feasible outcomes that resolve real-world issues.

Design and visual communication

In this area, students learn to apply design thinking. They develop an awareness of design by using visual communication to conceptualise and develop design ideas in response to a brief. In doing so, they develop visual literacy: the ability to make sense of images and the ability to make images that make sense. They apply their visual literacy through using sketching, digital modes and other modeling techniques to effectively communicate and present design ideas.

Students learn that designers identify the qualities and potential of design ideas in terms of the broad principles of design (aesthetics and function) and of sustainability. They also understand that designers are influenced by human, societal, environmental, historical and technological factors.

Learning pathways

Over the course of years 1–10, students learn in all five technological areas, developing their knowledge and skills in context. By offering a variety of contexts, teachers help their students to recognise links between technological areas. Students should be encouraged to access relevant knowledge and skills from other learning areas and to build on their developing key competencies.

Work towards progress outcomes in *computational thinking for digital technologies* and *designing and developing digital outcomes* should build each year in order to ensure learners achieve all of the significant learning steps.

In years 11–13, students work with fewer contexts in greater depth. This requires them to continue to draw fully on learning from other disciplines. For example, students working with materials and/or food technology will need to refer to chemistry, and students working on an architectural project will find that an understanding of art history is invaluable. Some schools may offer courses such as electronics and horticultural science as technology specialisations.

Learning for senior students opens up pathways that can lead to technology-related careers. Students may access workplace learning opportunities available in a range of industries or move on to further specialised tertiary study.

Development of the computational thinking for digital technologies progression

Mapping signposts

The developers and members of the oversight team met on 22 March 2017 to extend the map of signposts for the CT progression, drafted during phase 1, to levels 6–8 of the New Zealand Curriculum and consider the alignment of the current NCEA achievement standards to this progression. Signpost descriptors were drafted following this meeting, refined during the development process, and confirmed at the conclusion of the project once both progressions were complete and the Ministry of Education's consultation process had concluded. The final versions are included below.

Note that during the progression development process, the Ministry of Education made the decision to change the term used to describe each location on a progression. The rationale was that once the progressions were located in the context of the New Zealand Curriculum, alongside achievement objectives, the term "progress outcome" was more appropriate than the term "signpost". Consequently, the description below and the published updates to the New Zealand Curriculum use the term "progress outcome", while the remainder of this paper uses the term "signpost" to describe a location on a progression, as this was the term used throughout the development process.
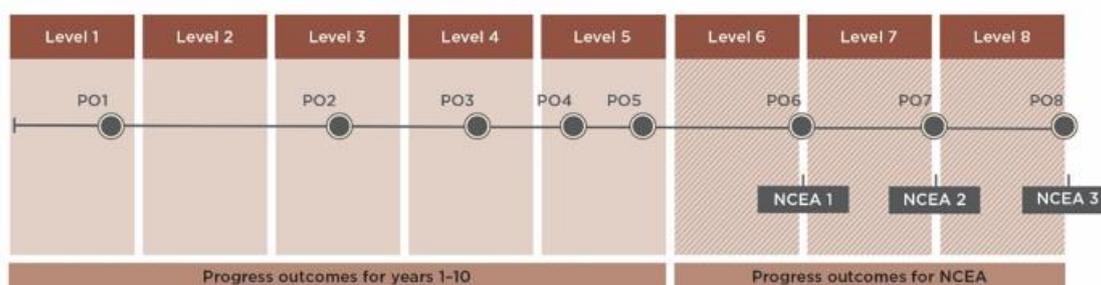
Description of the computational thinking for digital technologies progression

The progress outcomes describe the significant learning steps that students take as they develop their expertise in computational thinking for digital technologies.

The diagram below shows the alignment between levels 1–5 of the New Zealand Curriculum and the progress outcomes for computational thinking. The uneven spacing of the progress outcomes reflects the different learning and time required for each outcome and is based on data collected during the development of the digital learning progressions.

Progress outcomes 6–8 set out the learning expected for students engaging in more intensive and specialised digital technologies programmes for NCEA 1, 2 and 3. For this reason, they are directly aligned with levels 6–8 of the curriculum.

The alignment to levels 1-5 of the New Zealand Curriculum (NZC) is tentative and theoretically derived until teachers have had the opportunity to implement the digital progressions.

Progress outcome 1

In authentic contexts and taking account of end-users, students use their decomposition skills to break down simple non-computerised tasks into precise, unambiguous, step-by-step instructions (algorithmic thinking). They give these instructions, identify any errors in them as they are followed, and correct them (simple debugging).

Progress outcome 2

In authentic contexts and taking account of end-users, students give, follow and debug simple algorithms in computerised and non-computerised contexts. They use these algorithms to create simple programs involving outputs and sequencing (putting instructions one after the other) in age-appropriate programming environments.

Progress outcome 3

In authentic contexts and taking account of end-users, students decompose problems into step-by-step instructions to create algorithms for computer programs. They use logical thinking to predict the behaviour of the programs, and they understand that there can be more than one algorithm for the same problem. They develop and debug simple programs that use inputs, outputs, sequence and iteration (repeating part of the algorithm with a loop). They understand that digital devices store data using just two states represented by binary digits (bits).

Progress outcome 4

In authentic contexts and taking account of end-users, students decompose problems to create simple algorithms using the three building blocks of programing: sequence, selection, and iteration. They implement these algorithms by creating programs that use inputs, outputs, sequence, basic selection using comparative operators, and iteration. They debug simple algorithms and programs by identifying when things go wrong with their instructions and correcting them, and they are able to explain why things went wrong and how they fixed them.

Students understand that digital devices represent data with binary digits and have ways of detecting errors in data storage and transmission. They evaluate the efficiency of algorithms, recognising that computers need to search and sort large amounts of data. They also evaluate user interfaces in relation to their efficiency and usability.

Progress outcome 5

In authentic contexts and taking account of end-users, students independently decompose problems into algorithms. They use these algorithms to create programs with inputs, outputs, sequence, selection using comparative and logical operators and variables of different data types, and iteration. They determine when to use different types of control structures.

Students document their programs, using an organised approach for testing and debugging. They understand how computers store more complex types of data using binary digits, and they develop programs considering human-computer interaction (HCI) heuristics.

Progress outcome 6

In authentic contexts and taking account of end-users, students determine and compare the "cost" (computational complexity) of two iterative algorithms for the same problem size. They understand the concept of compression coding for different media types, its typical uses, and how it enables widely used technologies to function.

Students use an iterative process to design, develop, document and test basic computer programs. They apply design principles and usability heuristics to their own designs and evaluate user interfaces in terms of them.

Progress outcome 7

In authentic contexts and taking account of end-users, students analyse concepts in digital technologies (e.g., information systems, encryption, error control, complexity and tractability, autonomous control) by explaining the relevant mechanisms that underpin them, how they are used in real world applications, and the key problems or issues related to them.

Students discuss the purpose of a selection of data structures and evaluate their use in terms of trade-offs between performance and storage requirements and their suitability for different

algorithms. They use an iterative process to design, develop, document and test advanced computer programs.

Progress outcome 8

In authentic contexts and taking account of end-users, students evaluate concepts in digital technologies (e.g., formal languages, network communication protocols, artificial intelligence, graphics and visual computing, big data, social algorithms) in relation to how key mechanisms underpin them and how they are applied in different scenarios when developing real world applications.

Students understand accepted software engineering methodologies and user experience design processes and apply their key concepts to design, develop, document and test complex computer programs.

Alignment between the computational thinking for digital technologies progression and NCEA

The CT progression partially drafted in phase 1 was extended to include levels 6–8 of the New Zealand Curriculum.

The two proposed learning progressions for digital technologies are structured to ensure that once students complete year 10 they will be ready, with good teaching, to be successful in all of the NCEA achievement standards in digital technologies.

In the CT progression, this means students will have developed a base of skills and knowledge in three key areas: data representation, algorithms, and programming. These three areas map directly to the 2017 achievement standards as shown in Figure 2.

Computational thinking progression

Data representation

Algorithms

Programming

NCEA achievement standards

Understanding of computer science

Planning a computer program

Constructing a computer program
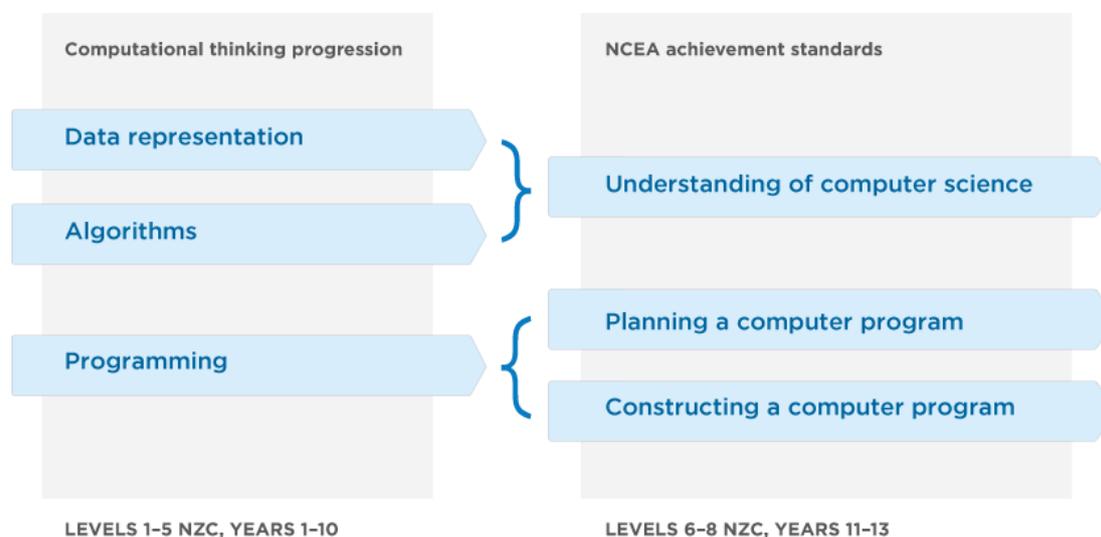
LEVELS 1–5 NZC, YEARS 1–10

LEVELS 6–8 NZC, YEARS 11–13

Figure 2. Alignment between the CT progression and current achievement standards

The data representation and algorithms areas of the CT progression map to the current achievement standards that describe the development of students' knowledge of computer science:

- Demonstrate understanding of basic concepts from computer science (L1, AS91074)

- Demonstrate understanding of advanced concepts from computer science (L2, AS91371)

- Demonstrate understanding of areas of computer science (L3, AS91636)

The programming area of the CT progression maps to the achievement standards that describe students' developing ability to plan and construct computer programs:

- Construct a plan for a basic computer program for a specified task (L1, AS91075)

- Construct a basic computer program for a specified task (L1, AS91076)

- Construct a plan for an advanced computer program for a specified task (L2, AS91372)

- Construct an advanced computer program for a specified task (L2, AS91373)

- Develop a complex computer program for a specified task (L3, AS91637)

While the achievement standards separate the planning of a computer program from its construction at levels 1 and 2, the progressions combine these elements at all signposts. The underlying rationale is that students can demonstrate they are genuine computational thinkers by planning and constructing programs.

The decision was initially made not to exemplify the signposts of the CT progression at levels 6–8 of the New Zealand Curriculum because the specialisation and complexity of the content at these higher levels makes exemplification problematic. Later in the project, this decision was reviewed, and work was subsequently undertaken to exemplify signposts 6–8 in the CT progression. This work is described in the section of this paper entitled "Exemplars for years 11–13".

Exemplar development

The developers drafted exemplars for the first five signposts of the CT progression. These are the signposts that are estimated to cover years 1–10. The developers collected student work samples and annotated these to draw out the key features of the students' work. A subject-matter expert reviewed each exemplar, with exemplars amended in response to feedback.

Table 3 shows the 17 exemplars that were drafted for signposts 1–5 of the progression.

Table 3: Exemplars for the CT progression

Signpost	Exemplars
1	Bees* Teaching robots to dance Copying a sequence (updated to Fitness routines and deleted from the progression following the online trial)
2	Repeating bees* How Māui slowed the sun Catching chickens
3	Animation* Different algorithms Coded messages (formerly Secret messages)
4	Beat the goalie game* Algorithms and programs for robotics Parity bit magic Comparing Algorithms for searching through data
5	The pirate game (formerly the penguin game*) Programming in Swift™ Playgrounds Understanding 24-bit colour calculations (formerly Creating colours from bits) Creating a colour-mixing paint program

* These exemplars were drafted in phase 1 of the project and were revised during phase 2 exemplar development.

Exploratory trials

Exploratory trials of the progression were undertaken in consultation with NZCER. The trial acted as an early check on the relative difficulty of the exemplars and provided an opportunity to collect qualitative feedback on the exemplars. Ten teachers participated in the trial: six teachers from a full primary school in Christchurch, two teachers from a Dunedin secondary school with experience teaching digital technologies at years 9–10, and two teachers supporting the implementation of digital technologies across the school who currently work with a number of schools in Dunedin.

Each teacher was interviewed individually and asked to compare pairs of exemplars to determine which of the pair describes the more sophisticated knowledge and skills in computational thinking. In addition to the paired comparisons task, participating teachers also provided feedback on the authenticity of the exemplars and the extent to which they describe rich teaching and learning. An online questionnaire was used to collect their feedback, and a copy of the questionnaire is included as Appendix A.

Following the trial, the results of the paired comparisons were analysed by NZCER, and the qualitative feedback was collated for the design team to consider.

Psychometric analysis

Measures of sophistication were calculated for each exemplar, based on the results of teachers' comparisons. These results are shown in Figure 3. The coloured diamonds indicate the sophistication measure of each exemplar, and the coloured squares indicate the average sophistication measure of the exemplars associated with a given signpost. The horizontal locations of the diamonds and squares are for visual clarity only.

Note that Figure 3 includes the codes that were used throughout the development process to identify each exemplar. The codes consisted of two letters and a two-digit number. The letters specified which progression the exemplar came from, and the numbers specified the signpost the exemplar came from and the particular exemplar. For example, the code CT23 was used to identify the third exemplar in the second signpost of the computational thinking progression.

Figure 3: Sophistication measures of the CT exemplars in the exploratory trial

In general, teachers regarded the signpost 1 exemplars as clearly less sophisticated than the signpost 2 exemplars. They also regarded the signpost 2 exemplars as clearly less sophisticated than the exemplars of signposts 3, 4, and 5. Teachers had difficulty distinguishing between the sophistication of the exemplars at signposts 3, 4, and 5, although overall signpost 3 was judged to be slightly less sophisticated than signpost 4, which in turn was judged to be slightly less sophisticated than signpost 5.

Qualitative feedback

Participating teachers were questioned about the authenticity of the collection of exemplars. All ten teachers regarded the learning tasks and student responses of the exemplars as authentic.

Teachers were also asked to provide feedback on each individual exemplar. In particular, they were questioned about the extent to which each exemplar illustrated rich teaching and learning, and asked

for any specific feedback they had on each exemplar. Responses were generally positive, but highlighted issues with two exemplars:

- CT13 (Copying a sequence) was considered to illustrate rich teaching and learning "a little" by two of the three teachers who provided feedback on this exemplar.

- The two teachers who provided specific feedback on CT21 (Repeating bees) both commented that the annotation was text-heavy, and could be improved with the use of bullet points.

Exemplar refinement

The exemplars were refined in response to both the quantitative and qualitative information that was collected in the exploratory trial.

The exemplars at signposts 4 and 5 were edited to make the complexity of the tasks clearer, with the aim of enabling teachers to distinguish between the sophistication of the exemplars at signposts 3, 4, and 5. Edits focused largely on the annotations of each exemplar and included accentuating descriptions of the technical knowledge and skills required. One exemplar also had its title changed from *Creating colours from bits* to *Understanding 24-bit colour calculations*.

The two issues identified in the qualitative feedback were addressed:

- The task in exemplar CT13 (Copying a sequence) required students to give and follow a set of precise instructions. The context was changed from an activity which required students to copy a sequence of coloured circles by colouring them in, to a physical education activity which required students to copy a sequence of exercises in a fitness circuit.

- Bullet points were added to the annotation of CT21 (Repeating bees).

Online trial

Teachers who were familiar with computational thinking in the classroom were invited to participate in the online trial via two organisations: The New Zealand Association for Computing, Digital and Information Technology Teachers (NZACDITT) and the University of Canterbury's Computer Science for Primary Schools (CS4PS). NZACDITT members are predominantly secondary school teachers, while CS4PS works with primary school teachers.

Key information about the trial was distributed via the email communication channels of these two organisations. Interested teachers responded by completing an online registration and consent form. Fifty-six registrations were received before registrations were closed, and a further nine teachers left their contact details as an indication of their interest in the trial of the second progression, planned for later in the year.

The online trial used the same comparative pairs methodology as the exploratory trial. Participating teachers were emailed a link to a web page which displayed pairs of exemplars. Teachers were asked to read a pair of exemplars and ask themselves "On balance, which of the two exemplars, paying particular attention to the student response and the annotation, describes a greater degree of sophistication in computational thinking knowledge and skills?"

Each teacher made judgments on 20 pairs of exemplars, and all 56 teachers responded to different pairs. In general, teachers worked with exemplars from the signposts that were most relevant to the year levels of the students they were currently teaching. Teachers recorded their responses on a spreadsheet, which they returned via email. Teachers' responses were collated and passed to NZCER for analysis.

Fifty-three teachers responded. Table 4 shows the year levels taught by these teachers.

Year levels taught	Number of teachers
Years 0–3	7
Years 4–6	13
Years 7–8	13
Years 9–10	20
TOTAL	53

In addition to the paired comparisons task, teachers also completed an online questionnaire which collected their feedback on the authenticity and transferability of the exemplars, and the extent to which they illustrated rich teaching and learning. A copy of the questionnaire is included in Appendix B.

Psychometric analysis

Sophistication measures were calculated for the each exemplar, based on the teachers' comparisons. Figure 4 shows these results. As with Figure 3, the coloured diamonds indicate the sophistication measure of each exemplar, and the coloured squares indicate the average sophistication measure of the exemplars associated with a given signpost. The horizontal locations of the diamonds and squares are for visual clarity only.
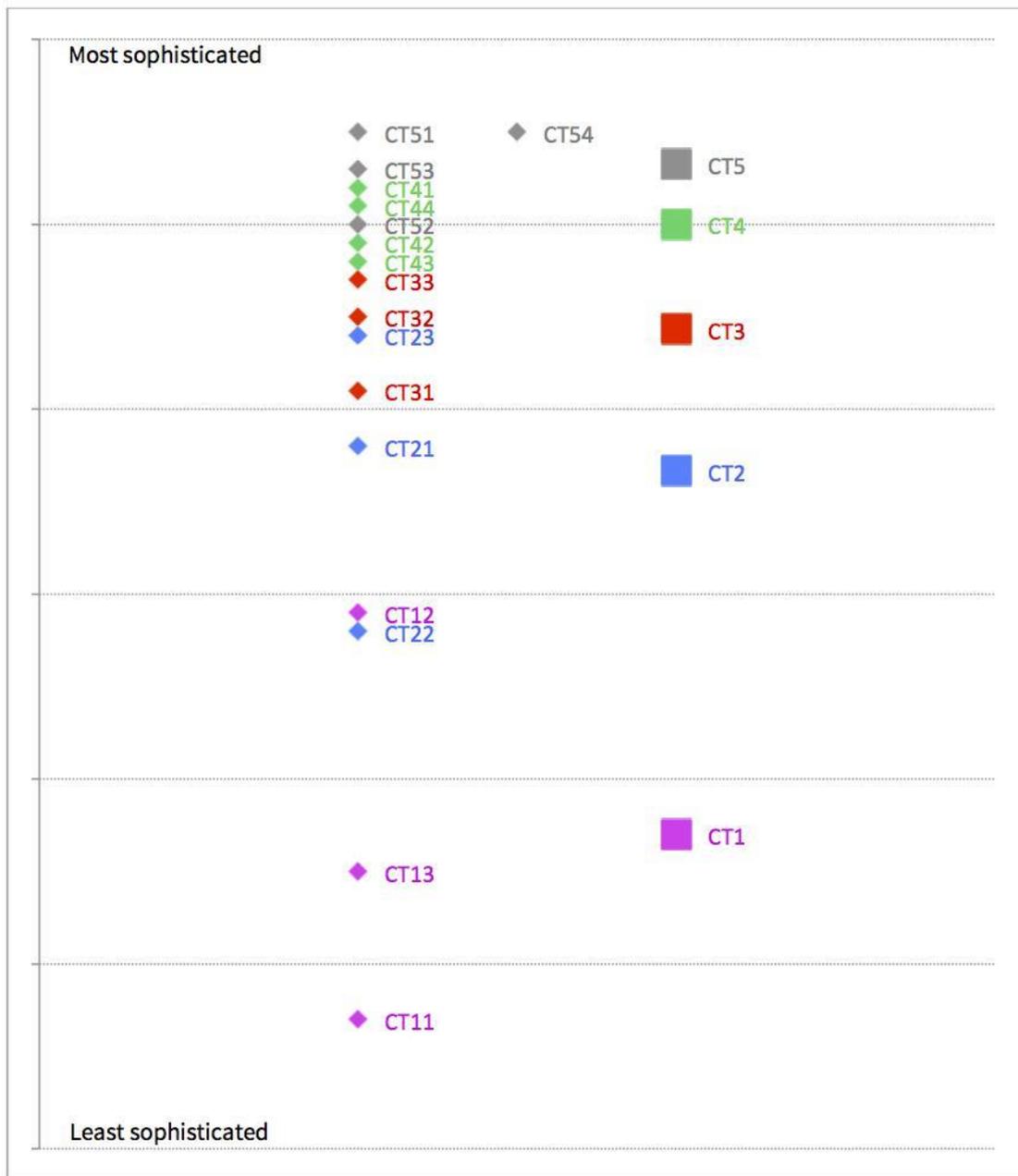
Figure 4: Sophistication measures of the CT exemplars in the online trial

The five signposts of the progression had detectably different sophistication measures, within measurement error. Teachers regarded the signpost 1 exemplars as clearly less sophisticated than the signpost 2 exemplars, which were clearly less sophisticated than the signpost 3 exemplars, and so on. While teachers were able to clearly distinguish between the sophistication of all of the signposts, they were not necessarily able to distinguish between the sophistication measures of the exemplars associated with each signpost. For example, CT52 (Understanding 24-bit colour calculations) a signpost 5 exemplar, was perceived to have a sophistication level that was within the range of the exemplars of signpost 4.

Qualitative feedback

Survey data were collated, and key themes in closed responses were identified. All open comment fields were coded to identify common themes. Any themes identified by more than five percent of participants were described.

In general, participating teachers regarded the exemplars as authentic. Ninety-four percent of teachers indicated that the learning tasks in the exemplars appeared authentic, while 91% indicated that student responses appeared authentic.

> *They showed a good range of CS activities in different contexts. They used resources that would be available in a typical classroom and the lesson sequences to get to the point of the exemplar were well explained.*

> *Yes, they were very good examples of how to teach computer science and would be something that I would use with a class.*

> *Student and teacher interactions look like typical classroom feedback.*

> *Typical child responses of different ages and stages.*

All teachers felt that, in general, the exemplars illustrated rich teaching and learning. When questioned on the extent of this, 55% of teachers noted that, in their opinion, the exemplars illustrated rich teaching and learning "quite a bit", while 45% noted the exemplars illustrated rich teaching and learning "a lot".

> *I think that these exemplars show rich learning and teaching in that the challenges they are taking on relate directly to the topic and the concepts match with real computational thinking.*

> *They were tied into real-world issues and problems so the students could see a reason behind the problem.*

One exemplar, CT13 (Fitness routines) was identified by 8% of teachers as not illustrating rich teaching and learning.

Teachers were asked whether the computational thinking exemplars would be reasonably transferable to their own school context. Seventy-nine percent of teachers indicated that the exemplars would be reasonably transferable.

> *I could easily reuse some as they are presented, and remix others to suit.*

> *I could use these ideas with my students. Even changing the context would not be difficult. Well done team!*

Nineteen percent of teachers were unsure whether the exemplars would be transferable to their own school context, and 2% believed they would not be transferable. Two factors that would limit the transferability were identified. Firstly, 9% of participants noted that teachers at their school would need support to implement the teaching and learning exemplified. Secondly, 6% of participants indicated that the students' understandings and use of language exemplified would be too complex for the current capability of students in their school.

Staffing would be major issue - few staff would be able to teach these lessons.

Would need some PLD to feel comfortable with the vocabulary and understanding of the tasks.

The challenge is really based on where the children are at more than anything else. As they develop they will become more familiar with some of the concepts.

It seems that the schools in the exemplars have been immersing their students in computer science and coding for a while. My school has not started this journey and we would need much more basic exemplars to start.

Teachers made a wide range of other comments about the exemplars, or the computational thinking progression more generally. The one common theme in these comments was that the exemplars contained some good teaching and learning activities. Six percent of participating teachers expressed this view.

Some really nice tasks here that should give teachers good ideas about how to incorporate this thinking in other contexts they already use.

There are some well thought out activities.

Teachers' responses indicated that they were familiar with teaching digital technologies in the classroom. Sixty-eight percent of participants noted they were classroom teachers, with 51% noting they held responsibility for digital technologies within the school. Almost all participating teachers (97%) indicated they were familiar with the types of tasks in the exemplars. Twenty-five percent of teachers indicated the tasks were "very familiar" to them as they regularly teach similar activities, and 72% indicated they were "somewhat familiar" as they sometimes teach similar activities.

Teachers provided a wide range of specific feedback on the exemplars they had viewed. There were no common themes in these comments, however two pieces of feedback were noted. One teacher commented that the code in exemplar CT51 (Programming in swift playgrounds) did not successfully carry out the set task (to collect the right number of gems and toggle open the right number of switches). Another teacher commented that exemplar CT52 (Understanding 24-bit colour calculations) needed the student to make one of the calculations manually to show understanding (rather than using a spreadsheet the teacher had provided). This comment was in keeping with the quantitative feedback on CT52.

Exemplar refinement

Three exemplars were amended on the basis of results from the online trial:

- The code in exemplar CT51 (Programming in swift playgrounds) was checked to ensure it successfully carried out the set task. While the code was correct for the task given (collect all of the gems, and then toggle all of the switches in order), it was altered so that it would be more robust and would run successfully in a slightly different task (gems and switches intermingled).

- CT52 (Understanding 24-bit colour calculations) was edited to ensure the complexity of the student understanding was evident. In particular, a transcript was added to show the student comparing 8-bit vs 16-bit vs 24-bit colour and explaining why the bit depth makes a difference to image quality (the greater the number of bits, the greater the number of shades that can be displayed).

- CT13 (Fitness routines) was removed from signpost 1 as the student understandings it described were included in the other two exemplars at that signpost: CT 11 (Bees) and CT 12 (Teaching robots to dance).

In addition to these changes, all of the exemplars were edited and information about students' use of the New Zealand Curriculum key competencies in each of the learning tasks was added. Where possible, tasks which involved the integration of digital technology with another learning area were also highlighted.

The context of exemplar CT54 (The penguin game) was changed from one which involved penguins to one which involved pirates stealing coins. The programming carried out by the student was the same in both contexts, but the pirate context did not involve "loss of life".

Design and style of exemplars

Two final steps were taken by the development team to complete the exemplars. An editor carried out a style edit across all exemplars, and a graphic designer styled the exemplars for publication. The edited and designed exemplars were delivered to the Ministry in August 2017.

Publication edits

The Ministry engaged a contractor to publish the exemplars. The publication team edited the learning area statement, progress outcomes (signpost descriptors), and all exemplars to ensure there was consistency across all aspects of the work. The development team worked with the publication team to ensure that any suggested changes retained the integrity of the digital technologies content and the authenticity of the exemplars.

Development of the designing and developing digital outcomes progression

Mapping signposts

The developers and members of the oversight team met on 1–2 May 2017 to map the signposts of the DDDO progression for levels 1–8 of the New Zealand Curriculum. Five signposts were initially drafted, and these were refined during the development process and reviewed at the conclusion of the project, following the completion of both progressions and results from the Ministry of Education's consultation process. The completed progression included six signposts, and the final description of these is included below.

Note that during the progression development process, the Ministry of Education made the decision to change the term used to describe each location on a progression. The rationale was that once the progressions were located in the context of the New Zealand Curriculum, alongside achievement objectives, the term "progress outcome" was more appropriate than the term "signpost". Consequently, the description below and the published updates to the New Zealand Curriculum use the term "progress outcome", while the remainder of this paper uses the term "signpost" to describe a location on a progression, as this was the term used throughout the development process.
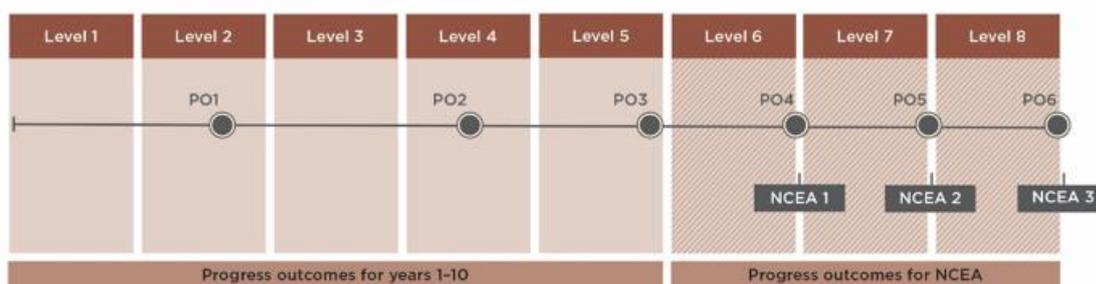
Description of the designing and developing digital outcomes progression

The progress outcomes describe the significant learning steps that students take as they develop their expertise in designing and developing digital outcomes.

The diagram below shows the alignment between levels 1–5 of the New Zealand Curriculum and the progress outcomes for designing and developing digital outcomes. The uneven spacing of the progress outcomes reflects the different learning and time required for each outcome and is based on data collected during the development of the digital learning progressions.

Progress outcomes 4–6 set out the learning expected for students engaging in more intensive and specialised digital technologies programmes for NCEA 1, 2 and 3. For this reason, they are directly aligned with levels 6–8 of the curriculum.

The alignment to levels 1-5 of the New Zealand Curriculum (NZC) is tentative and theoretically derived until teachers have had the opportunity to implement the digital progressions.

Progress outcome 1

In authentic contexts and taking account of end-users, students participate in teacher-led activities to develop, manipulate, store, retrieve and share digital content in order to meet technological challenges. In doing so, they identify digital devices and their purposes and understand that humans make them. They know how to use some applications, they can identify the inputs and outputs of a system, and they understand that digital devices store content, which can be retrieved later.

Progress outcome 2

In authentic contexts and taking account of end-users, students make decisions about creating, manipulating, storing, retrieving, sharing and testing digital content for a specific purpose, given particular parameters, tools, and techniques. They understand that digital devices impact on humans and society and that both the devices and their impact change over time.

Students identify the specific role of components in a simple input-process-output system and how they work together, and they recognise the "control role" that humans have in the system. They can select from an increasing range of applications and file types to develop outcomes for particular purposes.

Progress outcome 3

In authentic contexts, students follow a defined process to design, develop, store, test and evaluate digital content to address given contexts or issues, taking into account immediate social, ethical and end-user considerations. They identify the key features of selected software and choose the most appropriate software and file types to develop and combine digital content.

Students understand the role of operating systems in managing digital devices, security, and application software and are able to apply file management conventions using a range of storage devices. They understand that with storing data comes responsibility for ensuring security and privacy.

Progress outcome 4

In authentic contexts, students investigate and consider possible solutions for a given context or issue. With support, they use an iterative process to design, develop, store and test digital outcomes, identifying and evaluating relevant social, ethical and end-user considerations. They use information from testing and apply appropriate tools, techniques, procedures and protocols to improve the quality of the outcomes and to ensure they are fit-for-purpose and meet end-user requirements.

Progress outcome 5

In authentic contexts and with support, students investigate a specialised digital technologies area (e.g., digital media, digital information, electronic environments, user experience design, digital systems) and propose possible solutions to issues they identify. They independently apply an iterative process to design, develop, store and test digital outcomes that enable their solutions, identifying, evaluating, prioritising and responding to relevant social, ethical and end-user considerations. They use information from testing and, with increasing confidence, optimise tools, techniques, procedures and protocols to improve the quality of the outcomes. They apply evaluative processes to ensure the outcomes are fit-for-purpose and meet end-user requirements.

Progress outcome 6

In authentic contexts, students independently investigate a specialised digital technologies area and propose possible solutions to issues they identify. They work independently or within collaborative, cross-functional teams to apply an iterative development process to plan, design, develop, test and create quality, fit-for-purpose digital outcomes that enable their solutions, synthesising relevant social, ethical and end-user considerations as they develop digital content.

Students integrate in the outcomes they develop specialised knowledge of digital applications and systems from a range of areas, including: network architecture; complex electronics environments and embedded systems; interrelated computing devices, hardware and applications; digital information systems; user experience design; complex management of digital information; and creative digital media.

Alignment between the designing and developing digital outcomes progression and NCEA

As described above, the two proposed learning progressions for digital technologies are structured to ensure that once students have completed year 10 they will be ready, with good teaching, to be successful in all of the NCEA achievement standards in digital technologies.

The team considered the alignment of the DDDO progression with levels 6–8 of the New Zealand Curriculum. Twenty-seven of the current achievement standards were identified as relevant to the progression. While there are connections between the progression and the standards, the number and specialisation of the standards meant that it was not feasible to directly align the key areas of the progression with the 2017 achievement standards.

The decision was initially made not to create exemplars for signposts that were estimated to represent learning in senior secondary school because the specialisation and complexity of the content at these higher levels makes exemplification problematic. Later in the project, this decision was reviewed, and work was subsequently undertaken to exemplify these signposts. This work is described in the section of this paper entitled "Exemplars for years 11–13".

Exemplar development

The developers drafted exemplars for the first three signposts of the DDDO progression. These are the signposts that are estimated to cover students at years 1–10. Student work samples were collected and annotated to highlight the relevant features of students' work. Each exemplar was reviewed by a subject-matter expert and amended in response to feedback.

Table 5 shows the 14 exemplars for signposts 1–3 of the DDDO progression. Note that 12 exemplars were initially drafted, and two exemplars were added following the exploratory trial.

Table 5: Exemplars for the DDDO progression

Signpost	Exemplars
1	Identifying digital devices Input/output flow chart Developing a stop-motion video animation Papertronics (deleted following the online trial) Bottle-cap input (added following the exploratory trial)
2	Input/process/output video QR-code scavenger hunt Robotic systems and society (split into two exemplars following the exploratory trial) Collecting data for science fair (deleted following the combined trial) Robotic systems (split from Robotic systems and society)
3	Operating systems and file management in game design Our changing digital society – operating systems and digital devices Developing a digital media outcome – logo and business card design Developing a game – team digital media project

Exploratory trials

Exploratory trials of the progression were undertaken in consultation with NZCER from 24–28 July. The trials collected information on teachers' perceptions of the authenticity of the exemplars, and provided an opportunity to check they were being interpreted as intended. Initial information on the relative sophistication of exemplars was also obtained.

Eleven teachers participated in the trial: six teachers from a full primary school in Christchurch, three teachers from two Dunedin secondary schools with experience teaching digital technologies at years 9–10, and two teachers with experience teaching digital technologies at all year levels who currently work with a number of schools in Dunedin.

Each teacher was interviewed individually and asked to compare pairs of exemplars to determine which of the pair describes the more sophisticated knowledge and skills in designing and developing digital outcomes. In addition to the paired comparisons task, participating teachers also provided feedback on the authenticity of the exemplars and the extent to which they describe rich teaching and learning. An online survey was used to collect their feedback, and a copy of the survey is included as Appendix A.

Following the trial, the results of the paired comparisons were analysed by NZCER, and the feedback was collated for the design team to consider.

Psychometric analysis

Measures of sophistication were calculated for each exemplar, based on the results of teachers' comparisons. These results are shown in Figure 5. The coloured diamonds indicate the sophistication measure of each exemplar, and the coloured squares indicate the average sophistication measure of the exemplars associated with a given signpost. The horizontal locations of the diamonds and squares are for visual clarity only.

Note that as with Figures 3 and 4, Figure 5 includes the codes that were used throughout the development process to identify each exemplar. For example, DO32 identifies the second exemplar in the third signpost of the DDDO progression.
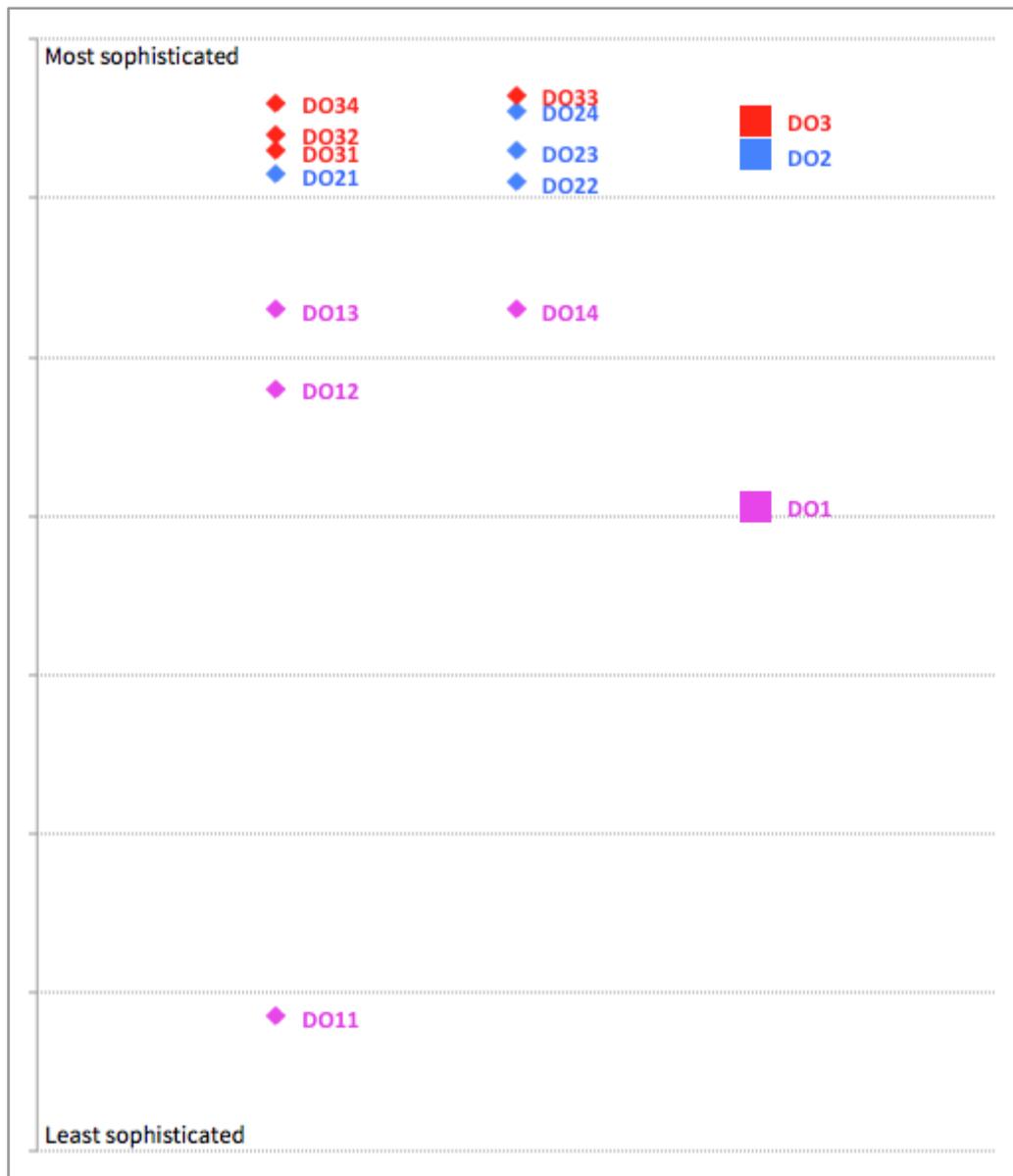
Most sophisticated

- DO34
- DO32
- DO31
- DO21
- DO33
- DO24
- DO23
- DO22
- DO3
- DO2
- DO13
- DO14
- DO12
- DO1
- DO11

Least sophisticated

Figure 5: Sophistication measures of DDDO exemplars in the exploratory trial

In general, teachers regarded the exemplars at signpost 1 as clearly less sophisticated than the exemplars at signpost 2. In turn, they regarded the exemplars at signpost 2 as less sophisticated than the exemplars at signpost 3, but they had some difficulty in distinguishing between the sophistication of the exemplars at these two signposts. Additionally, teachers were able to distinguish between the sophistication of the exemplars at signposts 1 and 2, and DO11 was considered to be the least sophisticated exemplar overall.

Qualitative feedback

Participating teachers were questioned about the authenticity of the collection of exemplars. All eleven teachers regarded the learning tasks and student responses of the exemplars as authentic.

Teachers were also asked to provide feedback on each individual exemplar. In particular, they were questioned about the extent to which each exemplar illustrated rich teaching and learning, and asked

for any specific feedback they had on each exemplar. Responses were generally positive, but highlighted issues with three exemplars:

- Exemplar DO11 (Identifying digital devices) was considered to illustrate rich teaching and learning "not at all" or "a little" by 7 of the 11 participating teachers.

- Exemplar DO12 (Input/output flowchart) was considered to illustrate rich teaching and learning "not at all" or "a little" by 6 of the 11 participating teachers.

- The 3 teachers of digital technologies at years 9 and 10 indicated that adding more evidence of the students' planning and research to exemplar DO34 (Designing a game – team digital media project) would show the technology process in action more clearly.

Exemplar refinement

The exemplars were refined in response to the qualitative information that was collected in the exploratory trial. The three issues identified were addressed:

- The task in exemplar DO11 (Identifying digital devices) was replaced. The teaching task in the original version involved students creating a slideshow to show different digital devices in their homes and classroom and explaining what they use these devices for. The task in the new version involved students creating an advertisement that showcases the advantages of the digital object, over a version of the object that is not digital. For example a traditional vacuum cleaner and a robot vacuum cleaner. In addition to being richer, the new task was also developed to be slightly more sophisticated than the original task.

- A second exemplar was developed to illustrate student understanding of the input/output process. The task in the original exemplar DO12 (Input/output flowchart) involved students creating a flowchart to show the sequence of giving input to a digital device; the process the device performs; and the output the device gives. For example, "we use the remote → the TV turns on → we can watch the TV." The task in the new exemplar, DO15 (Bottle-cap input) involved students creating a musical instrument out of everyday objects, a Makey Makey controller, and a simple Scratch program. The instrument provides the input and the sounds are the outputs. Both exemplars were included in the online trial.

- Further evidence of the students' design and development process was added to exemplar DO34 (Designing a game – team digital media project).

Two other additional changes were made:

- Exemplar DO33 (Developing a digital media outcome – logo and business card design) was edited. Some of the student work in the portfolio was removed, and it was replaced with a transcript of the dialogue between the student and teacher to illustrate the student's understandings. This change was made to increase the variety in the way student understanding was exemplified in the signpost 3 exemplars.

- One component of the student work in exemplar DO23 (Robotic systems) was removed and developed into a new exemplar: DO25 (Robotic systems and society). The change was made to increase the clarity of focus in each of these exemplars.

No actions were taken to further differentiate the sophistication levels of the exemplars at signposts 2 and 3, as it was considered that teachers of years 9 and 10, who have more specialised subject knowledge, would be able to clearly distinguish between the exemplars at these two signposts.

Online trial

Teachers who had participated in the online trial of the CT progression were invited to participate in the online trial of the DDDO progression. Key information about the online trial was emailed directly to teachers, and they were invited to respond by completing an online registration and consent form. Fifty-four registrations were received before registrations were closed, and one teacher left their contact details as an indication of interest in the framework trial planned for later in the year.

The online trial used the same comparative pairs methodology as the CT progression trials and the exploratory trial of the DDDO progression. Participating teachers were emailed a link to a web page which displayed pairs of exemplars. Teachers were asked to read a pair of exemplars and ask themselves "On balance, which of the two exemplars, paying particular attention to the student response and the annotation, describes a greater degree of sophistication in the knowledge and skills required to design and develop digital outcomes?"

Each teacher made judgments on 20 pairs of exemplars, and teachers responded to one of the twelve different sets of questions. In general, teachers worked with exemplars from the signposts that were most relevant to the year levels of the students they were currently teaching. There were two different sets of questions for teachers at years 0–3, three sets of questions for teachers at years 4–6, three sets of questions for teachers at years 7–8, and four sets of questions for teachers at years 9–10. Teachers recorded their responses on a spreadsheet, which they returned via email. Teachers' responses were collated and passed to NZCER for analysis.

Fifty-one teachers responded. Table 6 shows the year levels taught by these teachers.

Table 6: Teachers in the online trial

Year levels taught	Number of teachers
Years 0–3	6
Years 4–6	13
Years 7–8	11
Years 9–10	21
TOTAL	51

In addition to the paired comparisons task, 50 teachers also completed an online questionnaire which collected their feedback on the authenticity and transferability of the exemplars and the extent to which they illustrated rich teaching and learning. The questionnaire was very similar to the one used in the online trial of the CT progression, but included three additional questions which focused on the nature of student activities in digital technologies, and how difficult teachers found it to make decisions about the relative sophistication of the exemplar. These three additional questions are included in Appendix C.

Psychometric analysis

Measures of sophistication were calculated for each exemplar, based on the results of teachers' comparisons. These results are shown in Figure 6. As with previous figures, the coloured diamonds indicate the sophistication measure of each exemplar, and the coloured squares indicate the average sophistication measure of the exemplars associated with a given signpost. The horizontal locations of the diamonds and squares are for visual clarity only.

Each exemplar is identified by the code that was used throughout the development process. For example, DO32 identifies the second exemplar in the third signpost of the DDDO progression.
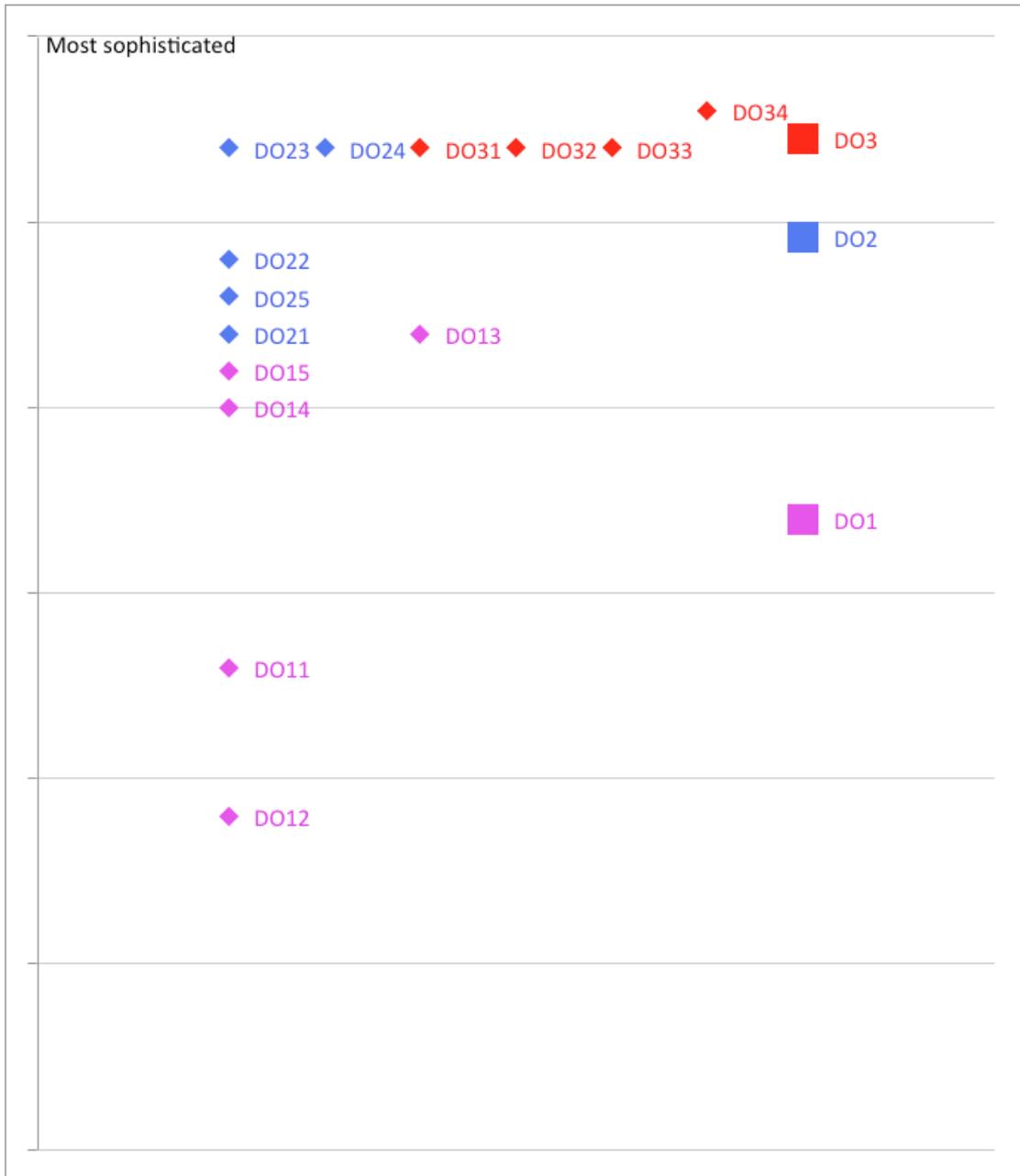
Figure 6: Sophistication measures of DDDO exemplars in the online trial

In general, teachers regarded the exemplars at signpost 1 as clearly less sophisticated than the exemplars at signpost 2. In turn, they regarded the exemplars at signpost 2 as less sophisticated than the exemplars at signpost 3, but they had some difficulty in distinguishing between the sophistication of the exemplars at these two signposts. Additionally, teachers were able to distinguish between the sophistication of the individual exemplars at signposts 1 and 2, and DO11 and DO12 were considered to be the least sophisticated exemplars overall.

Qualitative feedback

Survey data were collated, and key themes in closed responses were identified. All open comment fields were coded to identify common themes. Any themes identified by more than five percent of participants were described.

In general, participating teachers regarded the exemplars as authentic. One hundred percent of teachers indicated that the learning tasks in the exemplars appeared authentic, while 94% indicated that student responses appeared authentic.

> *Having been involved with a number of these such as Robocop, film etc I can see how these tasks have been created*

> *They all have examples and dialogue that make you feel like they have been completed by real students.*

> *I could totally see pupils writing these.*

> *They sound like something children would say.*

Almost all teachers felt that, in general, the exemplars illustrated rich teaching and learning. When questioned on the extent of this, 56% of teachers noted that, in their opinion, the exemplars illustrated rich teaching and learning "quite a bit", while 40% noted the exemplars illustrated rich teaching and learning "a lot".

> *Most tasks are open ended and have rich conversations between teacher and student(s).*

> *All tasks required independent problem solving and/or critical analysis, and Creativity!*

One exemplar, DO12 (Input/output flowchart) was identified by 14% of teachers as not illustrating rich teaching and learning.

Teachers were asked whether the designing and developing digital outcomes exemplars would be reasonably transferable to their own school context. Eighty-two percent of teachers indicated that the exemplars would be reasonably transferable.

> *Yes, with the correct set up this could be used in many locations.*

> *I could see myself using these tasks. …. Nice tasks to demonstrate some of that deeper knowledge and thinking.*

Eight percent of teachers were unsure whether the exemplars would be transferable to their own school context, and 10% believed they would not be transferable. One factor that would limit their transferability was identified: 6% of teachers commented that sourcing the required equipment would be problematic.

> *Buying some equipment would be costly and therefore limiting.*

> *Some require equipment that I don't have funding for.*

Teachers made a wide range of other comments about the exemplars, or the designing and developing digital outcomes progression more generally. The one common theme in these comments was that it was good to see cross-curricular links in the exemplars. Eighteen percent of participating teachers expressed this view.

Nice across curriculum learning.

Lots of integrated curriculum opportunities here.

Teachers' responses indicated that they were familiar with teaching digital technologies in the classroom. Sixty-six percent of participants noted they were classroom teachers, with 54% noting they held responsibility for digital technologies within the school. Almost all participating teachers (92%) indicated they were familiar with the types of tasks in the exemplars. Thirty-six percent of teachers indicated the tasks were very familiar to them as they regularly teach similar activities, and 56% indicated they were somewhat familiar as they sometimes teach similar activities.

Teachers provided a wide range of specific feedback on the exemplars they had viewed. There were two common themes in these comments. Three teachers commented that there was little evidence of student understanding in exemplar D025 (Robotic systems and society), and students could have obtained the information by copying and pasting. Four teachers commented that it would be helpful if student understanding was demonstrated in ways other than written reports (made in relation to DO23, DO25, and DO31).

Teachers were asked two specific questions about students' activities in digital technologies. Two activities were listed, and teachers were questioned about the importance of these in digital technologies, and the extent to which each was included in the exemplars. Table 7 shows teachers' views on the importance of the activities.

Table 7: Importance of student activities in DT

Student activity	Not important	Important	Very important
Using digital devices to create a variety of products or achieve a range of outcomes.	0%	26%	74%
Designing and developing digital outcomes: products, systems, or devices.	0%	18%	82%

All teachers regarded both activities as "important", with a substantial proportion regarding each as "very important". Seventy-four percent of teachers noted that using digital devices to create a variety of products or outcomes was very important in digital technologies, and 82% noted that designing and developing digital outcomes was very important. Teachers' responses also indicated that the exemplars included both of these student activities, with 84% indicating there were a lot of activities in the exemplars that involved using digital devices to create a variety of products or outcomes, and 80% noting there were a lot of exemplars that involved designing and developing digital outcomes. Teachers' comments also reiterated the value of both of these activities.

I like the project based design and development process as I think it provides a richer learning experience. However developing a proficiency in the use of digital devices, applications and managing digital systems, may be necessary for successful project outcomes..

There appeared to be a mix of both outcomes in the exemplars.

Tim Bell (critical friend to the project) was consulted at this point to discuss a growing concern over the focus of the DDDO progression and its relationship to the other technological areas. Tim agreed that it would be helpful to consult the wider technology group to gain their perspectives.

Exemplar refinement

A meeting of the technology working group was held to consider the positioning of the digital technologies progressions within the broader technology learning area. As described previously (see section entitled "Positioning digital technologies within technology and the New Zealand Curriculum") the group included practising teachers and subject-matter experts with expertise in the broader technology area (areas other than digital technologies), and a number of professional associations were represented.

The meeting took place over two days (11 and 13 September) and in two locations (Wellington and Dunedin) to maximise attendance. Ministry of Education representatives also attended the Wellington meeting.

Overall, the group reconfirmed the proposed structure of the technology learning area to include five technological areas, including DDDO. They agreed that the description of the DDDO area, the signpost statements and the exemplars needed to focus more explicitly on the digital aspect of the design and development process, and they expressed concern that if this was not addressed the DDDO learning progression will not provide sufficient support for teachers to understand and teach this aspect of digital technologies.

In order to address their concerns, the group revised the description of the DDDO learning area, identified a number of issues with the exemplars, developed some criteria to guide exemplar revision, and identified the extent of the revisions required for each exemplar.

The group identified the following issues with the exemplars.

- They do not provide sufficient clarification between using (consumers of) and developing (creators of) digital outcomes.

- The design component is not sufficiently visible.

- The digital outcomes of each exemplar are not sufficiently "called out" or focused on. In many cases they are lost in the detail of the "project".

- The digital purpose of the exemplar is not explicit – the lens is not focused enough on the digital component.

- If the digital outcome is part of the process (i.e., not the final outcome) then the digital technologies knowledge and skills need to be more explicitly noted and/or interrogated.

The following criteria were developed to guide the revision of exemplars.

- The design component needs to be explicit in each exemplar.

- The exemplar needs to include developing a digital outcome (which is NOT just using a digital tool or application).

- The digital outcome needs to be central to the exemplar and explicitly described.

A small working group was established to carry out the required revisions. The group worked together on 2–3 October in New Plymouth. In addition to addressing the revisions identified by the technology working group, the developers addressed the following issues identified in the online trial.

- Dialogue was added to exemplar DO12 (Input/output flowchart) to demonstrate the depth of student understanding involved and address the concern that the exemplar did not illustrate rich teaching and learning.

- The task was strengthened to include a class debate around the pros and cons of robots and robotic systems in society in exemplar DO25 (Robotic systems and society). Dialogue was also added to capture student discussion of these pros and cons. This addressed the concern that there was little evidence of student understanding.

- Student reports were removed from three exemplars to address teachers' comments that it would be helpful if student understanding was demonstrated in a variety of ways. Exemplar DO25 (Robotic systems and society) was changed as above, and student documentation of the robot-building process was removed from the task in DO23 (Robotic systems). In exemplar DO34 (Designing a game – team digital media project), some of the written student work was removed, and more dialogue was added.

The decision was made to repeat the online trial, due to the extent of the revisions that had been carried out. CT exemplars were also included in this trial to enable the relative sophistication of exemplars on both progressions to be established. This was referred to as the combined trial.

Combined online trial

Teachers who had participated in the online trial of either the CT or the DDDO progression were invited to participate in the combined trial. Key information about the trial was emailed directly to teachers, and they were invited to respond by completing an online registration and consent form. Fifty-five registrations were received.

The online trial used the same comparative pairs methodology as previous trials. Participating teachers were emailed a link to a web page which displayed pairs of exemplars. Teachers were asked to read a pair of exemplars and ask themselves "On balance, which of the two exemplars, paying particular attention to the student response and the annotation, describes a greater degree of sophistication in the knowledge and skills required for digital technologies?"

Each teacher made judgments on up to 27 pairs of exemplars, and teachers responded to one of the twelve different sets of questions. In general, teachers worked with exemplars from the signposts that were most relevant to the year levels of the students they were currently teaching. There were two different sets of questions for teachers at years 0–3, three sets of questions for teachers at years 4–6, three sets of questions for teachers at years 7–8, and four sets of questions for teachers at years 9–10. Teachers recorded their responses on a spreadsheet, which they returned via email. Teachers' responses were collated and passed to NZCER for analysis.

Fifty teachers responded, with one teacher completing two sets of questions. Table 7 shows the year levels taught by these teachers.

Table 7: Teachers in the combined trial

Year levels taught	Number of teachers
Years 0-3	6
Years 4-6	11
Years 7-8	10
Years 9–10	23
TOTAL	50

In addition to the paired comparisons task, 46 teachers also completed an online questionnaire which collected their feedback on the authenticity and transferability of the exemplars and the extent to which they illustrated rich teaching and learning. The questionnaire repeated the same questions that were used in the online trial.

Psychometric analysis

Two different purposes were served with the one dataset and psychometric analysis.

Firstly, the analysis provided information about the relative sophistication of exemplars in the DDDO progression. These results are shown in Figure 7. As with previous figures, the coloured diamonds indicate the sophistication measure of each exemplar, and the coloured squares indicate the average sophistication measure of the exemplars associated with a given signpost. The horizontal locations of the diamonds and squares are for visual clarity only. Each exemplar is identified by the code that was used throughout the development process. For example, DO32 identifies the second exemplar in the third signpost of the DDDO progression.

Figure 7: Sophistication measures of DDDO exemplars in the combined trial

In general, teachers tended to find the exemplars at signpost 1 less sophisticated than the exemplars at signpost 2. In turn, they tended to find the exemplars at signpost 2 less sophisticated than the exemplars at signpost 3. Additionally, teachers located the exemplars at signpost 3 across a narrow range of the scale, indicating they all represent a similar level of sophistication. In comparison, the exemplars at signpost 2 were located across a broader range of the progression, which overlapped with the range occupied by the exemplars of both signpost 1 and signpost 3.

The analysis also provided information about the relative sophistication of the DDDO and CT progressions. These results are shown in Figure 8.
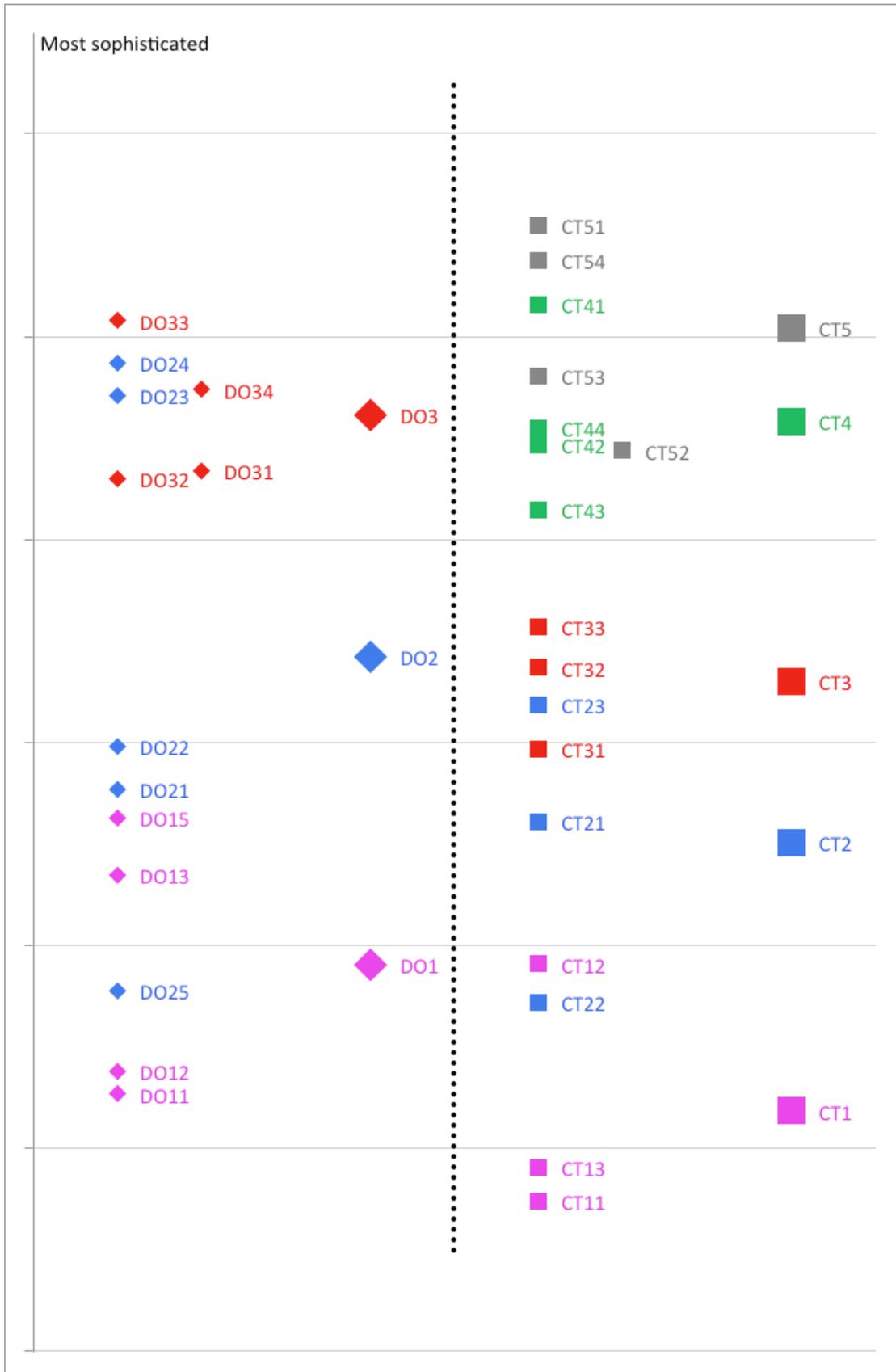
35

Most sophisticated

Figure 10: Sophistication measures of DDDO and CT exemplars in the combined trial

Figure 8 suggests that aside from the issues associated with the exemplars of DDDO signpost 2, the measures of sophistication for the two progressions align as expected.

Because the combined trial used a different psychometric model from the previous online trials, analysis for the CT online trial was repeated using the model employed in the combined trial. Results confirmed the initial analysis.

Qualitative feedback

Teachers' feedback in the combined trial was generally positive and very similar to that received in the online trial. Results on the authenticity and transferability of the exemplars were the same in both trials within a few percentage points. In the combined trial, 100% of teachers indicated that the tasks in the exemplars were authentic, and 94% of teachers indicated that the student responses were authentic. Further, 98% of teachers in the combined trial indicated that the exemplars illustrated rich teaching and learning either "quite a bit" or "a lot", and 85% of teachers noted that the exemplars were reasonably transferable to their own school context.

There were two common themes in the general feedback from the combined trial. The first was that it was good to see cross-curricular links in the exemplars. This was noted by 13% of teachers and is consistent with results from the online trial (18% of teachers noted this in the online trial).

> *A great example of cross curricular work...*

> *A report has been created with graphs and images, a great example of data integration in a digital outcome...*

The second common theme in the general feedback was that the activities in the exemplars were useful classroom tasks. Twenty-two percent of teachers made comments of this nature.

> *This is a great example of using physical computing to produce relevant data.*

> *A very creative task that involves multiple levels of skill and creativity.*

> *This is a brilliant activity, and could be augmented with the use of code to design the Bar and QR code.*

In addition to this general feedback, teachers provided a wide range of specific feedback on the exemplars in the combined trial. There was one common theme in these comments: three teachers commented that the use of video in exemplar DO13 (Developing a stop-motion video animation) provided opportunities for other learning, such as lighting and audio requirements from a technology perspective, or more general learning about filmmaking.

Teachers' responses indicated that they were familiar with teaching digital technologies in the classroom, and were also within a few percentage points of results from the online trial. Sixty-eight percent of participants noted they were classroom teachers, with 61% noting they held responsibility for digital technologies within the school. Almost all participating teachers (98%) indicated they were familiar with the types of tasks in the exemplars. Fifty percent of teachers indicated the tasks were very familiar to them as they regularly teach similar activities, and 48% indicated they were somewhat familiar as they sometimes teach similar activities.

Exemplar refinement

Following the combined trial, exemplars from signpost 2 of the DDDO progression were amended to ensure they were similar in sophistication. The following changes were made.

- The annotation of exemplar DO23 (Robotic systems) was amended to highlight the degree of scaffolding provided by the teacher. Consequently, this revised exemplar should be considered less sophisticated.

- Exemplar DO24 (Collecting data for science fair) was deleted from the collection.

- The annotation of exemplar DO25 (Robotic systems and society) was strengthened to make the sophistication of students' debate clearer. Consequently, this revised exemplar should be considered more sophisticated.

Design and style of exemplars

An editor carried out a style edit across all exemplars. The edited exemplars were delivered to the Ministry in November 2017.

Publication edits

The Ministry engaged a contractor to publish the exemplars. The publication team edited the learning area statement, progress outcomes (signpost descriptors), and all exemplars to ensure there was consistency across all aspects of the work. The development team worked with the publication team to ensure that any suggested changes retained the integrity of the digital technologies content and the authenticity of the exemplars.

Snapshots for years 11–13

A small working group was formed to illustrate the signposts of the CT and DDDO progressions that represent student learning in years 11– 13. The group included four experienced teachers: Julie McMahon (St Hilda's Collegiate), John Creighton (Burnside High School), Melinda Stevenson (Francis Douglas Memorial College), and Catherine Johnson (The Mind Lab). Gill Thomas and Sue Douglas (Education Technology Ltd) led the process and assisted with development.

The group met in Dunedin on 6–7 November and worked together to develop the snapshots. They agreed that it was not possible to fully exemplify all student learning in these years, due to the specialisation and complexity of the content. On this basis, the decision was made to highlight aspects of students' expertise at the relevant points on the learning progression using snapshots. Consequently, snapshots are different in format to the exemplars used to illustrate the progress outcomes that span years 1–10.

The snapshots illustrate the sophistication of students' conceptual understanding through insights into their thinking. Student voice is used to reveal students' thoughts and actions as they apply the understanding they have at this point to components of the learning task. It should be noted that the snapshots are not assessment tasks, nor do they fully describe students' responses to the kind of specialist, complex learning tasks that should form a typical digital technologies learning programme in years 11–13.

During the two-day working meeting, the group completed the following tasks.

- The relevant signposts of each progression were reviewed and updated. Signposts 6–8 in the CT progression were reviewed, and signposts 4 and 5 in the DDDO progression were developed into three separate signposts: 4, 5, and 6.

- The major content areas to be exemplified in each progression were identified. Three areas were identified in the CT progression: programming, algorithms, and data representation. Five areas were identified in the DDDO progression: digital information, infrastructure, web design, programming, and electronics.

- A structure was mapped for the collections of snapshots at each signpost. Each of the identified content areas was to be exemplified in each of the three relevant signposts using related themes or student tasks. This resulted in nine snapshots for the CT progression (three snapshots for each of the three content areas) and 15 snapshots for the DDDO progression (three snapshots for each of the five content areas).

- A format for the snapshots was developed. Each snapshot comprises a brief description of the learning task and a few insights into what the student knows and can do as they work on the task.

- The group worked together to collaboratively draft the first few snapshots.

- Group members worked independently to draft the remaining snapshots.

The snapshot drafting process was completed in the days following the working meeting, with the group providing peer review as required.

A style edit was carried out before the snapshots were delivered to the Ministry in early December.

Tables 8 and 9, respectively, list the completed CT and DDDO snapshots.

Table 8: CT snapshots

Signpost	Title	Focus
6	Designing a virtual golf game	Programming
	Linear versus binary searches	Algorithms
	Why compression matters	Data representation
7	Ordering smoothies	Programming
	Solving unsolvable problems	Algorithms
	Looking at cybersecurity	Data representation
8	An Agile approach to game design	Programming
	Can algorithms be biased?	Algorithms
	Communicating online successfully	Data representation

Table 9: DDDO snapshots

Signpost	Title	Focus
4	Keeping track of club members	Digital information
	A computer for the shearing shed	Infrastructure
	Designing a portfolio website	Web design
	Programming pizzas	Programming
	Keeping a watch on your fitness	Electronics
5	A bowls club database	Digital information
	Expanding the farm computer network	Infrastructure
	A kapa haka website	Web design
	Sandwich costings	Programming
	Irrigating the orchard	Electronics
6	Selling cellphone cases	Digital information
	Farm connections: Further extending the network	Infrastructure
	Monitoring wildlife	Web design
	Designing a flexible booking system	Programming

	Designing a speaker box	Electronics

Aligning progress outcomes to curriculum levels

This section proposes tentative alignments between the progress outcomes of the digital technology progressions and levels of the New Zealand Curriculum. It also points out the limitations of the psychometric work that supported the development of the progressions.

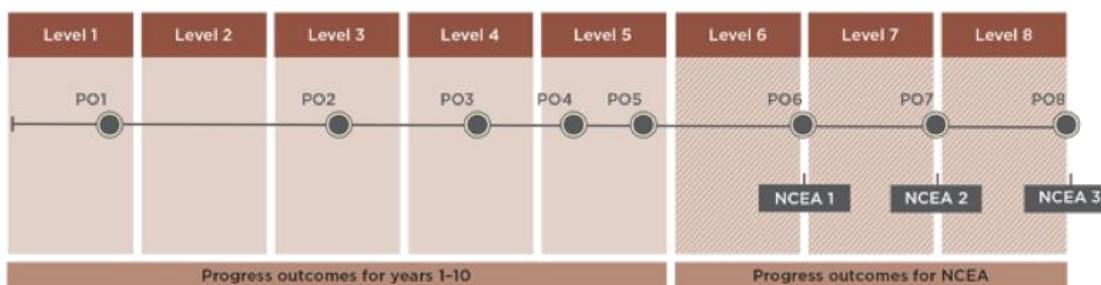## Computational thinking for digital technologies

Progress outcomes 1–8 describe the significant learning steps that students take as they develop their expertise in computational thinking for digital technologies.

The diagram below shows the probable alignment between levels 1–5 of the New Zealand Curriculum and the progress outcomes for computational thinking. The uneven spacing of the progress outcomes reflects the different learning and time that it is expected will be required for each outcome and is based on data collected and psychometric analysis undertaken during the development of the digital learning progressions.

Progress outcomes 6–8 set out the learning expected for students engaging in more intensive and specialised digital technologies programmes for NCEA 1, 2, and 3. These progress outcomes were written by specialist subject teachers and were informed by current teaching and learning programmes at years 11–13. For this reason, they are directly aligned with levels 6–8 of the curriculum.

The alignment to levels 1–5 of the New Zealand Curriculum is tentative and theoretically derived until teachers have had the opportunity to implement the digital progressions, and further alignment activity can be undertaken. The theoretical derivation was made by the development team, who determined that progress outcome 5 was consistent with the upper end of level 5 and that progress outcome 1 was consistent with the upper end of level 1. The placement of progress outcomes 2, 3, and 4 was based on their psychometric values from the final trial (as described on page 39).

Computational thinking for digital technologies

Designing and developing digital outcomes

Progress outcomes 1–6 describe the significant learning steps that students take as they develop their expertise in designing and developing digital outcomes.

The diagram below shows the probable alignment between levels 1–5 of the New Zealand Curriculum and the progress outcomes for designing and developing digital outcomes. The uneven spacing of the progress outcomes reflects the different learning and time that it is expected will be

required for each outcome and is based on data collected and psychometric analysis undertaken during the development of the digital learning progressions.

Progress outcomes 4–6 set out the learning expected for students engaging in more intensive and specialised digital technologies programmes for NCEA 1, 2, and 3. These progress outcomes were written by specialist subject teachers and were informed by current teaching and learning programmes at years 11–13. For this reason, they are directly aligned with levels 6–8 of the curriculum.

The alignment to levels 1–5 of the New Zealand Curriculum is tentative and theoretically derived until teachers have had the opportunity to implement the digital progressions and further alignment activity can be undertaken. The theoretical derivation was made by the development team, who determined that progress outcome 3 was consistent with the end of level 5 and that progress outcome 1 was consistent with the midpoint of level 2. The placement of progress outcome 2 was based on its psychometric value from the final trial (as described on page 39).

Designing and developing digital outcomes

Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8
	PO1		PO2	PO3	PO4	PO5	PO6
					NCEA 1	NCEA 2	NCEA 3
Progress outcomes for years 1-10					Progress outcomes for NCEA		

Limitations of the psychometric work undertaken for the digital technologies progressions

The learning progressions for digital technologies describe the kinds of things students know and can do at different points as they progress in their learning. In the psychometric work, data was collected and analysed to support and inform the development of these progressions. The data was collected from teachers and relied on their knowledge of the teaching and learning of digital technologies.

While this data collection represents good psychometric practice, it views learning through the lens of teaching and is therefore limited by teachers' current understandings and experience of learning and of digital technologies. These understandings and experiences will continue to grow and develop as teachers and students work with the digital technologies curriculum.

The data collection exercise was also modest in scope, and therefore the understandings of the teachers involved may not represent the understandings of all teachers.

Another limitation is that changes in digital technologies and students' experiences of learning in digital environments continue rapidly. These changes may impact on the way students learn and on teacher perceptions of this.

Finally, there is the question of how the progressions relate to the curriculum levels of the rest of the technology learning area. For progressions in mathematics, reading, and writing, the relationship between the progression and curriculum levels was determined using a curriculum leveling exercise where a group of subject-matter experts worked to determine how the progression aligned with curriculum levels. At this stage, no formal exercise has taken place, and as described above, the alignments are tentative and based on the knowledge and expertise of the development team.

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Appendix A: Exploratory trial feedback questionnaire

Note that the questionnaire shown is focused on the CT progression. A parallel questionnaire was developed for the DDDO progression.

Feedback: Computational thinking learning progressions

Thank you for your feedback. Your views are valuable and will be used to inform further development of the progressions. Please be assured that your responses will be confidential,

1. Do the learning tasks in the exemplars appear authentic to you?

◯ Yes

◯ No

◯ I'm not sure

Please elaborate.

2. Do the student responses illustrated in the exemplars appear authentic to you?

◯ Yes

◯ No

◯ I'm not sure

Please elaborate.

Question 3 was a filter to direct teachers to the appropriate version of questions 4 and 5.

4. To what extent do each of these exemplars illustrate rich teaching and learning?

	Not at all	A little	Quite a bit	A lot
Bees	○	○	○	○
Teaching robots to dance	○	○	○	○
Copying a sequence	○	○	○	○
Repeating bees	○	○	○	○
How Māui Slowed the Sun	○	○	○	○
Catching chickens	○	○	○	○

5. If you have specific feedback on any of these exemplars please note this here.

Bees	
Teaching robots to dance	
Copying a sequence	
Repeating bees	
How Māui Slowed the Sun	
Catching chickens	

Each teacher answered a version of questions 4 and 5 that focused on the exemplars that were most relevant to the year levels of the students they taught. Questions 6 to 15 are not included, as they are alternative versions of questions 4 and 5.

16. The computational thinking exemplars were developed at a limited number of schools. In your opinion, are the exemplars reasonably transferable to your own school context?

○ Yes

○ No

○ I'm not sure

Please comment.

If the teacher answered "No" or "I'm not sure" to question 16, then they also answered question 17.

17. What features of the exemplars make it challenging to transfer them to your own school context?

```
[                                                            ]
[                                                            ]
[                                                            ]
```

18. If you would like to make any other comments about the exemplars, or the computational thinking progression more generally please write them here.

```
[                                                            ]
[                                                            ]
[                                                            ]
```

19. At which year levels do you have experience teaching digital technology? Tick all that apply.

☐ Year 1   ☐ Year 6

☐ Year 2   ☐ Year 7

☐ Year 3   ☐ Year 8

☐ Year 4   ☐ Year 9

☐ Year 5   ☐ Year 10

Appendix B: CT online trial feedback questionnaire

Feedback: Computational thinking learning progression

Thank you for your feedback. Your views are valuable and will be used to inform further development of the progressions. Please be assured that your responses will be confidential,

* 1. Do the learning tasks in the exemplars appear authentic to you?

◯ Yes

◯ No

◯ I'm not sure

Please elaborate.

* 2. Do the student responses illustrated in the exemplars appear authentic to you?

◯ Yes

◯ No

◯ I'm not sure

Please elaborate.

* 3. In your opinion, to what extent do the exemplars illustrate rich teaching and learning?

◯ Not at all ◯ A little ◯ Quite a bit ◯ A lot

Please note any exemplars that do not illustrate rich teaching and learning.

* 4. The computational thinking exemplars were developed at a limited number of schools. In your opinion, are the exemplars reasonably transferable to your own school context?

◯ Yes

◯ No

◯ I'm not sure

Please comment.

If the teacher answered "No" or "I'm not sure" to question 4, then they also answered question 5.

5. What features of the exemplars make it challenging to transfer them to your own school context?

6. If you have specific feedback on any of the exemplars you have seen please note this here.

7. If you would like to make any other comments about the exemplars, or the computational thinking progression more generally please write them here.

Demographics

* 8. What is your name? (We will use this to track who has responded.)

* 9. What school do you currently work at? (We will use this to check we have responses from teachers who work in a range of schools.)

School name:

Institution number:

* 10. What is your role within the school? Tick all that apply

☐ Classroom teacher

☐ Syndicate leader

☐ Assistant Principal or Deputy Principal

☐ Teacher with responsibility for digital technologies

☐ Other (please specify)

* 11. At which year levels do you have experience teaching digital technology? Tick all that apply.

☐ Years 1 - 3

☐ Years 4 - 5

☐ Years 7 - 8

☐ Years 9 - 10

☐ I don't have any experience teaching digital technology

* 12. Which of these statements best describes your familiarity with the types of learning tasks in the exemplars?

○ The tasks are unfamiliar to me, I have never taught similar activities.

○ The tasks are somewhat familiar to me, I sometimes teach similar activities.

○ The tasks are very familiar to me, I regularly teach similar activities.

Please elaborate.

○ The tasks are unfamiliar to me, I have never taught similar activities.

○ The tasks are somewhat familiar to me, I sometimes teach similar activities.

○ The tasks are very familiar to me, I regularly teach similar activities.

Appendix C: DDDO online trial feedback questionnaire

The DDDO online trial feedback questionnaire used the same questions as the CT online trial feedback questionnaire, with three additional questions. These additional questions are shown here.

Feedback: Designing and developing digital outcomes progression

* 6. In your opinion, to what extent do the exemplars you have seen include these student activities?

	A little in the exemplars	Some in the exemplars	A lot in the exemplars	I'm not sure
Designing and developing digital outcomes: products, systems or devices.	○	○	○	○
Using digital devices to create a variety of products or achieve a range of outcomes.	○	○	○	○

Please elaborate or comment.

* 7. In your opinion, how important are each of these student activities in digital technologies?

	Not important	Important	Very important	I'm not sure
Designing and developing digital outcomes: products, systems or devices.	○	○	○	○
Using digital devices to create a variety of products or achieve a range of outcomes.	○	○	○	○

Please elaborate or comment.

* 14. In general, how difficult did you find it to decide which of the two exemplars in the comparison task was more sophisticated?

Not difficult		Very difficult	
○————————————————————			