

2019

Co-design for Curriculum Planning: A Model for Professional Development for High School Teachers

Nick Kelly

Queensland University of Technology, nick.kelly@qut.edu.au

Natalie Wright

Queensland University of Technology, n.wright@qut.edu.au

Les Dawes

Queensland University of Technology, l.dawes@qut.edu.au

Jeremy Kerr

Queensland University of Technology, jeremy.kerr@qut.edu.au

Amanda Robertson

Queensland University of Technology, a28.robertson@qut.edu.au

Recommended Citation

Kelly, N., Wright, N., Dawes, L., Kerr, J., & Robertson, A. (2019). Co-design for Curriculum Planning: A Model for Professional Development for High School Teachers. *Australian Journal of Teacher Education*, 44(7).
<http://dx.doi.org/10.14221/ajte.2019v44n7.6>

This Journal Article is posted at Research Online.
<https://ro.ecu.edu.au/ajte/vol44/iss7/6>

Co-Design For Curriculum Planning: A Model For Professional Development For High School Teachers

Nick Kelly
Natalie Wright
Les Dawes
Jeremy Kerr
Amanda Robertson
Queensland University of Technology

Abstract: This paper describes a model for teacher professional development as co-design for curriculum planning in which facilitators with design and pedagogical expertise iteratively work with groups of secondary school teachers, one school at a time, to plan whole terms of work, as a form of teacher professional development. It contains preliminary results from a design-based research study involving co-design with digital technologies teachers in two Australian secondary schools. It describes two phases of design involving workshops, strategies and instruments that work to facilitate effective co-design with teachers. Results from this pilot study suggest that the co-design for curriculum planning model leads to high quality teacher professional development for 21st century learning.

Keywords: teacher professional development, co-design, design thinking, 21st century skills, teacher education, digital technologies, STEM teacher, rural teachers, design-based research, teacher support, secondary school education

Introduction

Teacher professional development (TPD)—elsewhere referred to as continuing professional development or formal professional learning—refers to the many different ways in which teachers are able to actively develop their skills throughout their professional life (Craft, 2002; M. M. Kennedy, 2016). Yet despite research that defines and characterises *quality* teacher professional development (e.g., Avalos, 2011; Borko, 2004; Wayne, Yoon, Zhu, Cronen, & Garet, 2008) there remains frequent occurrence within Australia of what Darling-Hammond and Richardson (2009) refer to as “the drive-by workshop model of the past” (p. 46)¹ which is characterised by one-off workshops that: (a) are not tailored to teacher or school context; (b) do not maintain a relationship with teachers beyond the duration of the workshop; and (c) only superficially respect the experiences and knowledge that each teacher brings to the workshop. In contrast to such drive-by workshops are instances of professional

¹ This claim is based upon anecdotal evidence due to a lack of research into Australian teacher professional development. Registers of the professional development available to Australian teachers can be found in each of the teaching jurisdictions, however a broad analysis of the quality of these programs has not been conducted.

development that respect teacher autonomy, help teachers to develop relationships within their school, and support teachers to develop new, or enhance existing, competencies (Avalos, 2011; A. Kennedy, 2005; King, 2014; Roth, Assor, Kanat-Maymon, & Kaplan, 2007).

The need for quality teacher professional development has been amplified through changes occurring within the teaching profession. There is a significant push in Australia and worldwide for teachers to integrate skills for *computational thinking*—expressed as computational concepts, computational practices, and computational perspectives (Resnick et al., 2009)—across multiple curriculum areas and across all years of schooling (Grover & Pea, 2013; Lye & Koh, 2014; Wing, 2008). This forms one part of a worldwide movement towards developing students' *21st century skills* (Dede, 2010; Trilling & Fadel, 2009; Zhao, 2010), representing a shift from teachers focusing solely on foundational knowledge towards teachers focusing on humanistic and meta-cognitive development (Kereluik, Mishra, Fahnoe, & Terry, 2013).

This paper investigates these needs by proposing, developing, and testing a model for teacher professional development that is known as *co-design for curriculum planning* (Kelly, Dawes, Wright, Kerr, & Robertson, 2018). In this model a team of external facilitators with knowledge of pedagogy, design and curriculum content work in partnership with teachers in schools to realise high-quality teacher professional development through the process of jointly designing curriculum plans for an entire term of student work. Facilitators use a design thinking framework to challenge existing pedagogical practices. Teachers' strong contextual knowledge of school practices, student needs, and school policies determine the goals of the curriculum planning. The word *co-design* refers to a form of participatory design in which the process of design is a partnership between a designer (or design team) and the user(s) of a design (Lee, 2008); and has previously been used as a model to guide partnerships with teachers (Koh, Chai, & Lim, 2017; Roschelle & Penuel, 2006).

This paper describes the development of co-design for curriculum planning (CDCP) at a secondary school level as a *design-based research* study (Barab & Squire, 2004; Collins, Joseph, & Bielaczyc, 2004) in which the research team iteratively developed a model for using CDCP as a form of professional development. It follows a recent study by Koh et al. (2017) in Singapore at a primary school level, in which researchers co-designed the curriculum with teachers to promote 21st century learning. The contribution of this study consists of four parts, following Reeves (2006): (1) framing the problem that the design is trying to address and the desired outcomes; (2) describing the theoretical basis for proposing a design solution; (3) iterative testing of the design in the real world through the participation of stakeholders; and (4) the tangible outcomes from the research in terms of a description of the design artefacts produced (i.e., the model of professional development for teachers), the transferable design principles for designers considering similar problems, and the evidence supporting further design.

The Problem And Theoretical Background

Theorising Teacher Professional Development

Teachers need to continue to develop their professional capabilities in response to frequent shifts in school, policy, social, and technological contexts. A shift in any one of these contexts can lead to changes in professional expectations, something that occurs frequently for Australian teachers due to shifts in educational policy (Mayer, 2014). TPD is regarded as a way in which schools, school systems, and teachers themselves can actively

respond to changes in their profession. Beyond this instrumental need, TPD also serves to facilitate personal growth and to cultivate increased professional satisfaction (Avalos, 2011).

An international survey by Villegas-Reimers (2003) articulated an emerging paradigm within the research into TPD that supports models that are: *constructivist* in treating teachers as active and reflective learners (rather than transmissionist in treating teachers as passive recipients of knowledge); *sustained and strategic* with a progression of learning (rather than the one-off presentations mentioned in the introduction); *contextual* to the teachers' needs (rather than formulaic, e.g., something that is 'rolled out' across an entire jurisdiction); a *collaborative* (rather than individual) activity; and a part of the *cultural formation* of a school (rather than simply relating to 'upskilling' in specific domains). Yet despite the articulation of this paradigm and the presence of many competing models for professional development, the practice of TPD and the allocation of resources remains a contested area in which politics, economics, and entrenched ways of doing things all influence the adoption of new approaches. In particular, the need for teacher collaboration was recognised in a recent national review of policy, where:

Active collaboration—such as peer observation and feedback, coaching, mentoring, team teaching and joint research projects—allows teachers to learn from each other and typically has a positive impact on students. In contrast, collaboration that concentrates on simply sharing resources, planning activities or administrative issues has little or no positive effect on student achievement. (Gonski et al., 2018, p. 59).

These understandings of what makes for quality teacher professional development, whilst not new (e.g., Darling-Hammond & McLaughlin, 1995; Le Cornu & Peters, 2009), still resist widespread implementation.

Co-design for Curriculum Planning as Professional Development

The drive-by workshops described in the introduction characteristically make a separation between teachers having *time for work* and then being taken out of work to have *time for development*. Other approaches such as mentorship (Feiman-Nemser, 1996; Huling & Resta, 2001) and coaching (Kraft, Blazar, & Hogan, 2018) bring professional development into existing teaching activities, ensuring that the learning that occurs for the teacher is authentic to their specific context.

Co-design for curriculum planning belongs to this family of professional development that occurs in situ. Curriculum planning is a necessary task carried out by teachers during their preparation for teaching—the task of taking an official curriculum document and knowledge of learners' needs and using them to synthesise a plan for classroom implementation (Deng, 2018; Snyder, Bolin, & Zumwalt, 1992). Shawer (2017) summarises this process as *curriculum development at the classroom level* in which:

[Teachers] first assess student needs and decide on the curriculum elements in light of needs assessment. They adapt and supplement the official curriculum's learning outcomes. Instead of following coursebooks, they decide on their teaching topics (syllabus), supply and write their material (content), and use their teaching methods and techniques (activities). (p. 298)

The demands of 21st century learning dictate that many teachers need to alter their pedagogical practices (Koh, Chai, Wong, & Hong, 2015; Trilling & Fadel, 2009). In practice, this “invariably involves the engagement of students in collaborative work and real-world problem solving” to develop learners' metacognitive and humanistic skills (Koh et al., 2017, p. 173). We follow Koh et al. (2017) in suggesting that it is through co-design during

curriculum planning that teachers can innovate their practices to include this kind of collaborative, real-world problem solving, resulting in benefits for learners (in terms of 21st century skills) at the same time that teachers develop their technological and pedagogical content knowledge.

Context for the Present Study: A New Digital Technologies Curriculum

This paper describes teacher professional development needs in the context of a new subject implemented across Australia in 2019 called Digital Technologies (Digitech). The subject is being introduced as a part of a new Australian National Curriculum (ACARA 2015) and it will be implemented from years K-8 (where, in the Australian system, years 7 and upwards constitute secondary school), with schools having the option to implement it also for years 9-10². Like other countries internationally, this subject has been introduced to ensure that Australian students develop 21st century skills throughout K-12.

The new Digitech subject has created an almost ‘perfect storm’ of professional development needs for teachers in that prior to its implementation they are required to: (1) develop a curriculum plan for a new subject; (2) ensure in their curriculum planning that they can differentiate learning for students who are likely to have widely differing levels of prior knowledge, given that the subject has not previously been mandated at any level within the school system (e.g., students in the first year of one secondary school may never have encountered the subject, and in another school may have been exposed to four years of study); (3) make technology a focus of learning, requiring many teachers to learn unfamiliar technologies (i.e., certain digital systems and digital representations); (4) implement project-based learning with a pedagogical focus upon the creation of *digital solutions* (which for many teachers may involve developing new pedagogical approaches to their teaching); and (5) integrate Digitech with other learning areas, something implied by the suggested time allocation for the subject, the design of the curriculum and the official examples provided³.

Digitech calls for forms of project-based learning in which students produce digital solutions—digital artefacts that address a problem, or analogue prototypes to represent those artefacts—such as websites, databases, apps and functioning computer programs. The skills that students are required to develop in Digitech are summarised by ten key concepts of: abstraction, digital systems, data representation, data collection, data interpretation, specification, algorithms, implementation, interactions, and impact⁴. These concepts necessitate that teachers have a basic knowledge of computer programming (i.e., algorithms and abstraction), data structures (i.e., data representation and databases) and how to teach them.

Types of Knowledge Needed by Teachers for Digitech

The construct of technological pedagogical content knowledge (TPACK) is useful for discussing different types of teacher knowledge and their integration (Koehler & Mishra, 2009). Teachers require content knowledge of what the curriculum contains, pedagogical knowledge to know how to teach it, and technological knowledge to use the technologies that fit the curriculum along with the learning objectives. Most critically, they need to know how

² <https://www.australiancurriculum.edu.au/f-10-curriculum/technologies/digital-technologies/>, accessed 26th April, 2018

³ <https://www.digitaltechnologieshub.edu.au/>, accessed 26th April, 2018

⁴ <https://aca.edu.au/#home-unpack>

to integrate these three types of knowledge. This is particularly true in the context of modern technology that provides free access to reliable information and learning resources, whereby students can have different and even broader perspectives than their teachers (Sims, 2014). Fragmentation and dispersion of the classroom outside the school community requires that teachers adapt to this increasing diversity by recognising that individual students bring different experiences into the classroom. For many teachers, these demands require them to challenge their routine expertise and contextual perspectives and develop new capabilities that span technological, pedagogical and content knowledge (Koh et al., 2017; Koh et al., 2015).

The construct of technological pedagogical content knowledge (TPACK) is useful for discussing different types of teacher knowledge and their integration (Koehler & Mishra, 2009). Teachers require content knowledge of what the curriculum contains, pedagogical knowledge to know how to teach it, and technological knowledge to use the technologies that fit the curriculum along with the learning objectives. Most critically, they need to know how to integrate these three types of knowledge.

The new Digitech curriculum makes demands of teachers in all three of these areas. Teachers require new *technological* knowledge in terms of programming and data structures—whilst a high level of expertise is not demanded, teachers at least need to know how to set up an environment in which students can learn these skills and how to troubleshoot technological problems. They also require the *content* knowledge to understand the ten key concepts in the curriculum and the achievement standards that the curriculum mandates. Due to the focus on digital solutions, teachers need to integrate their content and technological knowledge into their *pedagogical* knowledge of teaching using a project-based approach. We follow Savery (2015) in conceiving of project-based learning as occurring where:

...learners are usually provided with specifications for a desired end product (build a rocket, design a website, etc.) and the learning process is more oriented to following correct procedures. While working on a project, learners are likely to encounter several “problems” that generate “teachable moments” ... Teachers are more likely to be instructors and coaches (rather than tutors) who provide expert guidance, feedback and suggestions for “better” ways to achieve the final product. The teaching (modelling, scaffolding, questioning, etc.) is provided according to learner need and within the context of the project. (p. 16)

To achieve this, teachers need the ability to plan, implement and assess project-based learning. Moreover, given the continued importance of educational design for change, diversity and quality, alternative ways to transform how teachers (as learning or instructional designers) think about learning and teaching and the environments in which learners and teachers engage, are urgently needed (Sims, 2014). “In-service teachers are well poised to integrate the pedagogical practices envisioned under 21st century learning, but in reality, such practices are not widespread in schools” (Koh et al., 2015, p. 87). Additionally, as Conole (2013, p. 102) observes, “a key issue is that teachers do not know how to design, mainly adopting an implicit approach based around prior experiences and practices”, which reinforces the importance of making those who are responsible for educational design perform that practice effectively. Aligning with the aspirations of Sims (2014), the CDCP approach provides a framework of pedagogy, practice and resources where “design alchemists create environments in which all participants interact to achieve learning outcomes relevant to their own needs and context and which harness the power of the technology to support those interactions” (p. 24).

Design Thinking as a Framework for Teacher Professional Development

Design thinking is a “way of thinking that can potentially enhance the epistemological and ontological nature of schooling” (Razzouk & Shute, 2012, p. 243) and refers to design practices and competencies practised for and with non-professional designers (Johansson-Sköldberg, Woodilla, & Çetinkaya, 2013). In response to Villegas-Reimers (2003) previously mentioned preferred model for TPD, design thinking as a framework satisfies the constructivist, sustained and strategic, contextual, collaborative and culture-forming objectives.

Design thinking can enhance problem-solving competency and context-adaptive teaching practice (Johnson, 2016); and, with refinement, assist educators to make epistemic leaps beyond routine expertise, resulting in learning framework outcomes which deliver a balance of efficiency and innovation (Schwartz, Bransford, & Sears, 2005). Teaching using design thinking is inherently *context-adaptive* in that it calls upon teachers to consider “students’ lives, heritage, languages, economic circumstance, cultural repertoires of practice, and the overall ecology from which students grow” (Johnson, 2016, p. 128), permitting teachers’ understanding of students’ sociocultural context to change the way that they teach. Findings from a design-led study conducted in regional and rural Queensland, Australia, suggest that educators valued context-adaptive pedagogical strategies and contact with design and research professionals for skill development. The same study showed a result of increased engagement during design for learning and increased reflection on teaching practices, theories and conceptions (Wright, Miller, Dawes, & Wrigley, 2018).

Design thinking is widely recognised as a means of developing 21st century capabilities (Koh et al., 2015; Noweski et al., 2012; Trilling & Fadel, 2012; Wright & Davis, 2014; Wright & Wrigley, 2019; Wright, Miller, Dawes, & Wrigley, 2018). Utilised in repetition it builds ‘creative confidence’ (Rauth, Köppen, Jobst, & Meinel, 2010) and progressively develops cognitive, interpersonal and intrapersonal skillsets (Wright & Wrigley, 2019). It focuses on diversity and encourages multimodal expressions and varied higher order thinking skills (Yelland, Cope, & Kalantzis, 2008).

In the present study we will refer to *design-led pedagogy* as a pedagogy that satisfies the definition of project-based learning and that additionally includes a focus on students’ developing the process, skills, and mindsets of *design thinking* (Goldman et al., 2012) to develop complex abductive reasoning, as well as inductive, problem-solving and analytical reasoning capabilities (Dorst, 2011). This means not simply engaging students through project-based activities, but also equipping them with a metacognitive understanding of human-centred, collaborative and experimental design activity “to support personalised, generic 21st century capabilities and life-long learning” (Wright & Wrigley, 2019, p. 5). In order to successfully enact this pedagogy, it is critical that teachers, as designers of learning technologies, are also equipped with the process, skills, and mindsets of design thinking (Koh et al., 2015).

Summary

The conceptual notions guiding this work are thus: (1) that teachers require professional development to develop their pedagogical practices for 21st century learning and to develop their technological and pedagogical content knowledge in the context of a new curriculum; (2) that co-design during curriculum planning offers a way to achieve these twin goals in a way that satisfies the needs of quality TPD (collaborative, sustained, contextual, collegial, respecting teacher autonomy and doing this through active, constructivist learning)

whilst ensuring that the teacher development leads to changes in learner experiences; and (3) that a design-thinking framework provides a strong foundation upon which to base the process of co-design, to ensure that teachers develop their skills, processes and mindsets for running the classroom as an effective place of 21st century learning.

Goals Of The Design-Based Research

The design problem that is being addressed through this design-based research thus has multiple dimensions that are interrelated. We formalise the design problem as four design goals, the first two of which are directly addressed in the present study:

- 1) There is a need for professional development for teachers, that fits with the understanding in the literature of high quality professional development;
- 2) This TPD needs to also fulfil the goal of helping teachers to develop TPACK for the new Digitech curriculum. This requires teachers to learn how to teach with certain technologies, how to teach using a project-based and design-led pedagogy, and how to integrate those things with the curriculum content.
- 3) The design needs to ensure that students meet the curriculum achievement standards, that learning must be engaging for the diverse range of students in any class, and must allow students to develop 21st century skills.
- 4) The design needs also to be a valid option for policy makers and represent an improvement upon existing forms of professional development. This requires that the approach be efficient (in terms of value for money and time), have measurable outcomes, and be scalable on a large scale—including specifically that it works equally well for regional and rural and metropolitan teachers.

These four design goals form the long-term objective of this design-based research. This implementation of CDCP described in this paper addresses the first two of these goals and theorises the latter two.

Methods: Iterating the Design

Design-based research (DBR) is appropriate for developing new approaches within the domain of education given the combination of highly context-dependent implementation of interventions and the lack of opportunity for implementing controls (Barab & Squire, 2004; Collins, 1992). DBR is characterised by multiple iterations of designing and testing in the real world with the participation of stakeholders to find a solution to a significant problem. This section of the paper describes a year-long DBR study that was conducted in two phases, one corresponding to each school partnership, to move from a theoretical basis to an implemented and tested model.

Research Participants and Nomenclature

The research involved working with two schools, one in each phase of the study, referred to as School A and School B. Both schools were secondary public schools within Queensland, Australia. School A was a large metropolitan school (~2000 students) with an Index of Community Socio-Educational Advantage (ICSEA) of ~1100. It should be noted that School A had been introduced to design thinking through a professional development

workshop in 2017. School B was small rural school (~500 students) with an ICSEA of ~900⁵. Ethics approval for the study was obtained from both the university ethics committee and from the state government department responsible for schools.

The study refers to *the teachers* in each school as those teachers who were involved in teaching Digitech in years 9 and 10 (the two years of secondary school immediately prior to senior years in Australia) and who were also involved in the research project. It refers to *the HoD* as the head of department responsible for the Digitech subject area. To preserve anonymity, teachers and the deputy principal from School A will be referred to using names starting with the letter A (e.g., Angela, Arthur, etc.), and likewise School B with the letter B. The study refers to *the co-design team* as the team assembled by the researchers to implement the model of professional development through co-design. This team consisted of four academics and a research assistant, who between them held expertise in STEM education, design-based pedagogy for teachers, design thinking, the digital technologies curriculum content; and one of whom was a registered teacher.

Uses of the word “Design”

Some disambiguation is required given the three different uses of the word *design* in this research. Firstly, the methodology by which the model was developed was through *design-based research (DBR)*, in that it was solving a real-world problem through the involvement of participants in multiple phases of design and testing; and where the object of design was a model of professional development that satisfied the aims of the study. Secondly, the proposed way of addressing this design problem was through a form of professional development that consists of *co-design* between the research team and the teachers. Thirdly, we refer to the curriculum planning that was achieved through the co-design process, which led to students addressing a *term long design project (10 weeks)* as a part of the Digitech studies. Fourthly, *design-led pedagogy* as a pedagogy that satisfies this definition of project-based learning and that additionally includes a focus on students developing the process, skills, and mindsets of *design thinking*.

Overview of the CDCP Model

In the CDCP model the research team moves from contact with a school (1), through to conversations with school leadership (2) and selection of teachers for participation (3). The criteria for involvement was schools that were offering Digitech in years 9 and 10 and that had not yet fully planned how they intended to teach the curriculum. The essence of the proposed model is contained in two workshops, the first of which is heavily structured and scaffolded for developing goals and creative ideas (4), and the second of which is focused on achieving a pragmatic outcome for structuring a term of work (5). Asynchronous collaboration between teachers and the research team (6) via email allows for continued work on the curriculum planning. This results in (7) a set of documents that constitute a draft plan for a term of work which are (8) revised through ongoing re-development as the teachers respond to the needs of the school and their students. Parts of these curriculum planning documents are (A) shared with other schools through future co-design (future applications of this model) and are (B) co-configured through ongoing relationships with the broader community of all Digitech teachers through a web portal.

⁵ Source: <https://www.myschool.edu.au>

Research Data and Study Design

The model was developed iteratively through two phases of design corresponding to co-design activities with each of the two schools, Figure 1. During Phase 1, the focus was upon moving from a theoretical understanding of how co-design can work as quality TPD through to a tested model. During Phase 2 the focus was upon iterating upon the outcomes from Phase 1 to improve the quality of CDCP and to test for whether the model works in an entirely online modality; this was important both for ensuring the model works for regional and rural schools and for testing that the model is scalable.

Semi-structured interviews with teachers from both schools were held before and after teaching with the co-designed unit. A limitation of the research design is that teachers were not interviewed prior to co-design activities. Artefacts from co-design activities were gathered following each workshop, and artefacts of student work from classes that implemented CDCP were collected at the end of term. These artefacts serve to demonstrate the outcomes of CDCP and close the loop, from initial workshops and teacher perceptions through to a completed term of student work and teacher perceptions looking back at CDCP.

Figure 1 shows the research study as two phases of design, including testing of workshop ideas, development of materials to support the workshops, and iterations for improvements. The two phases will be described in further detail to understand the development of the design.

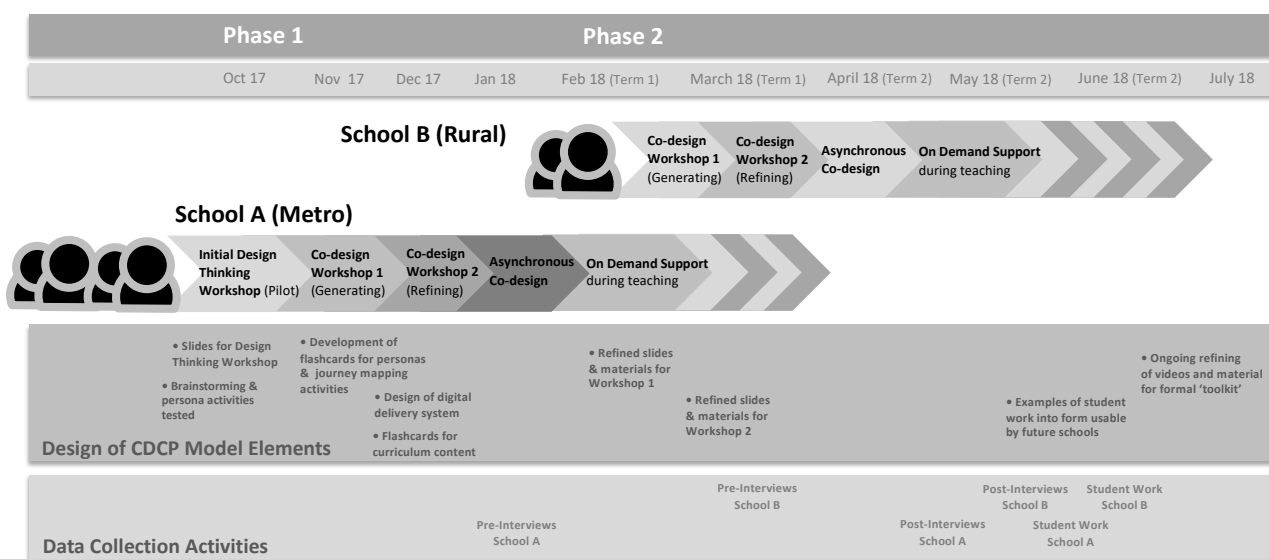


Figure 1 Data-collection, participants, co-design and model development over time

Phase 1: Developing the Model in Partnership with School A

The first phase of design proceeded through a partnership with School A. Ideas for how to run a co-design workshop to develop ideas for curriculum planning were tested in an *initial workshop* which were subsequently formalised into a series of two workshops, one for *generating* the ideas for the term of work and for helping teachers to think outside of their normal curriculum design approach; and then a second for *refining* these ideas to produce a plan for something that would work in the classroom. These workshops were followed up with an asynchronous collaboration to produce a curriculum plan through OneNote and via email.

Initial Workshop

An initial *two-hour workshop* was conducted to serve as an initiation into the project for teachers, and to gauge general receptivity towards the co-design approach. Another school was involved as intended project participants, however due to limited research team resources and communication difficulties with school leadership in the second school, only School A proceeded. This initial experiential workshop introduced participants to a scaffolded design thinking process applicable to the classroom, facilitated by the research team using the Cooper Hewitt Smithsonian Design Museum's model of the design process through: (1) defining problems; (2) getting ideas; (3) prototyping and making; and (4) testing and evaluating. It was designed to encourage experiential, collaborative, metacognitive and human-centred *mindshifts* through use of design thinking tools (Goldman et al., 2012). This involved approaching curriculum design from a student-centred perspective (i.e., as user-centred design) by using personas. Central to this workshop was an element of competitive collaboration, in which teachers from the two schools formed four combined teams, undertaking a defined rapid design challenge. This approach was taken to provoke playfulness and experimentation within participants and emphasise (through demonstration) how a design-led pedagogy can operate in contrast to traditional classroom formats.

The design thinking tool of *personas* (Cooper, 1999) was used in the workshop to encourage empathy and a non-traditional approach to curriculum design as a part of step (1), 'understanding the problem' (this is an example of participants commencing the design process before being given the design brief). In the workshop, teachers were asked to consider one of their disengaged students in Year 9 and were asked to select from 10 diverse cartoon illustrations of young people/students, Figure 2, to use as a basis for constructing a persona to represent that student; where a persona is an "archetypal character that is meant to represent a group of users in a role who share common goals, attitudes and behaviours when interacting with a particular product or service" (Cooper, 1999). Teachers were guided to select disengaged students so that this persona could, throughout the rest of the design process, serve as a reminder that they are designing for the engagement of all students in the class, even those who are typically more resistant to engagement. They then created a short profile for the student, outlining their interests and learning preferences, strengths and weaknesses. Teachers then shared these personas with other team members through an extended discussion about student needs and behaviours.

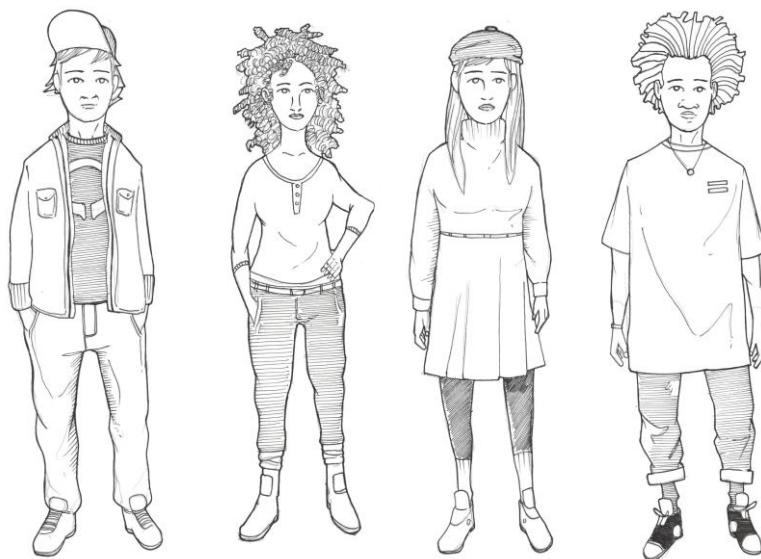


Figure 2 Examples of persona images used by teachers to represent students

In their groups, teachers went through the complete Cooper Hewitt Smithsonian Design Museum design process in response to the problem statement of: *How might we... engage this group of Year 9 students in front of us, through a fun and fascinating teaching plan that has students creating a digital solution?* In stage (1), ‘understanding the problem’, facilitators led the teams through an exercise in thinking about the design brief by working together to use mind maps to represent their understanding of the design problem. In stage (2), ‘getting ideas’, ideating and brainstorming were used to develop a range of potential solutions that could then be considered. Facilitators instructed teams to produce *30 ideas in 10 minutes* on post-it notes, with the added instruction that this should be composed of: 10 wild ideas, 10 daring ideas, and 10 practical ideas. This framework encouraged participants to generate ideas in a way that avoided fixation (by having no time for evaluation of ideas) and self-limitation (by making it perfectly okay to propose wild ideas), creating a safe atmosphere of ‘anything goes’.

Upon completion of the task, stage (3), ‘prototyping and making’, was commenced by facilitators removing the 10 practical ideas, forcing teams to explore, and perhaps combine, the ideas that they had deemed either ‘daring’ or ‘impossible’—this served as a cue for innovation, to help the teachers break out from their routine approaches to curriculum design. Teams were guided in reaching a consensus on an idea (or synthesis of ideas) that was their basis for creating a teaching plan, a ‘rapid prototype’ to respond to the design brief. Teams worked to develop and represent their ideas using a range of media provided by the facilitators: low-fidelity prototyping using everyday objects like cardboard, string and tape; post-it notes; and sketching and annotation on A1 sheets of paper. Stage (4), ‘testing and evaluating’ was carried out through participants presenting their ideas for feedback to other participants and facilitators using whatever means they could to convey their idea—this involved using their materials from stage (3) as props and combining them with elements of performance, role-play and presentation.

Throughout the design workshop the facilitators—composed of four design academics (each with over 3 years’ experience of working with teachers)—worked with teams, encouraging them to make reference to the personas that they had constructed, with questions such as, “how would [this student] experience this teaching plan that you are proposing?” This served as a reminder to the teachers that they needed to have the students’ engagement in the front of their mind whilst planning their teaching. The prototypes developed by participants were compiled by the research team and used as stimulus and resources for subsequent co-design sessions with schools.

Co-design Workshops

Two subsequent co-design workshops were scheduled with School A to move from the conceptual ideas in the initial workshop towards a fully-fledged curriculum plan that teachers could use to enact the Digitech curriculum for Year 9 in Term 1 of 2018. The first workshop was focused on further refining core approaches and themes for the unit of study. It was heavily scaffolded, with brainstorming exercises and the introduction of an experience/journey mapping exercise. An *experience/journey map* is a visual representation which illustrates a user’s flow within a product or service (Følstad & Kvale, 2018). In this case, teachers were asked to populate a student journey map template of the unit, Figure 3, to define key stages of learning and develop key milestones and experiences throughout the term for students.

In this exercise, teachers were encouraged to consider opportunities for learning and experiences outside the conventional classroom and a variety of different approaches to

learning. To provoke a more dynamic curriculum design, teachers were provided with a template that was built around the visual metaphor of a road trip, indicating that the students were ‘off on an adventure into the unknown’, Figure 3. Teachers used this template to generate engaging learning events and experiences that occurred on this ‘road trip’. Teachers also received flash cards that depicted the personas of the challenging/disengaged students from the initial pilot workshop, Figure 4, to reinforce this notion that teachers were designing their teaching plan for their students’ engagement—as opposed to, say, designing it to “cover” the curriculum (Munby & Russell, 1990).

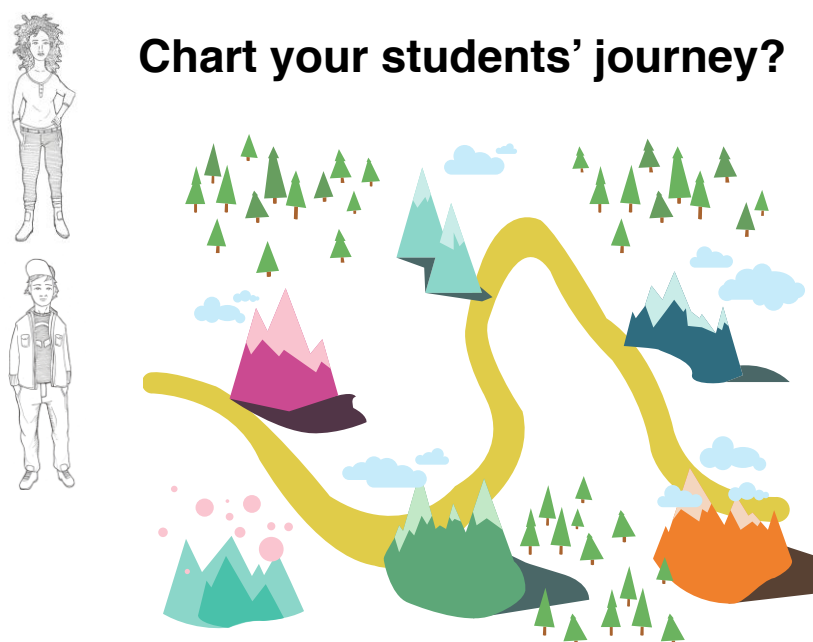


Figure 3 Student Journey Map Template



Figure 4 Persona cards

The second workshop involved a more pragmatic approach with a focus on school-specific aspects of refining the teaching plan. For this reason, the workshop was less structured, as teachers were now familiar with the iterative design process used by the research team. The content development shifted to a more granular level, including contextual considerations of school calendar, and timetabling—all within the conceptual structure developed from earlier workshops.

In this workshop the team used Digitech curriculum checklist flashcards, Figure 5, as a way of communicating content needs when designing the full term of study and to provide a means of ensuring that the developed teaching plan did still meet the mandated ‘achievement standards’ of the curriculum. This ensured the integration of digitech learning goals was maximised within curriculum design and teaching plans.

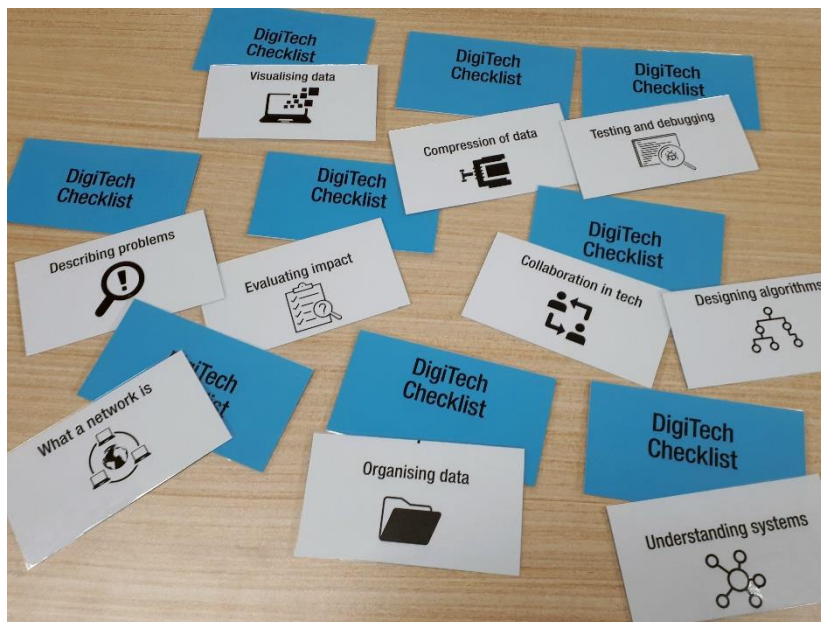


Figure 5 Digitech flashcards

Discussions with School A resulted in a decision to choose a *digital delivery platform* for the curriculum. A digital tool had clear rationale in that it could be used: (1) during planning, facilitating online collaboration between teachers and facilitators in designing the learning; (2) during teaching, allowing both teachers to easily make use of the materials; and (3) had an additional benefit, for both teachers and students, in that ‘the medium becomes the message’. The subject being digitech, it follows that digital literacy is tacitly extended and online workflow is normalised by having students access unit materials online. In this project, the Microsoft OneNote software was decided upon as the digital delivery platform, based upon jurisdiction licenses and software functionality. OneNote was thus used as the tool for communication of unit content, student collaboration, documentation of prototype work, and peer and teacher feedback on project iterations. Operating similar to a physical notebook, the program allows the compiling of digital notes and other digital content in an organised way. The program allows for the addition of images, drawings, web links, embedded audio, videos and diagrams, along with other content and it saves this information in *pages* organised into *sections* within *notebooks*. Along with allowing distribution of material to other users over the Internet or a network, and updating of content through synchronisation, it allows groups of users to create their own collaborative spaces and to develop projects.

Asynchronous Collaboration

Following this second workshop, the research team continued to work with teachers asynchronously directly via OneNote and email. Aspects of the content, scheduling and delivery were iteratively refined, with the initial prototype OneNote package passed back and forth between facilitators and teachers to improve the content.

The developed teaching plan was enacted in Term 1 of 2018, where the new Digitech curriculum was used with five classes in School A. At this point, the co-design facilitators took on the role of providing ‘on demand’ support for teachers via OneNote and email. This support largely involved helping teachers to customise their Digitech curriculum notebooks as classes occurred, so they could directly adapt curriculum design to individual class needs, student interests, and learning progress. For instance, a teacher delivering more than one class altered the pace of delivery in different classes due to different abilities within student cohorts. Additional content was sourced during term, and incorporated into teaching plans, for classes struggling with aspects of the curriculum.

Curriculum Plan from Phase 1

Key features of the curriculum plan that was developed by teachers in School A through co-design with the researchers were:

- 1) A single major group project formed the focus of the term of work. For School A this was the design of a website around the provocation of “It’s not fair when...”, identifying situations in the students’ lives that they found unfair (e.g., one group selected the high cost of public transport in their city). This required students to develop HTML and CSS coding skills as well as related file, image, and text manipulation skills.
- 2) In addition to developing the website as a group, individual students had to maintain a physical reflective journal in which they sketched their ideas and responded to lessons as both their individual work and a way to develop their design thinking skills.
- 3) The project was organised into seven modules of two or three suggested lessons each, and this was mapped out to the school calendar. Lessons were a mix of fully fleshed out lessons (including aims, timing, resources, and workshops), technical lessons (including code, exercises, web links, and relationship to the project), and semi-structured lesson outlines (concepts and related resources without details). In practice, many teachers merged lessons and deviated from this schedule, but they liked to have the fully fleshed out plan as a reference.

Particular attention was paid to the initial lesson as a “hook” to get students engaged in the unit, featuring a video and a way of relating the term of work to the students’ lives. Lessons were all structured with the format of a typical lesson plan, and included a lesson overview, objectives, expected time frames for activities, resources needed for running the lesson, and then details of running each of the activities. Lesson plans all had a consistent format to give teachers an at-a-glance understanding of the preparation required before a lesson, and easy to find details when needed during a lesson.

Phase 2: Second Iteration with School B

In Phase 2, the model emerging from Phase 1 was formalised as two distinct workshops, one each for ideating and refining. The model was implemented and tested under different conditions with School B, a rural school that was located over 1,000kms away from the facilitators. A focus in Phase 2 was an aim for scalability, by removing the need for face-to-face interaction but without compromising the quality of the TPD.

Workshop 1 with School B occurred using the online video conferencing software Zoom and entailed using the persona design activity to promote a student-centred focus to curriculum design (Activity 1), followed by applying the Cooper Hewitt Smithsonian Design

Museum Design Process Model to create a prototype for the Digitech curriculum design (Activity 2), and then a journey/experience mapping exercise to further develop the prototype (Activity 3). All activities were scaffolded as before and allowed participants to both learn about the development of personas, the design thinking process and experience/journey mapping, at the same as applying these approaches to curriculum design in the context of their school. School B was sent workshop slides ahead of time in the event of issues with internet connections, as well as design templates for all activities to take place in the session. School teachers printed out these templates and brought along specified materials to the session (pens, scissors and paper for prototyping). Upon completing the activities, photos of all design artefacts were taken and sent to the research team in preparation for co-design Workshop 2.

As occurred in the prior iteration of the model, the focus of co-design Workshop 2 was refining the initial ideas developed in Workshop 1. This workshop was less structured and also occurred virtually. Regular references were made to both student personas (to ensure student-centredness) and Digitech flashcards (to ensure curriculum focus). Resources developed from the collaboration with School A were shared with teachers from School B. This assisted the design process, with School B teachers opting for a similar website design project, and use of OneNote as a digital delivery system—but with both of these employed to meet the (very different) needs of the school.

Curriculum Plan from Phase 2

The curriculum outcomes from Phase 2 were similar to those from Phase 1. However, teachers made very different design decisions to ensure relevance for their students. Perhaps due to the school's rural location, the teachers developed a design brief where students were exploring the issue of rural tourism through a group project. Students developed a tourist-centred web site to promote their town, with each group emphasising aspects of the town that they were interested in. In developing this digital solution, students did much more than web design coding—they went through the steps of design thinking to find their own 'angle' to promote their town to potential tourists and digitally documented this aspect of the town to use in the site. This included field trips outside the school to explore possibilities for the tourism campaign. As with School A, as well as doing groupwork, individual students maintained a physical reflective journal in which they sketched their ideas and responded to lessons as both an individually assessable artefact and an authentic way to develop their design thinking skills.

Discussion

The outcomes from the study were: (1) documentation of the design for a model of professional development (the CDCP model); (2) the evidence regarding the design's success in meeting the stated goals; and (3) transferable design principles from the design research.

Design Artefact: The CDCP Model

The CDCP model represents an approach that works within individual schools and that we believe has the potential to work at a system-wide level. We recognise that the evidence in this paper only provides preliminary evidence for the former claim, and requires

further research to support this latter claim. In CDCP, individual schools are engaged through phases of organisation, co-design, and ongoing support and sharing. Each of these phases has been fully documented through forms and processes (for the organisation phase); slides, videos and a toolkit of resources for workshops (for the co-design phase), and technologies and processes for sustaining contact and for sharing work from the project (in the ongoing support and sharing phase). The full toolkit and examples of related resources are shared through the project website⁶, while a closed community platform connects all teachers from the different schools that have taken part in CDCP.

At a system-wide level, the approach aims for scalability (e.g., across a jurisdiction) towards the development of an evidence-based culture of practice for design-led educational innovation so that it can have the added benefits of: (1) facilitating knowledge transfer between schools; (2) helping teachers to access the benefits of existing resources provided for them; and (3) catering for the diversity, differences and limited opportunities and resources in regional and rural Australian schools, as illustrated in Wright & Wrigley's (2019, p.8) *Design-led Education Program Framework*. A key issue in scaling up the CDCP approach to cover, say, an entire jurisdiction, is that skilled personnel are required to facilitate programs. CDCP needs to be facilitated by a team that includes expertise and experience in secondary school teaching (generally), curriculum knowledge (specific to the curriculum being designed for), and design thinking facilitation for education. Teaching and curriculum knowledge are common skills within the teaching profession, and there are many design thinking facilitators and learning environment designers with at least 'competent' design expertise outside of the teaching profession (Wright & Wrigley, 2019). It seems feasible that any scaled up CDCP program could be staffed by a combination of these two groups, rather than relying upon continued university involvement.

Curriculum planning at the classroom level often occurs within silos—in staffrooms within a school. Through successive co-design interventions, we hypothesise that the CDCP approach works to facilitate meaningful collaboration across these silos, through workshop facilitators bringing ideas from past CDCP workshops into a present workshop, and even sharing resources where appropriate. In the present study, School B iterated upon the work of School A, demonstrating significant knowledge transfer. The suggestion is that CDCP may enable this kind of transfer to be scaled up to cover an entire jurisdiction, with facilitators (of workshops) also serving as a form of 'knowledge broker' (between schools). Further, we believe that this may be effective through online video facilitation at-a-distance, which is what makes scalability possible, without losing the benefits of real time (virtual) eye contact and presence.

Also, many existing initiatives that exist to support teachers are not used to their full potential, either through lack of knowledge on the part of teachers, or through the time commitment required from teachers for engagement. For example, online resource banks, comprehensive curriculum plans (e.g., Curriculum2Classroom⁷), and online communities for teachers are all well-funded but often lack teacher engagement and uptake (Kelly et al., 2015, Kelly, 2019). We hypothesise that the hands-on and goal-directed nature of the co-design approach, and the curriculum design outcomes which link to many of these, help to add significant value to these existing resources. Through the process of joint curriculum planning, the co-design team was able to not just inform teachers about these initiatives (saving them retrieval time), but also reduce the threshold for engagement so that they could use these resources purposefully in their work in a way suited to their school context.

⁶ <https://www.codesignforcurriculumplanning.org>

⁷ <http://education.qld.gov.au/c2c/index.html>, accessed 26th April, 2018

Finally, we hypothesise that the participatory nature of the co-design process—with teachers as joint designers equipped to focus on the specific needs of their students—makes it a powerful way of valuing the differences between schools, such as those between metropolitan and regional/remote rural schools (Halsey, 2018; Reid et al., 2010). By adopting a design-led pedagogy, teachers allow students to bring their own personalised experiences and diverse attributes into the classroom. We hypothesise that this represents a positive shift for regional and rural schools, where difference comes to be a strength that teachers (and students) can draw upon, as observed in the work with School B who made rural tourism the focus of the students' projects.

Evidence for Meeting Design Goals

Returning to the initial design goals guiding the present study, teacher professional development in response to a new curriculum needs to satisfy the goals of being high quality teacher professional development and of developing teachers' TPACK for Digitech. In this section, selected quotes from interviews are used as prima facie evidence for the way that the CDCP approach has satisfied these goals. The additional design goals of creating student-centred engaging curriculum, and ensuring that CDCP is a genuine policy option, are discussed with reference to the study.

Evidence of High Quality TPD

Our approach, through using the process and tools of design thinking (e.g., brainstorming, mapping, rapid prototyping and peer evaluation), reframed teachers' engagement with curriculum planning. The deputy principal recognised that, beyond changing things for teachers in the immediate group, it was an opportunity to change the culture of the whole school community.

“Not only can we think about that approach that we've taken—in terms of brainstorming the project discussion and then also presenting and doing a rapid pitch—all of those things can happen in a faculty meeting now. It's about affording teachers the time to be able to do that.” (Albert, Deputy principal)

Teachers valued the authenticity of the CDCP approach, recognising teacher feedback on the genuine professional challenges within the new curriculum. The professional development occurs in the process of supporting teachers to respond to these challenges. In this way they came to respect the process, rather than feeling as though it was a drain upon their time.

“So initially teachers were perhaps slightly hesitant, but then as we worked with [the university] through the workshops and had meetings and shared resources and saw the wonderful work that was happening, then teachers really bought into it because they could see the direction it was going in.” (Amy, HoD)

The fact that the TPD seemed to have a lasting impact upon the school culture, points to its effects as a sustained, high quality TPD. Other teachers expressed similar sentiments, recognising the generalisability of what was learned—these were ideas that teachers had from their involvement in the project that were not prompted by the researchers and were outside the scope of this project:

“I think several of the things that we've done that help support the design thinking process are definitely applicable to other subjects.” (Bryan, Teacher)

And:

“We have, now we've built confidence and renewed enthusiasm, grand ideas for our next unit for next term, which does involve working collaboratively and students doing research across different departments, different faculties for their project or the project that we want to renew, and part of that OneNote would form a really vital part of that for receiving - conducting surveys and receiving information and collaborating with other teachers and students.” (Arnold, Teacher)

Evidence of Developing Teachers' TPACK

Evidence suggests that the approach worked to help each teacher involved realise their proximal zone of development with relation to the Digitech curriculum. The HoD of School A recognised that each class had students at very different levels, but that the design-led approach allowed teachers to make sure that the project could be adapted to the needs of each class.

“We're catering for a very diverse range of students. We are an international school so we also have a lot of students for whom English is a second language and that can sometimes be a barrier. So there were all these, you'd say fairly complex factors involved, and so therefore it was really important to have an entry point where everyone was on the same page. The expectations were the same but everyone could understand but also be creative and collaborate--that's what the program allowed.” (Amy, HoD)

Additionally, she appreciated the benefits of partnering with academics through the CDCP approach.

“By working with [the university] we were able to basically build the capacity of staff to work within the digital technologies context and to get a deeper and richer understanding of the Australian Curriculum. It certainly has achieved beyond our expectations and has really developed the capacity of teachers to work not just from a design context but with the technical elements of digital technologies and to be prepared and ready for that every day when they walk into the classroom.” (Amy, HoD)

An unexpected outcome from the work was that a number of teachers with no previous experience using OneNote, remarked that they had found it a useful tool for collaborating both in and out of the classroom. Involvement in the CDCP had given them an authentic problem which motivated them to learn this technology in order to work with their colleagues:

“[The OneNote collaboration space] was really useful for me when it came to giving them that collaborative mark to see who was giving the most input and just generally reflecting in class [...] Like this is your role and delegating and just going this is what you're responsible for, I need this done by this time, setting deadlines, delegating. They learned those skills pretty quickly [laughs].” (Arthur, Teacher)

One teacher described his appreciation of the resources within the curriculum planning documents which improved his confidence in his own problem-solving abilities.

“I think that would probably be the greatest asset of this whole process is my much greater capacity to problem solve. I didn't have to - if someone asked me a question, I'd be like I've got no clue. I'll go home after school and I'll try and figure it out. But I've got no clue really where to look. Whereas this one we at least - when they had a question I'm like okay, here is three places we can go to

see how they've done it and going from there, which is incredibly helpful.”
(Bryan, Teacher)

Towards Evidence of Student-Centred, Engaged Curriculum

The CDCP model was developed with a goal of ensuring that teachers enact the Digitech curriculum in a way that is student-centred and engaged. The co-design facilitators supported this through the format of the design workshops, such as through the development of personas (that teachers could use to remember the needs of the students) and through a focus upon real-world problem solving. This was recognised by a school leader in the project, the deputy principal of School A, who noted that an outcome of the project was that:

“For us, it’s transformed our digital technologies curriculum to a real-world curriculum...students really get or understand something better when they realise they can use it in real life, and they find it more interesting and engaging.”
(Albert, Deputy principal)

A limitation of the study is that no data were gathered on outcomes in terms of student engagement, perceptions, or learning outcomes. Teachers did comment on their perception that changes to their way of teaching, inspired by the project, was of significant benefit to students. However, further research is required to gather evidence to substantiate these claims.

Towards Evidence of Scalability and Efficiency

Policymakers require that there is an evidence basis to support the impact of an intervention, that it can be costed in terms of per-unit value, and that it is able to reach an appropriate scale. Further research is required to understand CDCP in terms of cost per school or per teacher, and for a more robust understanding of the impact upon teachers and, ultimately, students. For example, quantitative measures of teachers’ self-efficacy and classroom activities (self-reported) both before and after the intervention would allow for some understanding of the impact of CDCP within a school. In establishing the value of the approach, it is relevant that it multiplies the value of existing spending through enabling re-use of knowledge between schools and by helping teachers to access and maximise the benefit of existing government initiatives. In relation to the present study, it is relevant that the federal government has spent significant funds creating online resources and physical workshops for the new curriculum. The CDCP team could direct teachers to these resources, increasing their value. We believe that CDCP is most useful when there is any new curriculum that teachers need to prepare for, because it is when teachers are most motivated to embrace a new way of approaching curriculum planning, as well as when there are typically government resources being made available.

Co-design inherently requires human-human connection, however due to connected technologies it was possible to run workshops entirely online, as demonstrated with School B. In this way, the approach becomes theoretically scalable in terms of distance. Online teacher professional development is common and widely successful (Dede, Jass Ketelhut, Whitehouse, Breit, & McCloskey, 2009; Hill, Beisiegel, & Jacob, 2013); however, a serious shortcoming of alternative approaches that *do* scale (e.g., resources websites, online videos, and online communities) is that they do not recognise the *difference* between schools and school contexts (Luft & Hewson, 2014).

Transferable Design Principles

The CDCP approach focused upon professional development for Australian teachers in response to a new Digitech curriculum. However, it is possible that the idea of co-design for curriculum planning—as a form of TPD—is generalisable to other new curricula and to other countries. Further research is required to determine if this is the case, but the documentation of the design process in this paper serves to assist such work.

This structure of detailed lessons (with an outline of activities), within modules (as logical and ordered clustering of lessons and resources) within units (as a logical and ordered clustering of modules) could be described as a reusable *design pattern* (Goodyear, 2005). Even when new teachers joined the unit of study partway through the term (as happened with one teacher in School A), the feedback was that they intuitively understood the learning design as it was presented in this way. This suggests that the model may be useful for heads of department in situations where staffing from year to year is unpredictable, as it is in many schools. It presents a transferable model for lessons that are well explained, without being prescriptive and provides a replicable process and effective tools that teachers can model independently for the benefit of future curriculum design in their schools.

Conclusions

This paper has described the development of *co-design for curriculum planning* as a design-based research study. It has articulated the nature of the problem, where teachers facing a new curriculum require professional development; and the specific Australian situation in which teachers require TPD in response to the new ACARA Digitech curriculum.

It has presented the theoretical basis for proposing co-design for curriculum planning as a form of high quality teacher PD in the sense that it is: contextual (teachers in each school set their own goals); sustained (through an ongoing relationship); respectful (of teacher autonomy) yet collaborative (involving teachers from disparate subject areas for added stimulus); and functions through active learning (in which teachers are guiding the design process).

It has described the process by which a design solution for implementing CDCP was developed through two phases of participant involvement and has presented preliminary evidence to support the CDCP approach. At the time of writing we are commencing work with a third secondary school, aiming to experiment with using the CDCP approach across the middle years of schooling and with a wider range of subjects. School A has continued to use the design thinking framework that was introduced through this project, even after the research project was completed. Further research is required to determine the impacts of the approach upon student learning, and whether the model can be scaled up as a viable policy option whenever new curricula are introduced.

Acknowledgements

This project was funded by the Queensland Department of Education through an Education Horizons Grant. We would like to thank teachers and school leaders from Queensland state high schools for embracing the project. We would like to thank Anna Kinnane, Karsten Schulz, Adam Jefford, and Kathy Nickels for their advice throughout the project. Dr Kelly would like to thank the Australian Department of Foreign Affairs and Trading (DFAT) for their support through an Australian Endeavour Fellowship.

References

- Australian Curriculum Assessment and Reporting Authority (ACARA). (2015). Retrieved July 2, 2019, from <https://www.australiancurriculum.edu.au>
- Avalos, B. (2011). Teacher professional development in teaching and teacher education over ten years. *Teaching and Teacher Education*, 27(1), 10-20. <https://doi.org/10.1016/j.tate.2010.08.007>
- Barab, S., & Squire, K. (2004). Design-based research: Putting a stake in the ground. *Journal of the Learning Sciences*, 13(1), 1-14. https://doi.org/10.1207/s15327809jls1301_1
- Borko, H. (2004). Professional development and teacher learning: Mapping the terrain. *Educational Researcher*, 33(8), 3-15. <https://doi.org/10.3102/0013189X033008003>
- Collins, A. (1992). Towards a design science in education In E. Scanlon & T. O'Shea (Eds.), *New Directions in Educational Technology*. Berlin: Springer-Verlag. https://doi.org/10.1007/978-3-642-77750-9_2
- Collins, A., Joseph, D., & Bielaczyc, K. (2004). Design research: Theoretical and methodological issues. *The Journal of the learning sciences*, 13(1), 15-42. https://doi.org/10.1207/s15327809jls1301_2
- Conole, G. (2013). *Designing for learning in an open world. Explorations in the learning sciences, instructional systems and performance technologies*, vol. 4: Springer. <https://doi.org/10.1007/978-1-4419-8517-0>
- Cooper, A. (1999). *The inmates are running the asylum: Why high-tech products drive us crazy and how to restore sanity*. Indianapolis: Sams.
- Craft, A. (2002). *Continuing professional development: A practical guide for teachers and schools*. NY: Routledge.
- Darling-Hammond, L., & McLaughlin, M. W. (1995). Policies that support professional development in an era of reform. *Phi Delta Kappan*, 76(8), 597-604. <https://doi.org/10.1177/003172171109200622>
- Darling-Hammond, L., & Richardson, N. (2009). Research review/teacher learning: What matters. *Educational Leadership*, 66(5), 46-53.
- Dede, C. (2010). Comparing frameworks for 21st century skills. *21st century skills: Rethinking how students learn*, 20, 51-76.
- Dede, C., Jass Ketelhut, D., Whitehouse, P., Breit, L., & McCloskey, E. M. (2009). A research agenda for online teacher professional development. *Journal of Teacher Education*, 60(1), 8-19. <https://doi.org/10.1177/0022487108327554>
- Deng, Z. (2018). Pedagogical content knowledge reconceived: Bringing curriculum thinking into the conversation on teachers' content knowledge. *Teaching and Teacher Education*, 72, 155-164. doi:<https://doi.org/10.1016/j.tate.2017.11.021>
- Dorst, K. (2011). The core of 'design thinking' and its application. *Design studies*, 32(6), 521-532. <https://doi.org/10.1016/j.destud.2011.07.006>
- Feiman-Nemser, S. (1996). *Teacher Mentoring: A Critical Review*. ERIC Digest.
- Følstad, A., & Kvale, K. (2018). Customer journeys: a systematic literature review. *Journal of Service Theory and Practice*, 28(2), 196-227. <https://doi.org/10.1108/jstp-11-2014-0261>
- Goldman, S., Carroll, M. P., Kabayadondo, Z., Cavagnaro, L. B., Royalty, A. W., Roth, B., Kwek, S.H., & Kim, J. (2012). Assessing d. learning: Capturing the journey of becoming a design thinker. In H. Plattner, C. Meinel & L. Leifer (Eds.), *Design thinking research: Measuring performance in context* (pp. 13-33). Berlin, Heidelberg: Springer. https://doi.org/10.1007/978-3-642-31991-4_2

- Gonski, D., Arcus, T., Boston, K., Gould, V., Johnson, W., O'Brien, L., . . . Roberts, M. (2018). *Through Growth to Achievement: Report of the Review to Achieve Educational Excellence in Australian Schools*. Canberra: Commonwealth of Australia.
- Goodyear, P. (2005). Educational design and networked learning: Patterns, pattern languages and design practice. *Australasian Journal of Educational Technology*, 21(1). <https://doi.org/10.14742/ajet.1344>
- Grover, S., & Pea, R. (2013). Computational thinking in K–12: A review of the state of the field. *Educational Researcher*, 42(1), 38-43. <https://doi.org/10.3102/0013189X12463051>
- Halsey, J. (2018). *Independent Review into Regional, Rural and Remote Education*. Department of Education and Training, Commonwealth of Australia. Retrieved July 2, 2019, from <https://www.education.gov.au/independent-review-regional-rural-and-remote-education>
- Hill, H. C., Beisiegel, M., & Jacob, R. (2013). Professional Development Research: Consensus, Crossroads, and Challenges. *Educational Researcher*, 42(9), 476-487. <https://doi.org/10.3102/0013189X13512674>
- Huling, L., & Resta, V. (2001). *Teacher mentoring as professional development*. Washington DC: ERIC Clearinghouse on Teaching and Teacher Education.
- Johansson-Sköldberg, U., Woodilla, J., & Çetinkaya, M. (2013). Design thinking: past, present and possible futures. *Creativity and innovation management*, 22(2), 121-146. <https://doi.org/10.1111/caim.12023>
- Johnson, Z. (2016). Teachers as designers of context-adaptive learning experience. In S. Goldman & Z. Kabayadondo (Eds.), *Taking design thinking to school: How the technology of design can transform teachers, learners, and classrooms* (pp.126-142). New York : Routledge. <https://doi.org/10.4324/9781317327585>
- Kelly, N. (2019). Online Networks in Teacher Education. *Oxford Research Encyclopedia of Education*. Retrieved May 25, 2019, from <https://oxfordre.com/education/view/10.1093/acrefore/9780190264093.001.0001/acrefore-9780190264093-e-416>
- Kelly, N., Clará, M., & Kickbusch, S. (2015). How to develop an online community for pre-service and early career teachers. *Paper presented at the ASCILITE 2015*, Perth, Western Australia. <https://eprints.qut.edu.au/90985/>
- Kelly, N., Dawes, L., Wright, N., Kerr, J., & Robertson, A. (2018). *Co-Design for Curriculum Planning: A white paper on the co-design approach to developing teachers' 21st Century skills*. Retrieved July 2, 2019, from <https://eprints.qut.edu.au/121431/>
- Kennedy, A. (2005). Models of continuing professional development: a framework for analysis. *Journal of in-service education*, 31(2), 235-250. <https://doi.org/10.1080/13674580500200277>
- Kennedy, M. M. (2016). How does professional development improve teaching? *Review of Educational Research*, 86(4), 945-980. <https://doi.org/10.3102/0034654315626800>
- Kereluik, K., Mishra, P., Fahnoe, C., & Terry, L. (2013). What knowledge is of most worth: Teacher knowledge for 21st century learning. *Journal of Digital Learning in Teacher Education*, 29(4), 127-140. <https://doi.org/10.1080/21532974.2013.10784716>
- King, F. (2014). Evaluating the impact of teacher professional development: an evidence-based framework. *Professional Development in Education*, 40(1), 89-111. <https://doi.org/10.1080/19415257.2013.823099>
- Koehler, M., & Mishra, P. (2009). What is technological pedagogical content knowledge (TPACK)? *Contemporary Issues in Technology and Teacher Education*, 9(1), 60-70.

- Koh, J. H. L., Chai, C. S., & Lim, W. Y. (2017). Teacher Professional Development for TPACK-21CL: Effects on Teacher ICT Integration and Student Outcomes. *Journal of Educational Computing Research*, 55(2), 172-196. <https://journals.sagepub.com/doi/10.1177/0735633116656848>
- Koh, J. H. L., Chai, C. S., Wong, B., & Hong, H.-Y. (2015). *Design thinking for education: Conceptions and applications in teaching and learning* (pp. 1-15). Singapore: Springer. https://doi.org/10.1007/978-981-287-444-3_1
- Kraft, M. A., Blazar, D., & Hogan, D. (2018). The Effect of Teacher Coaching on Instruction and Achievement: A Meta-Analysis of the Causal Evidence. *Review of Educational Research*. <https://doi.org/10.3102/0034654318759268>
- Le Cornu, R., & Peters, J. (2009). Towards constructivist classrooms: The role of the reflective teacher. *The Journal of Educational Enquiry*, 6(1).
- Lee, Y. (2008). Design participation tactics: The challenges and new roles for designers in the co-design process. *Co-design*, 4(1), 31-50. <https://doi.org/10.1080/15710880701875613>
- Luft, J. A., & Hewson, P. W. (2014). Research on teacher professional development programs in science. *Handbook of research on science education*, 2, 889-909.
- Lye, S. Y., & Koh, J. H. L. (2014). Review on teaching and learning of computational thinking through programming: What is next for K-12? *Computers in Human Behavior*, 41, 51-61. <https://doi.org/10.1016/j.chb.2014.09.012>
- Mayer, D. (2014). Forty years of teacher education in Australia: 1974–2014. *Journal of education for teaching*, 40(5), 461-473. doi:10.1080/02607476.2014.956536
- Munby, H., & Russell, T. (1990). Metaphor in the study of teachers' professional knowledge. *Theory into practice*, 29(2), 116-121. <https://doi.org/10.1080/00405849009543441>
- Noweski, C., Scheer, A., Büttner, N., von Thienen, J., Erdmann, J., & Meinel, C. (2012). Towards a paradigm shift in education practice: Developing twenty-first century skills with design thinking. In H. Plattner, C. Meinel, & L. Leifer (Eds.), *Design thinking research: Understanding innovation* (pp. 71-94). Berlin, Heidelberg: Springer-Verlag. https://doi.org/10.1007/978-3-642-31991-4_5
- Rauth, I., Köppen, E., Jobst, B., & Meinel, C. (2010). *Design thinking: An educational model towards creative confidence*. Paper presented at the DS 66-2: Proceedings of the 1st international conference on design creativity (ICDC 2010).
- Razzouk, R., & Shute, V. (2012). What is design thinking and why is it important? *Review of Educational Research*, 82(3), 330-348. <https://doi.org/10.3102/0034654312457429>
- Reeves, T. (2006). Design research from a technology perspective *Educational design research* (pp. 64-78): Routledge.
- Reid, J., Green, B., Cooper, M., Hastings, W., Lock, G., & White, S. (2010). Regenerating rural social space? Teacher education for rural—regional sustainability. *Australian journal of education*, 54(3), 262-276. <https://doi.org/10.1177/000494411005400304>
- Resnick, M., Maloney, J., Monroy-Hernández, A., Rusk, N., Eastmond, E., Brennan, K., . . . Silverman, B. (2009). Scratch: programming for all. *Communications of the ACM*, 52(11), 60-67. <https://doi.org/10.1145/1592761.1592779>
- Roschelle, J., & Penuel, W. R. (2006). *Co-design of innovations with teachers: Definition and dynamics*. Paper presented at the Proceedings of the 7th international conference on Learning sciences.
- Roth, G., Assor, A., Kanat-Maymon, Y., & Kaplan, H. (2007). Autonomous motivation for teaching: How self-determined teaching may lead to self-determined learning. *Journal of Educational Psychology*, 99(4), 761. <https://doi.org/10.1037/0022-0663.99.4.761>

- Savery, J. R. (2015). Overview of problem-based learning: Definitions and distinctions. *Essential readings in problem-based learning: Exploring and extending the legacy of Howard S. Barrows*, 9, 5-15. <https://doi.org/10.7771/1541-5015.1593>
- Schwartz, D. L., Bransford, J. D., & Sears, D. (2005). Efficiency and innovation in transfer. In J.P. Mestre (Ed.), *Transfer of learning from a modern multidisciplinary perspective* (pp.1-52). Greenwich, CT: Information Age Publishing.
- Shawer, S. F. (2017). Teacher-driven curriculum development at the classroom level: Implications for curriculum, pedagogy and teacher training. *Teaching and Teacher Education*, 63, 296-313. doi:<https://doi.org/10.1016/j.tate.2016.12.017>
- Sims, R. (2014). *Design alchemy: Transforming the way we think about learning and teaching*. New York: Springer. doi: <https://doi.org/10.1007/978-3-319-02423-3>
- Snyder, J., Bolin, F., & Zumwalt, K. (1992). Curriculum implementation. *Handbook of research on curriculum*, 40(4), 402-435.
- Trilling, B., & Fadel, C. (2009). *21st century skills: Learning for life in our times*. San Francisco: Jossey-Bass.
- Villegas-Reimers, E. (2003). *Teacher professional development: An international review of the literature*. Paris: International Institute for Educational Planning.
- Wayne, A. J., Yoon, K. S., Zhu, P., Cronen, S., & Garet, M. S. (2008). Experimenting with teacher professional development: Motives and methods. *Educational Researcher*, 37(8), 469-479. <https://doi.org/10.3102/0013189X08327154>
- Wing, J. M. (2008). Computational thinking and thinking about computing. *Philosophical transactions of the royal society of London A: Mathematical, physical and engineering sciences*, 366(1881), 3717-3725. <https://doi.org/10.1098/rsta.2008.0118>
- Wright, N., & Davis, R.M. (2014). Educating the creative citizen: Design education programs in the knowledge economy. *Techne Series: Research in Sloyd Education and Craft Science A*, 21(2), 42-61.
- Wright, N., Miller, E., Dawes, L., & Wrigley, C. (2018). Beyond ‘chalk and talk’: Educator perspectives on design immersion programs for rural and regional schools. *International Journal of Technology and Design Education*, 1-31. <https://doi.org/10.1007/s10798-018-9487-7>
- Wright, N. & Wrigley, C. (2019) Broadening design-led education horizons: Conceptual insights and future research directions. *International Journal of Technology and Design Education*, 29(1), pp. 1-23. <https://doi.org/10.1007/s10798-017-9429-9>
- Yelland, N., Cope, B., & Kalantzis, M. (2008). Learning by design: Creating pedagogical frameworks for knowledge building in the twenty-first century. *Asia-Pacific Journal of Teacher Education*, 36(3), 197-213.
- Zhao, Y. (2010). Preparing globally competent teachers: A new imperative for teacher education. *Journal of Teacher Education*, 61(5), 422-431.
- Yelland, N., Cope, B., & Kalantzis, M. (2008). Learning by design: Creating pedagogical frameworks for knowledge building in the twenty-first century. *Asia-Pacific Journal of Teacher Education*, 36(3), 197-213. <https://doi.org/10.1080/13598660802232597>
- Zhao, Y. (2010). Preparing globally competent teachers: A new imperative for teacher education. *Journal of Teacher Education*, 61(5), 422-431. <https://doi.org/10.1177/0022487110375802>