Supporting the Implementation of **Digital Technologies in Disadvantaged Schools**

Case study of impact, outcomes and sustainability

Julianne Lynch | Glenn Auld | Anne Cloonan | Joanne O'Mara | Christopher Speldewinde

Acknowledgements

Disclaimers

The views expressed herein represent those of the research team and do not necessarily represent the views of the Australian Curriculum, Assessment and Reporting Authority.

To protect the identity of the participants in the case study schools, no project photographs have been used in this report. The included images are stock photographs, selected to provide some representation of digital technologies in disadvantaged schools.

Glossary

Acronyms

ACARA	Australian Curriculum, Assessment and Reporting Authority
BYOD	Bring your own device
DP	Data Point
DTiF	Digital Technologies in Focus
ICSEA	Index of Community Socio-Educational Advantage
ICT	Information and Communications Technology
LOTE	Languages Other Than English
MOOC	Massively Open Online Course
NISA	National Innovation and Science Agenda
NBN	National Broadband Network
STEM	Science, Technology, Engineering and Mathematics
VR	Virtual Reality

Other terms used in the report

Assistant teacher — Different terms are used in each state to denote the role of assistant teachers who work with individual students and small groups to support the classroom teacher.

Curriculum officer — ACARA uses this term to denote the Digital Technologies curriculum experts employed by ACARA through DTiF to support each school. Curriculum officers were allocated to geographic clusters of schools.

DTiF leader — Most schools identified a staff member who had leadership of that school's project in DTiF.

Foundation — Used to refer to the first year of formal schooling in Australia, where states use different terminology.

General capabilities — In the Australian Curriculum the generic capabilities identify areas of knowledge, skills, behaviours and dispositions that support students' capability across the curriculum and in their lives outside school. It is intended that teachers teach and assess the general capabilities that are incorporated into the subject learning areas.

Homelands — Places where people reside away from colonised settlements to fulfil ceremonial obligations and be themselves amongst culturally familiar landscapes and waterways.

Indigenous — A broad term used to refer to Aboriginal and Torres Strait Islander peoples in the context of this Australian study. This term is used in conjunction with Non-Indigenous that refers to people who are not of Aboriginal and Torres Strait Islander heritage.

Maker spaces — Creative, self-directed learning spaces where students can create, invent and learn.

Relief Teacher — Casual teachers paid by the hour or day to relieve classroom teachers for other duties or to replace teachers on leave.

Remote — Used in official documentation to indicate geographical distance from urban centres and the facilities found there. However, we note that 'remote' describes a Settler perspective of Country, and one that is city-based. If this place is your Country, where you live and belong, it is the centre of your world and not remote to you. We acknowledge all schools in this case study are on places that always were and always will be Aboriginal Land. We acknowledge that the sovereign claims Aboriginal people have to land where these schools are located problematise the Settler terminology of 'remote'.

Unplugged — Describes Digital Technologies learning that does not make use of digital technology, instead using other, tangible or kinaesthetic modalities.

Contents

Executive summary

As a part of the Australian Government's National Innovation and Science Agenda (NISA), the Australian Curriculum, Assessment and Reporting Authority (ACARA) was funded to promote the implementation of the Australian Curriculum: Digital Technologies in Australia's most disadvantaged schools. The Digital Technologies in Focus (DTiF): Supporting Implementation of Digital Technologies was funded as a three-year project (2017-19), providing professional learning for school leaders and teachers in 160 primary and secondary schools with a low Index of Community Socio-Educational Advantage (ICSEA) value. All Australian states and territories were represented by schools participating in the project. In late 2018, the timeline of the DTiF was extended into 2020 to accommodate schools that came late to the project or encountered delays. Due to COVID-19 and the impact of travel restrictions, the project was further extended to June 2021 to ensure schools in later phases of the project continued to be supported by ACARA.

Curriculum implementation and teacher learning at each school was framed by a site-specific action plan and action research cycle. ACARA Digital Technologies specialists (known as curriculum officers) worked with geographical clusters of schools, providing school leaders and teachers with support in designing and implementing an action research project that addressed implementation of the Digital Technologies curriculum in their school. School leaders were guided through the processes of identifying areas for improvement and offered a range of supports to work towards these improvements and opportunities to network with other schools.

School-based action research was supported by a professional learning ecosystem designed to support school implementation of the curriculum and sustainability of implementation. The ecosystem included curriculum officers enabling collaborations between participating schools with Indigenous, professional, industry, tertiary, and regional jurisdictional partners through geographical and project focus clusters. Also included were professional learning workshops (including face-to-face intensives, webinars and Massive Open Online Courses (MOOC)), as well as site-specific customised support provided by curriculum officers via face-to-face and online interactions, supported by some teaching relief.

This case study evaluation

To investigate the extent to which the project meets its aims with respect to impact, outcomes and methodology in participating schools, ACARA implemented a program of evaluation. As part of this evaluation, a team from the Deakin University School of Education was commissioned to undertake a close-up case-study of six participating schools, the results of which are presented in this report.

The purpose of this external evaluation was to investigate:

- the impact of ACARA's NISA project for school personnel including the potential for sustainability in each school and potential for transferring outcomes to other schools;
- the project methodology in terms of its capacity to effect change and support implementation of the Digital Technologies curriculum in disadvantaged schools and whether the project methodology might be transferrable to other initiatives.

The external evaluation employed a case study design with the purpose of providing rich, in-depth information regarding:

- the contexts and histories of participating schools with regards to Digital Technologies curricular practices, resourcing and teacher professional learning;
- schools' level of participation in the Digital Technologies in Focus project activities, including school leadership workshops, professional learning workshops;
- engagement with curriculum officers, engagement with professional learning and online support, and engagement in project reporting and evaluation processes;
- the outcomes of their participation at the school, teacher and student levels and;
- evidence of impact and sustainability of new and developing practices.

Case studies focussed on six schools from four states and territories. Schools were selected to incorporate diversity of contextual factors (state, sector and location—urban, regional and remote) and included two schools located in major cities, two schools located in regional Australia and two remote schools. Case study schools were located across four Australian states and territories. They included four government schools, one Catholic school and one independent Indigenous school.

Case study data were collected from each school across three data collection points that spanned two years, focusing respectively on:

1. Historical and contextual factors impacting on the school; the history of Digital Technologies and Information and Communications Technology (ICT) implementation in the school (prior to commencement in the project); the school's resourcing for Digital Technologies; gaining insight into teachers' backgrounds, plans and concerns; and developing rapport with participants; individuals' and schools' early engagements with the DTiF project, and how these engagements were being received.

2. Accounts and evidence of curriculum and pedagogy that were developed as part of schools' participation in the DTiF program, and learning outcomes observed; the schools' engagement with the project, including the focus and progress of each school's project plan and issues encountered; teacher engagement and professional learning in the project; teacher-selected student cases that illustrated engagement, growth or particular issues or affordances of the Digital Technologies work in each school.

3. Individuals' and schools' new and continued engagements with the DTiF project; accounts and evidence of curriculum implementation and pedagogy; accounts of outcomes for students; strategies for sustainability of impacts and outcomes.

Data collection methods included interviews and focus groups with key stakeholders—school leaders, teachers and assistant teachers—as well as some direct observation of school spaces and facilities, and the collection of relevant documentary artefacts. In total, thirty staff members were interviewed. Staff turnover across the period of the evaluation was high, with some case study schools experiencing very significant staff changes. Only eight of the staff members interviewed at the final data collection point had been interviewed at all three points.

This final report builds on two interim progress reports which have communicated the progress and preliminary findings of data collection points 1 and 2 to ACARA. The report is informed by an ongoing dialogue between ACARA and the Deakin University evaluation team. In addition to the visits to case study schools, the evaluation team's understanding of the progress of the project and the engagement of schools in its program has been supported by a number of meetings with the ACARA project lead, and two meetings with the ACARA team of curriculum officers.

The case study methodology enabled development of narratives from the point of view of school leaders and teachers that evidence change over the life of the project drawing on interview, observational and documentary data that targeted three evaluation components: impact, outcomes, and the effectiveness of the project methodology. Detailed accounts of the project at each case study school are provided in this report. A cross case analysis was undertaken to explain challenges, opportunities and outcomes evident in the case study schools with respect to the specific context of each school. Fragilities and complexities are analysed across case studies as well as ways in which participants responded to these fragilities and complexities within the context of their school's involvement in DTiF. Innovative approaches developed and implemented with support from this project are explored, as are participants' views on the sustainability of impacts and outcomes.

Continuing, sustaining and transferring impacts within and beyond DTiF schools

The points below summarise the key findings and implications of the cross-case study analysis with respect to impacts and outcomes for schools, together with considerations for transferring outcomes to other disadvantaged schools.

Positive outcomes of the DTiF

1. Positive outcomes for student engagement, inclusion and achievement were reported at each case study school. Impacts on student engagement were supported variously by the use of inquiry and design pedagogies, the incorporation of inspiring Digital Technologies equipment and apps, building on community strengths and resources, and promoting the general capabilities. For Indigenous students, positive impacts on engagement and general capabilities were noted and supported with accounts of particular examples of successful practices and specific students. At schools with high proportions of Indigenous students, alignment with the cross-cultural priority of Aboriginal and Torres Strait Islander Cultures and Histories was an important consideration, with learning activities making connections with community cultural and linguistic resources.

2. Positive impacts on teacher professional knowledge were reported at each case study school, including strengthening ICT capabilities, familiarisation with Digital Technologies curriculum, familiarisation with Digital Technologies pedagogies, increased technical knowledge and skills in the implementation of specialist equipment and apps, and new insights about how to manage devices and digital media. The DTiF stimulated and supported much teacher-led innovation. Enhanced professional networking between schools and collaboration within schools was a positive outcome for teachers at some schools.

Importance of local knowledge in disadvantaged schools

3. Structural disadvantage and ongoing disruption to programs at the case study schools required strategies for developing resources and expertise that respond to the specific contexts of each school, their local histories, circumstances and conditions, community resources and strengths. Teacher and principal knowledge of local students and communities was integral to the development and implementation of successful strategies. In some disadvantaged schools, in a context of high staff turnover, assistant teachers provide continuity as a critical source of this knowledge. This was particularly the case at schools with high proportions of Aboriginal students.

Complementarity of Digital Technologies, the general capabilities, and engagement priorities in disadvantaged schools

4. Successful strategies took advantage of alignment between the Digital Technologies curriculum, pedagogies and equipment; the general capabilities; and strategies to promote student engagement and inclusion. Complementarity between these three areas was evident at each school. These strategic alignments manifested in different aspects of schooling and teachers' work, including school-wide documentation and processes, teacher professional learning, curriculum planning, and within units of work and learning activities. Sites where these strategic alignments were evidenced across these different aspects reported the greatest success and the most optimism regarding sustainability.

Importance of school-level strategic alignment

5. The case study schools were all subject to multiple projects and agendas that targeted aspects of disadvantage. This presented both opportunities for alignment and potential for competing priorities, requiring highly skilled leadership to manage the governance of projects and to leverage potential impacts fully. Frequent staffing changes added another layer of complexity and at some sites put gains made at risk and threatened sustainability.

Building teacher capability

6. General ICT skills and familiarity with specialist Digital Technologies equipment was a focus at each school. Teacher capability with ICT requires skills and confidence and resources. Building teachers' skills and confidence was challenging but important in sites where historically problematic infrastructure, outdated devices and lack of equipment had not supported positive dispositions towards using digital tools and infrastructure. In the context of high staff turnover and attrition of knowledge, building capacity in individual teachers puts school programs at risk, particularly in primary settings where Digital Technologies is less likely to be allocated to a particular role in the school. Sustainable, school-wide capacity building required careful consideration of how distributed models of professional learning could be implemented, and this was not easily done in schools already experiencing financial hardship or where the impacts of disadvantage overwhelmed opportunities for strategic planning.

Establishing infrastructure and equipment

7. Establishment of robust infrastructure, suitable devices, inspiring specialist equipment and in some cases specialist Digital Technologies spaces was an important aspect of the case study schools' implementation of the Digital Technologies curriculum. Significant gains in this aspect of the material context were made at most case study schools. However, challenges related to storage, access, and ongoing maintenance were difficult to manage. In disadvantaged settings where financial resources are scarce, these challenges are often met by teachers rather than specialist technical staff and detract from time spent curriculum planning, which is not a sustainable practice.

Transferring aspects of the DTiF project methodology to other initiatives

The following points summarise the key findings and implications of the cross-case analysis with respect to the transferability of the DTiF methodology to other curriculum implementation and teacher professional learning initiatives.

Successful mentoring and networking

8. Effective mentoring and networking was central to project successes in the case study schools. The ACARA curriculum officers were key to this, and their flexible and responsive approach to providing support was the most lauded aspect of the DTiF. Mentoring by the curriculum officers took many forms, including formal whole school presentation, demonstration teaching, by-the-side in-class assistance, help with programming and assessment planning, as-needed remote support (via telephone and email), and resource sharing. The DTiF project methodology also supported networking across schools (both virtual and face-to-face) and opportunities to nurture collaborations within schools. This combination of mechanisms for support was highly suited to disadvantaged sites whose capacity to engage in the project work was sometimes tenuous and subject to fluctuations.

Action research and promoting teacher professional reflection

9. The school-based action research projects were the most vulnerable aspect of the DTiF project in the case study schools. The work associated with the action research projects did not align well with teachers' work and the established processes in the schools, and at all of the case study schools was seen as an add-on to the main work of learning about, resourcing and implementing the Digital Technologies curriculum. Professional reflection did take place at each site, but this was not positioned or enacted as research. Interactions with the curriculum officers was an important site for professional reflection on the success of strategies and resources. However, the practice of audit and review was viewed as important for sustaining schools' engagement and accountability in the DTiF, as were the timelines and milestones associated with these processes.

Potential for multimedia legacy products

10. Across the schools, the DTiF has supported a wealth of experiences related to how to implement Digital Technologies curriculum in disadvantaged settings. Many successful pedagogies and resources have been developed, and many accounts of success for students and teachers have been relayed. These experiences and associated materials, assumed to be reflective of the richness at other non-case study sites, is a source of knowledge that would be valuable to disadvantaged schools outside of the project if packaged and disseminated in ways accessible and valuable to teachers. Potential high-value artefacts might include short video cases of learning activities, packaged together with unit and lesson resources and examples of whole school planning documents.

Continuity of support

11. Given the valuable contribution made by the relationships between the ACARA curriculum officers and the case study schools, consideration should be given to how this site-specific support might be continued, particularly because some schools are still in the early stages of leveraging learning to benefit all teachers, and face ongoing challenges.

Unknown Legacies

12. Given the high level of staff turnover evident at the case study schools, it is likely that teachers and school leaders who left these schools to move into other school settings will bring benefits to their new schools through the new professional knowledge they developed as consequence of their involvement in the DTiF.

Conclusion

The data in this independent case study evaluation show clearly that DTiF brought many benefits to participating schools and staff, including supporting positive outcomes for student engagement and learning, and for teacher professional learning. Student learning outcomes extended beyond the Digital Technologies curriculum to include the general capabilities (particularly ICT Capability; Critical and Creative Thinking; and Literacy) and other curriculum domains. Within these very disadvantaged contexts, impacts on student engagement in school learning was noted at each school, as were positive impacts on inclusion with numerous accounts of positive experiences and growth for previously marginalised learners.

Teacher professional learning outcomes included increased familiarity with the Digital Technologies curriculum, including associated pedagogies. Teachers gained awareness and skills in the use of specialist equipment (for example, programmables) and apps (for example, for coding) as well as building their general ICT skills and confidence. Teachers experienced success in the use of design and inquiry pedagogies to implement aspects of the Digital Technologies curriculum; integrating general capabilities into Digital Technologies learning; and integrating Digital Technologies with other curriculum areas. Teachers also gained knowledge about programming and assessing for Digital Technologies.

The DTiF provided impetus and support for professional networking between schools, as well as promoting new collaborations within schools and strengthening existing partnerships. These impacts were seen as particularly valuable in small schools, those that are geographically isolated, and those where one staff member is responsible for implementing Digital Technologies curriculum. The strategies used in the DTiF for promoting networking allowed teachers and schools to affirm and build on local strengths.

Schools benefitted via impetus and support to establish and improve Wi-Fi infrastructure, provision of digital devices, implementation of cloud storage and cloud media tools, and use of specialist equipment. In some schools, local legacy documents were also established such as assessment plans, and approaches to curriculum and pedagogy pertinent to the Digital Technologies curriculum were built into school-level strategic documentation and reporting.

Features of the DTiF supporting these outcomes and impacts include support for developing school-specific foci for professional learning and change; flexible and generous support from the ACARA DTiF curriculum officers allocated to each school; the three-year period of the project with periodic reporting requirements promoting engagement and continuity; and the promotion of a multimodal, multi-faceted professional learning ecosystem that include on-site support, remote support, online resources, both face-to-face and online networking opportunities with other schools, and ongoing opportunities for professional reflection.

> These features provided the DTiF with traction in very disadvantaged schools, setting the DTiF apart from other, shorter-term, less responsive professional learning opportunities, and supporting outcomes that would otherwise be very difficult to achieve in these contexts.

The project speaks to the level of commitment and amount of time needed to support disadvantaged schools to engage local strengths and resources in ways that promote authentic and sustainable cultural change. In many ways, Digital Technologies is an area of curriculum ideally suited for identifying how disadvantage manifests in schools in multiple, interconnected ways; and for promoting a raft of interrelated strategies (material, professional, curricular, pedagogical) for promoting school-wide improvement. The DTiF engaged schools in all of these ways.
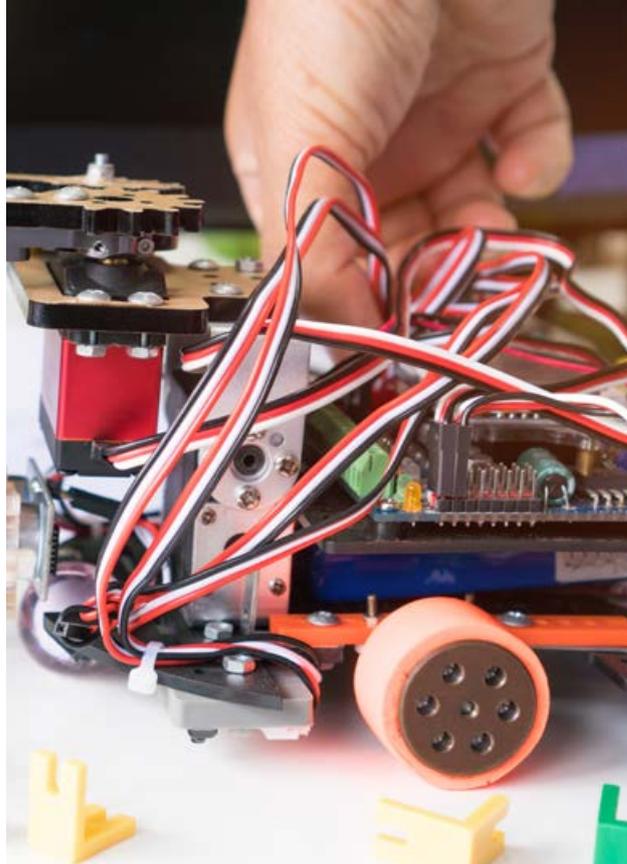

> " In many ways, Digital Technologies is an area of curriculum ideally suited for identifying how disadvantage manifests in schools in multiple, interconnected ways; and for promoting a raft of interrelated strategies (material, professional, curricular, pedagogical) for promoting school-wide improvement.

Introduction

Background and purpose of the Digital Technologies in Focus project

As a part of the Australian Government's National Innovation and Science Agenda (NISA), the Australian Curriculum, Assessment and Reporting Authority (ACARA) was funded to promote the implementation of the Australian Curriculum: Digital Technologies (herein Digital Technologies) in Australia's most disadvantaged schools. The *Digital Technologies in Focus (DTiF): Supporting Implementation of Digital Technologies* was funded as a three-year project (2017-19), providing professional learning for school leaders and teachers in 160 primary and secondary schools with a low Index of Community Socio-Educational Advantage (ICSEA) value[1]. Schools participated in geographical clusters in every Australian state and territory. In late 2018, the timeline of the DTiF was extended into 2020 to accommodate schools that came late to the project. Due to COVID-19 and the impact of travel restrictions, the project was further extended to June 2021 to ensure schools in later phases of the project continued to have support.

---

[1] ACARA (2015) What does the ICSEA value mean?
Available at: docs.acara.edu.au/resources/20160418_ACARA_ICSEA.pdf (accessed 31 August 2020).
Sydney: Australian Curriculum, Assessment and Reporting Authority.

Key features of Digital Technologies in Focus

Curriculum implementation and teacher learning at each school was framed by a site-specific action plan and action research cycle. ACARA Digital Technologies specialists (known as curriculum officers) worked with geographical clusters of schools, providing school leaders and teachers with support in designing and implementing an action research project that addressed implementation of the Digital Technologies curriculum in their school. School leaders were guided through the process of identifying areas for improvement and offered a range of supports to work towards these improvements and opportunities to network with other schools.

Action research processes included development of a school-based project implementation proposal with a school specific research question; and four staged progress reports which schools shared with ACARA curriculum officers and other schools in their cluster, both in face to face and webinar formats. Teachers evaluated strategies for data collection and success against developed criteria. Challenges and outcomes of the project were outlined. Final reports from schools took the form of a case study including student work samples based on the Digital Technologies Processes and Production Skills strand (investigating and defining, generating and designing, producing and implementing, evaluating, and collaborating and managing).

School-based action research was supported by a professional learning ecosystem designed to support school implementation of the curriculum and sustainability of implementation. The ecosystem included curriculum officers enabling collaborations between participating schools with Indigenous, professional, industry, tertiary, and regional jurisdictional partners through geographical and project focus clusters. Also included were professional learning workshops (including face-to-face intensives, webinars and Massive Open Online Courses (MOOC)), as well as site-specific customised support provided by curriculum officers via face-to-face and online interactions, supported by some teaching relief.

Evaluation purpose and methodology

To investigate the extent to which the project meets its aims with respect to impact, outcomes and methodology in participating schools, ACARA implemented a program of evaluation. As part of this evaluation, a team from the Deakin University School of Education was commissioned to undertake a close-up case-study of a small selection of six participating schools, the results of which are presented in this report.

The purpose of this external evaluation was to investigate:

- the impact of ACARA's NISA project for school personnel including the potential for sustainability
- the outcomes of ACARA's NISA project with a focus on the projects undertaken in a cross-section of schools and
- the project methodology in terms of its capacity to effect change and support implementation of the Australian Curriculum: Digital Technologies in disadvantaged schools

The external evaluation employed a case study design with the purpose of providing rich, in-depth information regarding:

- the contexts and histories of participating schools with regards to Digital Technologies curricular practices, resourcing and teacher professional learning
- schools' level of participation in the Digital Technologies in Focus project activities, including school leadership workshops, professional learning workshops
- engagement with curriculum officers, engagement with professional learning and online support, and engagement in project reporting and evaluation processes
- the outcomes of their participation at the school, teacher and student levels
- evidence of impact and sustainability of new and developing practices

Case studies focussed on six schools from four states and territories. Schools were selected to incorporate diversity of contextual factors (state, sector and location—urban, regional and remote) and included:

- Two schools located in major cities, two schools located in regional Australia and two remote[2] schools
- One school located in Victoria, two located in New South Wales, one located in Queensland and two located in the Northern Territory
- Four government schools, one Catholic school and one independent Indigenous school

Schools were allocated pseudonyms relating to minerals and gemstones as follows: Amethyst Primary School, Emerald School, Jade Primary School, Opal School, Pyrite Secondary School and Quartz Primary School. Case study data were collected from each school across three data collection points that spanned two years. Table 1 summarises the timing of collection and interviews conducted for each school.

School	Data Collection Point 1 (DP1)	Data Collection Point 2 (DP2)	Data Collection Point 3 (DP3)
Amethyst Primary School	May 2018 3 interviews conducted	August 2018 5 interviews conducted	October 2019 4 interviews conducted
Emerald School	June 2018 5 interviews conducted	October 2018 5 interviews conducted	October 2019 3 interviews conducted
Jade Primary School	September 2018 5 interviews conducted	February 2019 2 interviews conducted	N/A
Opal School	May 2018 3 interviews conducted	November 2018 3 interviews conducted	October 2019 2 interviews conducted
Pyrite Secondary School	August 2018 3 interviews conducted	May 2019 2 interviews conducted	February 2020 2 interviews conducted
Quartz Primary School	March 2018 5 interviews conducted	September 2018 4 interviews conducted	November 2019 5 interviews conducted

Table 1: School pseudonyms, timing of data collection points and interviews conducted

---

[2] We note that the terminology 'remote' describes a Settler perspective of Country. We acknowledge all schools in this case study are on places that always were and always will be Aboriginal Land. We acknowledge that the sovereign claims Aboriginal people have to land where these schools are located problematise the Settler terminology of 'remote'.

Data collection point 1 (DP1) was conducted between March and September 2018 and focussed on establishment of historical and contextual factors impacting on the school; gaining insight into the history of Digital Technologies and Information and Communications Technology (ICT) implementation in the school (prior to commencement in the program); a history of the school's resourcing for Digital Technologies; gaining insight into teachers' backgrounds, plans and concerns; and developing rapport with participants. This data collection point also provided insights into individuals' and schools' early engagements with the DTiF project, and how these engagements were being received.

Data collection point 2 (DP2) was conducted between May 2018 and May 2019 and focused on the case study schools' accounts and evidence of curriculum and pedagogy that were developed as part of their participation in the DTiF program, and of learning outcomes observed. The schools' engagement with the project, the focus and progress of each school's project plan, and issues encountered were canvassed. Teacher engagement and professional learning in the project was addressed as well as teacher-selected student cases that illustrated engagement, growth or particular issues or affordances of the Digital Technologies work in each school which contributed to emerging narratives of curriculum, pedagogy and learning outcomes.

Data collection point 3 (DP3) was conducted between October 2019 and February 2020 and focused on individuals' (including new members of staff) and schools' new and continued engagements with the DTiF project. Case study schools' accounts and evidence of curriculum and pedagogy focused on further development of narratives of curriculum, pedagogy and learning outcomes were explored. Specific to this data collection point was a focus on the impacts of school participation in the DTiF project and strategies for sustainability.

Data collection methods included interviews and focus groups with key stakeholders—school leaders, teachers and assistant teachers—as well as some direct observation of school spaces and facilities, and the collection of relevant documentary artefacts. In total, sixteen staff members (four school leaders, nine teachers, and three assistant teachers) were interviewed at DP3. Eight of these staff members had participated in DP1 and DP2, two of these staff members had participated in DP2 only and six staff were only interviewed for DP3.

Individual availability was ultimately determined by staff departure and availability of participants interviewed at DP1 and DP2. Actual numbers of participants at each school for each data collection point are described in the case studies. While it was initially intended that focus group discussions with students would also inform the case studies, this component of the data collection did not go forward due to ethical concerns and the difficulties involved in obtaining truly informed consent from parents and guardians who do not speak English and/or are located long distances from the school. In lieu of direct contact with students, at DP2 teachers were invited to share anonymised accounts of student learning and student work samples.

This final report builds on two interim Progress Reports which have communicated the progress and preliminary findings of DP1 and DP2 and is informed by an ongoing dialogue between ACARA and the Deakin University evaluation team. In addition to the initial visits to case study schools, the evaluation team's understanding of the progress of the project and the engagement of schools in its program has been supported by a number of meetings with the ACARA project lead, and two meetings with the ACARA team of curriculum officers.

The case study methodology enabled development of narratives from the point of view of school leaders and teachers that evidence change over the life of the project drawing on interview, observational and documentary data that targeted three evaluation components: impact; outcomes; and the effectiveness of the project methodology.

Six individual school cases were developed which were discussed in terms of:

- School contexts[3], specifically:
  - Situated contexts (such as locale, school histories, demographics and settings)
  - Professional contexts (such as values, teacher commitments and experiences, policy management, and approach of leadership)
  - Material contexts (such as staffing, budget, buildings, technology and infrastructure)
- Project focus, activities and progress
- Outcomes for students and staff, including mini cases illustrating outcomes
- Sustainability of outcomes and impacts

A cross case analysis was then undertaken to explain challenges, opportunities and outcomes evident in the case study schools with respect to the three dimensions of context used to discuss each case study. Fragilities and complexities are analysed across case studies as well as ways in which participants responded to these fragilities within the context of their school's involvement in DTiF. Innovative approaches developed and implemented with support from this project are explored.

---

[3] Communication of school contexts draws on the framework developed by Braun, A., Ball, S. J., Maguire, M., & Hoskins, K. (2011). Taking context seriously: Towards explaining policy enactments in the secondary school. Discourse: Studies in the cultural politics of education, 32(4), 585-596.
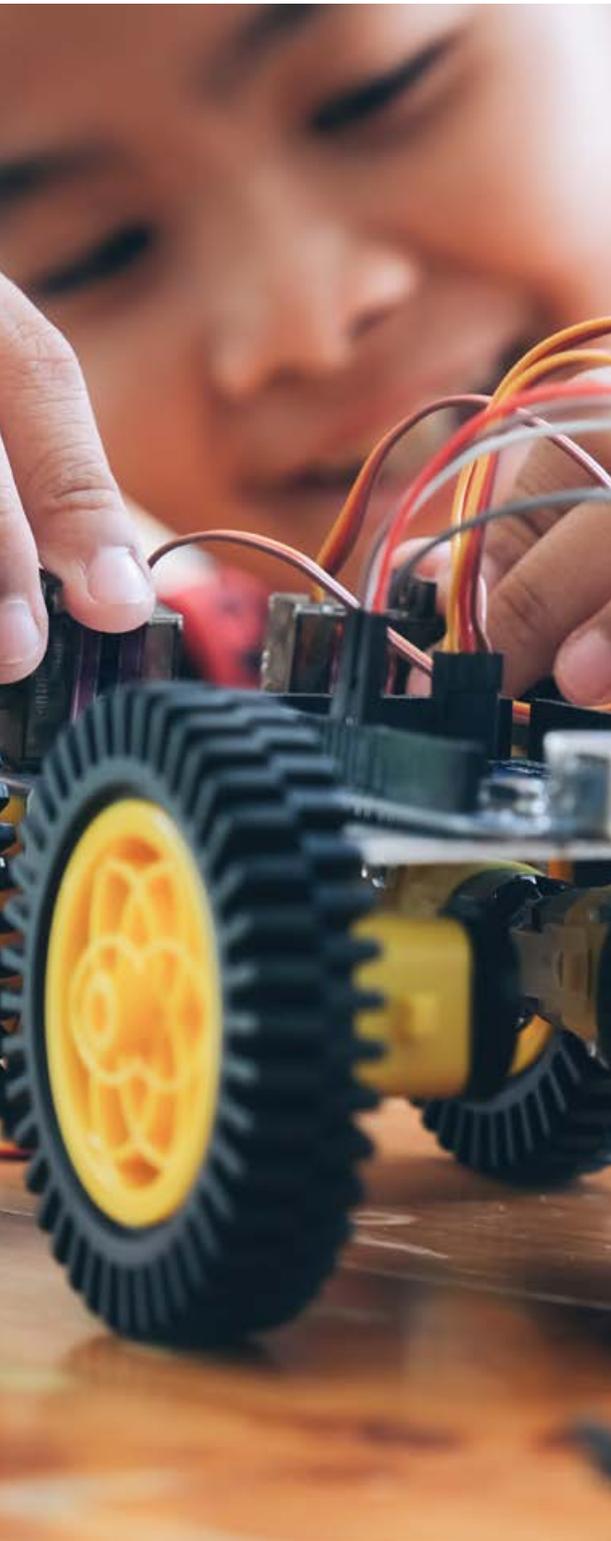
Structure of this report

The remainder of this report is organised into three main sections. First, detailed accounts of each case study school are provided, including a narrative of the schools' engagement with the DTiF, the site-specific outcomes, and implications for sustainability of impacts at each school. The school case studies are followed by a cross-case analysis, discussing the challenges and strengths found in the case study schools and the successful strategies that were developed. The final section summarises the key findings and implications of the cross-case analysis with respect to both outcomes and impacts for schools and the transferability of the DTiF methodology to other initiatives. To protect the identity of the participants in the case study schools, no project photographs have been used in this report. The included images are stock photographs, selected to provide some representation of digital technologies in disadvantaged schools.

School Case Studies

The six case studies are presented in this section. For each case, an overview of the data collected is followed by an account of the situated, professional and material context of the school. The specificities of these interrelated contexts are critical for understanding how each school engaged with the DTiF, the significance of the impacts and outcomes at that school, and the challenges and possible strategies for sustaining success. To illustrate notable outcomes for students and teachers at each school, a selection of mini cases is incorporated for each school. The mini cases provide insights into how outcomes manifested at each site, as understood by the assistant teachers, teachers and principals interviewed. They provide accounts of the experiences and achievements of individual teachers and students and of successful aspects of the project at particular sites.

Quartz Primary School

The Quartz case study draws on fourteen interviews, conducted with six participating staff members across the three data collection points. Participating staff members include the principal and three teachers (QT1, QT2, QT3)—each interviewed at each data collection point, and two assistant teachers—one interviewed at DP1 and one interviewed at DP3. The principal and two of the teachers formed the core project team. The third teacher was included in interviews on the suggestion of the principal, as a staff member who had self-identified as having low ICT skills and having specified this area of skill as a focus of professional learning. All Quartz interviews were conducted on site at the school, with DP1 including a tour of the school with the principal. DP2 included detailed discussion of particular student cases, with reference to work samples, selected by the three teachers.

Situated context

Quartz Primary School is a co-educational, non-government school located in an inner-city urban setting, close to public housing. It is a small school, enrolling approximately 100 students. With 80% of students in the bottom quartile of socio educational advantage and an ICSEA value of less than 880, Quartz is a highly disadvantaged school. Eighty percent of students have a language background other than English. Less than ten percent identify as Indigenous. In interview, teachers reported that a significant proportion of the student population are children of refugee parents or are refugees themselves; that some exhibited effects of trauma; and that many had literacy deficits, including in their first language. Teachers were very aware that family trauma and poverty affected their students' school learning and they expressed heartfelt desires to nurture their students' resilience and build readiness to learn:

> I think his family has had a lot of trauma and he's, so his mum would have been refugee, so I'm pretty sure that all the kids were born here but there might be some older ones that weren't. …So he was born here so he's not technically EAL, but I don't know how much English they speak at home, I don't know how literate mum is, but I don't think that there would be a high, like it's one of those kids that comes to Foundation with not as much language. And I think the trauma of their life has had a huge impact on his learning, and I think it's, yeah it often is like, you know lack of sleep, lack of feeling safe, they get sick quite often, like even just the healthiness of their bodies. Yeah so there's no learning difficulty technically as diagnosed by anything, but I'd say that there are definitely like low socio-economic factors that come to play.

Quartz uses interpreters to communicate with some of its parent community, providing a means to translate important information, and two of the assistant teachers share cultural backgrounds with student communities.

Professional context

The core project team at Quartz included: the principal who was new to the school; an experienced classroom teacher who did not see technology as her strength but believed she could bring her broader pedagogical knowledge and experience to the project; and, a graduate teacher who has a particular passion for technology and innovation and who was newly employed at the school as a part-time Digital Technologies specialist. Each member of the project team communicated a passion for improving practices to better support their students to learn. Interviewees reported that the school was a supportive work environment, with a shared commitment to student wellbeing and social inclusion. Wellbeing was a strong thread in conversations about students, positioned as centrally important to student engagement and learning.

The school leadership at Quartz stressed the importance of being strategic with respect to the DTiF project, taking account of both 'the big picture' (Teacher interview, DP1) and also how individual staff members might be brought onboard. An important consideration was how the project aligned with the broader goals of the school. The school leadership saw the project as an opportunity to promote deeper thinking and knowledge in both students and staff, in alignment with existing foci in the school, and to generate data that would persuade teachers of the need for change. For example, the principal was interested in the types of pedagogy promoted by the Digital Technologies curriculum (for example, design pedagogies that integrated curricula) and the possibility of this influencing teaching and learning practices more broadly. From the outset, the principal at Quartz wanted to see how the project could align with and support what was seen as important strategic work in the school, including the development of the school's strategic plan. This strategic approach was evident at each of the data collection points.
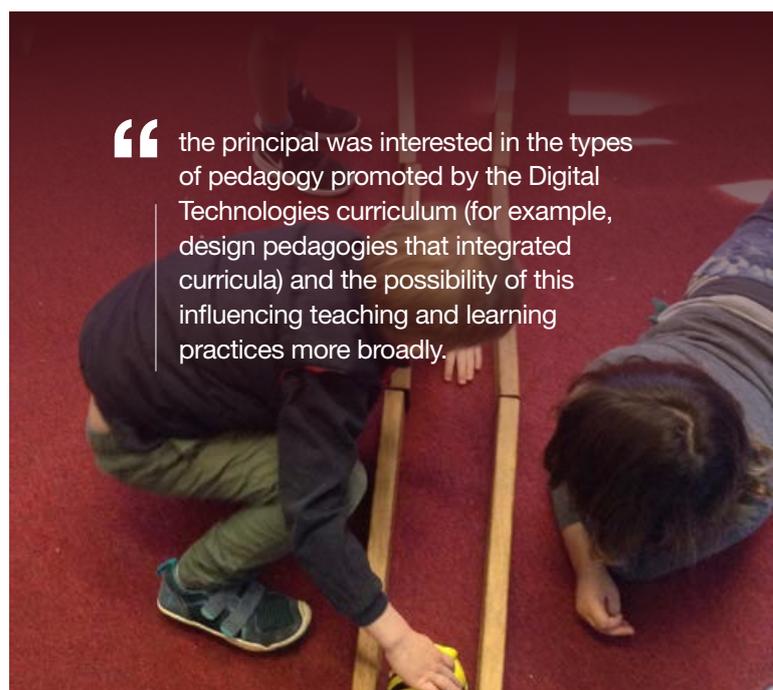
> " the principal was interested in the types of pedagogy promoted by the Digital Technologies curriculum (for example, design pedagogies that integrated curricula) and the possibility of this influencing teaching and learning practices more broadly.

Material context

Quartz is a small, well maintained school, with learning spaces of various types and ages, including a newly built multipurpose learning space that houses the library, a wet area/kitchen, a stage, several small conference or meeting rooms, and a classroom that has been designated the specialist Digital Technologies classroom. For security, the school is fully enclosed by high fences and has a video-monitored main entrance that is locked during school hours. Other entrances are also locked, reportedly to prevent students from leaving the site without permission. At the time of our first visit to Quartz, the multipurpose learning space was locked to prevent students from removing items from the building. On later visits, the building was open and spaces were freely accessible.

The school has invested in devices for student use during class time across the curriculum, having purchased laptops for use in the older years and iPads in lower years. These devices do not go home with the students. Across the life of the project, processes appeared to have improved to allow students to continue with previous work even though they do not have a personal device. This included making better use of individual logins to cloud repositories.

At the early stages of the project, Quartz did not have access to digital equipment and accessories commonly associated with the Digital Technologies curriculum, such as programmable robots. Later in the project, the school had begun using an equipment lending library recommended by the ACARA curriculum officer (Computer Science Education Research Lending Library at University of Adelaide). The Digital Technologies specialist described this resource with enthusiasm, noting that other (more privileged) schools would have invested in purchasing this type of equipment:

> [The Lending Library offers] different kits. We got a mixed kit, so they had some Bee-Bots, some Sphero-Bots, what else was there, Ozo Bots and Makey Makey kits, which was a great introduction. I mean like a school like us, we have access to chrome books and we have access to iPads, but there's never been any real drive or funding put into, like being able to buy a whole set of Bee-Bots or, which other schools do.

The Computer Science Education Research Lending Library provided an opportunity for staff to become more familiar with these types of resources and for the Digital Technologies specialist lessons to implement activities and equipment demonstrated by the curriculum officer and to develop further curriculum and activities that utilise equipment that was viewed as inspiring for students and to which they would not usually have exposure.

Although situated in an inner-city suburb of a major city, Wi-Fi connectivity was an issue at the school at some locations (in some classrooms) and at some times (for example, connectivity issues were experienced later in the project following an upgrade). Teachers expressed their frustration with the intermittent nature of connectivity issues: 'The internet, it's always going in and out and that's just a mystery to me that I cannot even solve or understand' (Teacher interview, DP1). These issues were not significant enough, however, to be prohibitive to teachers' implementation of devices and applications requiring Wi-Fi. They were seen as part of the everyday material context that needed to be negotiated, as expressed by this teacher at DP2:

> Even when the internet is not working and they're not connected, [the students] will just go to another—they are really good at thinking 'this is what happens sometimes'. … There is nothing [we] can do about it so we just kind of move on and do it a different way or try another device, which is really good to see.

Although at DP1, the principal was recently recruited to the role and reported significant staffing changes over the past year with the loss of several long-term teachers, the staffing across the period of the project appeared relatively stable, and much more stable than other schools among the case study sites. The employment of a part-time Digital Technologies specialist teacher and timetabling of a specialist Digital Technologies lesson for all grades in a dedicated classroom, proved to be highly enabling with respect to this school's engagement with the DTiF project. It was reported that this strategy ensured that the Digital Technologies curriculum was being taught to all students, while general classroom teachers focused on ICT skills and integration and the development of their own knowledge of the Digital Technologies curriculum. The Digital Technologies specialist teacher supported the professional learning of her generalist colleagues in several ways: sourcing resources, helping with planning, and assisting with teaching in generalist classes that involved digital equipment. The principal identified the financing of this teacher's role as an important part of the school's participation in the DTiF project, one that had been integrated into the school's wider plans and would continue beyond the formal project timeline. However, the school leadership were also cautious about building a 'dependency model', acknowledging that different teachers would have different needs:

> So, I imagine I'll get different levels of feedback from people, you know, and some people will say, 'oh I can do it on my own but I would like to have someone in there to support me'. Others will say, 'oh no I need someone—I still need someone to help'.

Some resources were deployed to better enable the project team to participate in DTiF project activities. For example, time release was provided so staff could complete the MOOC (completed concurrently by the project team with the on-site support of the curriculum officer). However, project team members still struggled to commit the time they thought was needed to fully participate and maintain progress in the project, particularly in the action research project, data collection, and documentation. These activities—additional to teachers' core teaching work—were thought to be particularly taxing in a small school, where all school roles needed to be covered by a small number of staff. It appeared that additional release time was not provided for undertaking these types of project activities. Although the teachers interviewed reported some anxiety around what they perceived as failures to progress project data collection and documentation, particularly with relation to a follow-up skills audit that had not been performed at DP3, the principal was more philosophical and believed that the processes that had been undertaken were having a very positive impact on the school's progress against its goals even though the planned collection of evidence hadn't taken place.

Project focus, activities and progress

The action research project and associated action plan at Quartz were focused on building ICT capabilities among both students and teachers and integrating ICT skills across the curriculum. This focus was seen to be a foundational step in a setting where many students had very little access to devices at home, so were missing basic familiarity and skills that might be expected in other school settings. As part of the action research component of the project, an initial audit of ICT skills was conducted by each classroom teacher, reporting on their own students as well as their own skills. This audit identified low levels of ICT skills among both students and teachers.

The core project team—the principal, a generalist classroom teacher, and the Digital Technologies specialist—participated in a range of project activities, including webinars with other project schools, face-to-face workshops at regional centres and the Computer Science Education Research MOOC, further to their own meetings and school-based work. The curriculum officer assigned to Quartz visited the school regularly across the project to provide support to the team and also to present and run workshops for the whole staff and run Digital Technologies learning activities with students in their specialist classroom. For example, all Quartz staff participated in meetings where the curriculum officer described the Digital Technologies curriculum, and where they had opportunities to try out particular coding applications and to use digital equipment such as drones. The curriculum officer also provided remote support via email and telephone.

The on-site activities facilitated by the curriculum officer were looked upon very positively, and the tenor of the following interview excerpts was typical:

> So [the curriculum officer] took us through a little bit of the curriculum again and kind of just been breaking it down. Like it's this huge overwhelming thing. [They] did spend some time with my class again and then ... stayed for like a staff meeting so it was great to have [them] actually in the classroom. Again [they] did some coding—I had a different group of kids this year obviously to last year and so [they] really looked at doing some unplugged and then some plugged stuff with the kids … And then [they] stayed on which was really helpful as well and [they] got the teachers to do what [they] had done with the children. So that was really good and [the curriculum officer] certainly always making [themself] available to us and touching base regularly so it's been really good to have [them] actually physically here as well as available online and so on.

> I think having [the curriculum officer] visit all the time is probably the most valuable thing. It's good to hear what other schools are doing but there's nothing so specific and relevant as when [the curriculum officer comes] and like, 'Okay, I'm going to help you write this assessment schedule,' or 'I'm going to help you— you're running out of ideas for your unit for this level. Let me help you.' … just a pit of knowledge that [they tailor and make] relevant to your school. Always willing to help, email whenever.

> ❝ 'It's good to hear what other schools are doing but there's nothing so specific and relevant as when [they come] and like, 'Okay, I'm going to help you write this assessment schedule,' or 'I'm going to help you — you're running out of ideas for your unit for this level. Let me help you.' … just a pit of knowledge.'

In the period from DP1 to DP2 the school made significant gains in building skills among students and teachers. Although the skills audit was not repeated, the team members spoke confidently about the learning that had taken place and were able to provide anecdotal accounts of the use of new digital tools and processes and the value of these, including detailed accounts of learning activities and student work. Among the interviewees, one teacher not in the DTiF project team provided numerous examples of how their practices had changed as they worked with their students and colleagues to implement digital tools in planning and administration and digital tools and media in the classroom. By DP3, the school had developed a strong narrative of change, with a range of digital tools and media having been implemented and becoming part of teacher and classroom routines. These changes were perceived as promoting greater efficiency, enhancing student—teacher communication, and improving student learning and inclusion. The principal explained that, although the initial skills audit was valuable for providing evidence of their learning needs, the follow up audit that had initially been planned seemed unnecessary given how apparent the increase in digital work and associated skills had been, and no longer seemed as relevant when the focus had shifted away from basic ICT skills to building curriculum knowledge.

> ❝ the school had developed a strong narrative of change, with a range of digital tools and media having been implemented and becoming part of teacher and classroom routines. These changes were perceived as promoting greater efficiency, enhancing student—teacher communication, and improving student learning and inclusion.

At Quartz, all three members of the project team spoke to the value of the project, particularly the impetus that project activities had provided, the input provided by the curriculum officer and the role of project meetings and deadlines in ensuring that they maintained momentum. The main challenges reported were the need for more planning time and the impact of staff turnover, where some teacher knowledge was lost to the school.

Reflecting on the progress the school had made with respect to teachers' and students ICT capabilities, the principal noted that, having established a strong foundation in basic skills, they could move the focus to 'unplugged' Digital Technologies learning and areas of the curriculum such as computational thinking that could also be integrated across the curriculum where relevant. The principal identified the school's next step in the implementation of the Digital Technologies curriculum as engaging teachers outside the core project team in Digital Technologies concepts. This would support teachers to develop understandings about the distinctions and relationships between digital devices, ICT capabilities and the Digital Technologies curriculum, which the principal believed were still lacking in many of the teachers. Across the project, students had been engaging in the Digital Technologies curriculum in their specialist lessons and in some general classroom learning, but most teachers were yet to incorporate Digital Technologies learning explicitly into their planning. At DP3, the principal explained the downside of their initial focus on ICT skills and the need for future work in enhancing curriculum awareness in all teachers:

> Because in some ways the plugged technology distracts, makes the thinking skills harder to see, and I think if teachers develop understanding of the curriculum, they realise that a lot of the thinking skills they were [already] teaching anyway. They were teaching them in that literacy activity, or they're teaching them in, you know, in their enquiries and in maths.

Outcomes for students and staff

Outcomes at Quartz include:

- Notable improvements in teachers' and students' general ICT capabilities
- Implementation of new digital processes for teacher planning and communication with students, including using online tools and repositories
- Development of new teacher knowledge and practices in the implementation of a specialist Digital Technologies lesson for all students, including the use of equipment not previously used in the school
- Development of detailed knowledge of the Digital Technologies curriculum and associated pedagogies among the project team, and an understanding of what further learning is needed to support teachers outside of this team
- Development of new curriculum for implementation of Digital Technologies
- Incorporation of a school-wide Digital Technologies Plan for 2020 implementation
- Interconnected benefits for literacy learning, thinking skills, and inclusion of students with special needs or who otherwise struggle to productively participate in classroom learning

Mini case studies illustrating outcomes

The six cases below were selected among the many accounts provided at Quartz of professional learning, new practices, and positive outcomes for students.

> " QT1's story of skill development and changed practice evidences quite dramatic change attributed to the school's participation in DTiF activities.

Case 1 —
changed professional practice

Teacher QT1 is not part of the team that participates directly in the ACARA DTiF project. Teacher QT1 was identified by the principal as a good test case for impact. QT1 is an experienced teacher, but started from a very low skill base in digital devices and tools, and reports having had very low confidence at the start of the project. This teacher self-identified to the principal as needing to focus on improving the digital skills used in professional work and in teaching. QT1 was interviewed in March 2018 and again in August 2018. In the initial interview QT1 admitted to not seeing how the Digital Technologies curriculum or the use of digital devices might be incorporated into teaching. QT1 admitted not being familiar with the focus and scope of the Digital Technologies curriculum. The second interview evidenced a significant change in attitude and confidence. This teacher recounted some previous professional practices (for example, creating all of planning documents by hand and then needing to scan them to get them into the school system), and described some new current practices (for example, using the Google suite to create planning docs; expecting students share their work electronically; and, incorporating videos and photography into teaching for the first time):

> I was still at that point of writing a lot of my program and lesson plans. So I'd hand write them and scan them and then store them on the teacher file that way. And now I'm doing everything on the Laptop so—I can find things, I can work my way around it, I somewhat know what I'm doing. Also I can communicate with my students, you know we email back and forward yeah I'm becoming like a normal person (Laughing)… There's still a lot I'd like to learn … But I think I've come, like if I was assessing myself I've come a long way since we last spoke with my own personal use… My confidence has gone up because I don't feel as inadequate you know.

QT1's story of skill development and changed practice evidences quite dramatic change attributed to the school's participation in DTiF activities. This teacher was able to provide examples of using digital media and tools with students to support learning across the curriculum, including online repositories and online production tools. QT1 believes the use of these tools has improved student learning processes and outcomes.

Case 2 —
Digital Technologies Specialist

Teacher QT2 is employed part-time in the school to teach Digital Technologies as a specialism. QT2 participated in a MOOC provided by the DTiF project and noted that, although much of the content was familiar and similar to that encountered in other professional learning courses, it provided additional ideas about implementing the Digital Technologies curriculum. QT2 commented that the MOOC was valuable for colleagues who do not have a strong familiarity with the Digital Technologies curriculum, particularly the support provided for understanding the specialist terminology found in this curriculum area, much of which QT2 believes would be new to the generalist teachers at the school. When teaching, QT2 has made use of the Computer Science Education Research Lending Library that was recommended via the DTiF project, borrowing robotics and electronics kits for use in lessons. Although responsible for teaching Digital Technologies within the school, QT2 hopes to use other equipment made available via the lending library to encourage colleagues to use robotics in other curriculum areas—for example, encouraging teachers to use Bee-Bots in mathematics. QT2 has also been working alongside generalist teachers to assist with integrated studies planning and how digital tools might be used to support that. Working with colleagues, QT2 has found it useful to draw on resources from the Digital Technologies Hub and adapt them for use with their students. In terms of professional practice, QT2 commented that, as the only Digital Technologies specialist in a small school, there are not specialist colleagues to work with and to promote accountability in terms of curriculum planning. In this context, and as a graduate teacher, contact with the curriculum officer has provided important affirmation of curriculum practices.

Case 3 —
Productive links between literacy & coding

Student QS1 has problems with receptive and expressive language. He gets frustrated when he does not respond to the specificity of teacher instruction, or when others (peers/teachers) do not respond to his own non-specific expressive language. As part of the Digital Technologies specialism offered in the school, this student has participated in learning activities involving visual block coding using Scratch. His classroom teacher reports that participation in these activities has required QS1 to attend to the detail in language (in this case, a coding language) and has supported a realisation that particular instructions produce particular responses:

> He understood that actually there are times you have to be very explicit, there are times you have to be very specific and you also have to take responsibility. So, if you don't give the right directions or the right information well then it's not going to turn out the way you wanted.

The classroom teacher said that this realisation and practice has resulted in a broader awareness of the importance of detail, and has supported improved social interactions for this child in class.
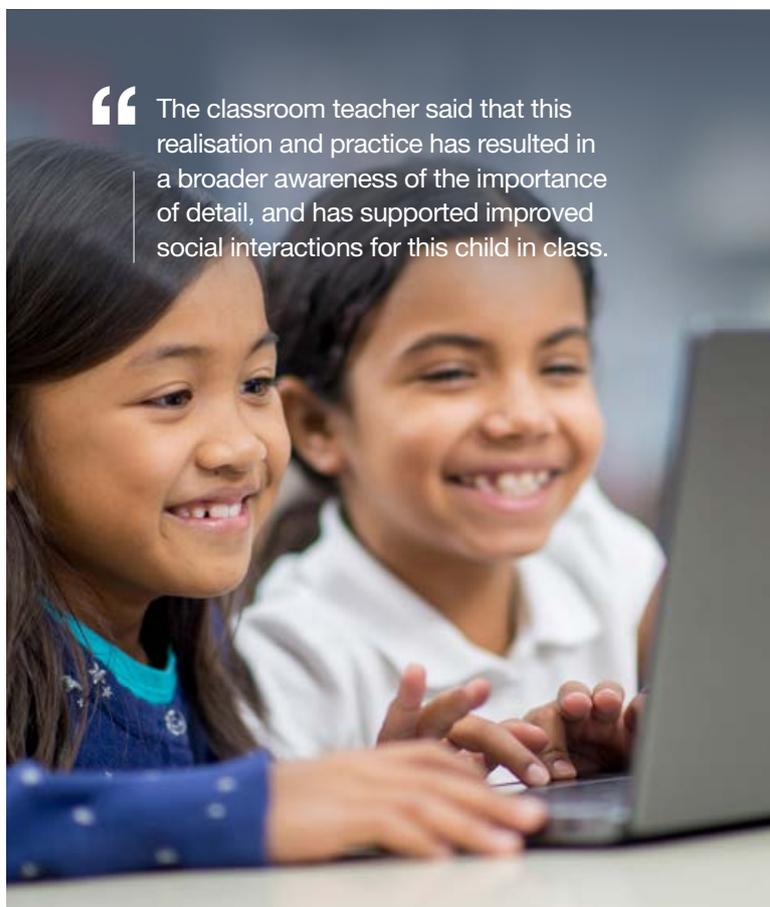
> " The classroom teacher said that this realisation and practice has resulted in a broader awareness of the importance of detail, and has supported improved social interactions for this child in class.

Case 4 —
Digital Technologies as a level playing field

Student QS2 is below his peers in literacy and numeracy, starting from a low base in Foundation and having participated in both Reading Recovery and Mathematics Intervention. Because very few students in the school have access to devices outside of school and students' skill levels were generally very poor (as assessed by an initial skills audit), 'plugged' learning activities provide a relatively level playing field, where this student does not have the deficits evident in other learning areas. QS2 has thrived in this curriculum environment, developing his expertise and now supporting his peers in coding activities. For this student, academic success and being positioned as a burgeoning expert is a new experience, enabling a focus on his capacities rather than his deficits. His classroom teacher noted with a strong sense of hope that 'it took a lot of convincing him, but he's actually one of the best in his class at it'.

Case 5 —
Digital tools are enabling

Student QS3 has very low literacy skills and difficulty producing legible handwriting. His classroom teacher explained how, by using digital tools for composition, QS3 has shown improved processes and achievement in writing:

> " it would be about two words of handwriting, and now he's able to produce like half pages of work in a really short amount of time, like the growth is incredible.

This advantage of using digital tools was noted with respect to numerous students who struggled with handwriting which became a source of stress and a barrier to engaging in traditional composition activities. The production of digital texts was also noted as promoting review and editing processes, supporting skill development in this area and better quality final products.

Case 6 —
Digital research

Student QS4 became highly engaged in an investigation activity involving internet searching and the preparation of an online presentation. In the course of her investigations, the teacher introduced QS4 to considerations of the authority and reliability of internet sources, as well as issues concerning plagiarism and the risks involved in combining handwritten notes with text cut and pasted from internet sources.

> " This student became fascinated with the existence of different accounts about an historical figure that she was investigating and with the emergent conversations about the effective and ethical use of online sources

The use of digital online sources and tools in this learning activity supported an authentic consideration of the reliability of sources that might otherwise not have been addressed (and which is not found in the Digital Technologies curriculum until higher levels).
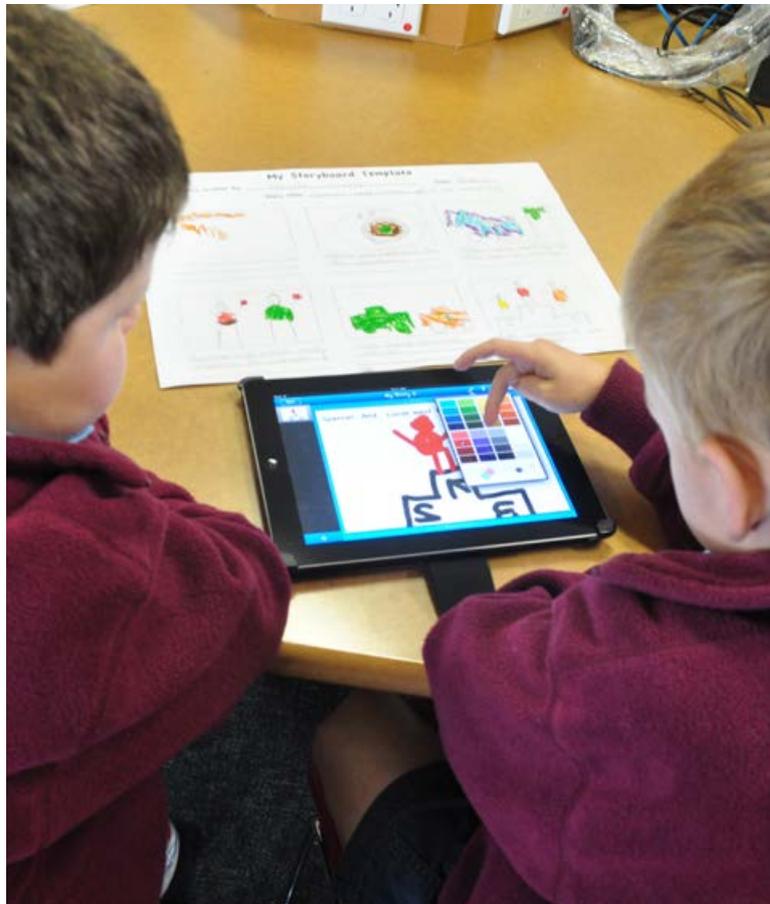
Sustaining impacts

Progress at Quartz was supported by strategic leadership and resourcing, where the Principal had a vision from the beginning of the project of how the work of the project aligned with the broader work of the school, complementing priorities outside of Digital Technologies. The employment of a specialist Digital Technologies teacher and the strategic deployment of this teacher's skills to support generalist teachers (including co-constructing curriculum and team teaching) allowed for a focused approach to delivering the Digital Technologies curriculum in specialist lessons, while also providing breathing space for non-specialist teachers to develop their ICT capabilities and technology integration across the curriculum.

In terms of project methodology, the ACARA curriculum officer was identified as highly impactful and attracted much praise for the level of availability and the usefulness of on-site support, including delivering demonstration lessons to students and facilitating hands-on workshops for teachers. At Quartz, the curriculum officer provided invaluable support working closely with the team to develop an assessment schedule for Digital Technologies. Project activities like the webinars and face-to-face workshops, together with the documentation requirements and timelines, provided impetus and momentum for the project. These activities and requirements were perceived as well-timed and well-facilitated. Webinars and other activities that involved multiple project schools were seen as effective ways to share ideas and issues. Resources such as the MOOC, the Digital Technologies Hub, and the lending library were seen as useful, particularly when they stimulated the translation of ideas and activities to the specific curriculum and learning needs of the school.

The action research component of the project methodology was not fully leveraged at Quartz, with the principal suggesting that a building phase where schools had time to explore and develop a strategic focus, may have resulted in a more ambitious aim at Quartz and more sustained interest in this aspect of the project:

> …We went in and we had to develop the plan … but you don't know what you don't know. So, in a sense it wasn't until about 12 months in that we got sort of started to think about what actually, we had a few ideas. So, I'm just wondering even when you use an inquiry process, you would do that building phase initially, so rather than—you don't just jump straight in to the inquiring. And maybe if you're going to enter an action research, it's like, are you in a state of readiness? Because I'm not sure we were in a state of readiness in terms of jumping in and doing all of that, like it was sort of a bit, like even on the day we just sat there and said, 'Oh we don't really know exactly where to go'… If I was going to do that again I would think either do some building first or ask schools about you know—how much work have you?—Well do you have a bit of a vision?

The initial data collection (ICT skills audit) at Quartz was valuable, providing evidence of gaps in skills and helped to build teacher commitment, but as teachers and students developed skills, the focus of the project work shifted such that post-data was not collected and was not seen as needed to drive the project.

The principal at Quartz was highly attuned to risks that the gains made in developing teacher knowledge and practice in the Digital Technologies curriculum could be lost if the knowledge was held by only a small number of people. The principal was actively exploring strategies with the whole school staff for broadening the knowledge base and teacher buy-in. This principal had strong views on how to sustain innovation in schools, believing that although an innovation needed a 'driver', there should always be a team involved:

> " We need a succession plan, but to be honest we need that in everything. I'm a big believer that you can't just have one person.

The school had made a financial commitment to delivering Digital Technologies as a specialist subject, but was experimenting with how the specialist teacher's time and knowledge might be leveraged to build capacity more broadly. The principal explained:

> It is trying not to create a dependency model. But I think we're not quite ready… we've got to make sure we're bringing everyone along.

At DP3, the school was several weeks into trialling a second weekly Digital Technologies class for each generalist class group, during which the classroom teacher led the class with a lesson they had developed, but with the specialist teacher available for support. The school was also looking at how Digital Technologies can be incorporated into their Integrated Studies curriculum and trying to make links into all curriculum areas. These initiatives were getting mixed responses from teachers, but the principal saw this as expected and believed the initiatives were worth persisting with to promote embeddedness and sustainability: 'It's about moving fast enough to embed it before we lose the people that actually carry a lot of the knowledge' (DP3). The principal was also considering strategies for including assistant teachers and non-classroom teaching staff in 'a truly whole school approach' (DP3).

By DP3, school documentation at Quartz was explicitly incorporating reference to the Digital Technologies curriculum, with a 'digital technology plan' featuring in the school's 2020 Improvement Plan, together with learning outcomes and an assessment schedule that would be implemented across the grades and strands for this curriculum area. The principal had thought carefully about a communication strategy for taking these documents to the staff and bringing teachers on-board via a combination of support and accountability requirements, commenting that being involved in the DTiF project had provided a timeline and a degree of accountability that was important for keeping the school 'on track', and that future sustainability would need other mechanisms for doing that.

In terms of sustaining the improvements in students' and teachers' ICT capabilities, the normalisation of digital processes and tools (for example, adoption of an online suite of digital tools in the older grade levels) was seen as requiring and promoting these skills. The relatively stable staff base (when compared with other case study schools in the project) contributes to a critical mass of skill and knowledge, where new staff members might be enculturated to the new normalised processes. The principal discussed this challenge as a matter of induction—inducting new staff into the ways of the school.

Jade Primary School

At DP1, the principal, the DTiF leader, three other teachers (JT1, JT2, JT3) and an assistant teacher were interviewed. Of the five Jade staff members who participated in DP1 interviews, only two were available for DP2—the principal and the DTiF leader. Accounts of individual student learning were not provided, but wider benefits of participation in DTiF were noted and evidenced in the context of wider school agendas. DP3 data collection was interrupted by the bushfires in late 2019 and the principal requested to postpone data collection until 2020. This was then further interrupted by the COVID-19 pandemic. As a result, DP3 was not conducted.

Situated context

Jade is a co-educational government primary school on the outskirts of a capital city. There are around 350 students, with equal numbers of male and female students. The ICSEA was around 800, with almost all students in the lower half of school distribution. Many students enrolled in the school come from a nearby large housing commission estate. Just over a quarter of the students are Indigenous. Approximately 40 percent of the student body comes from a language background other than English. The school teaches a local Indigenous language.

Jade has been focused on a whole of school renewal program, with the integration of ICT at the centre of many of the developments. The school evidences challenges relating to school climate and perceived risks to security. The school grounds are surrounded by a large metal fence that is kept locked during the school day, with entry facilitated via video link to the General Office at two sequential entry points both involving confirmation of identity. The fencing is to both stop students from running away and to stop members of the community from entering the school grounds during the day, and was built as a result of previous incidents. On entry, visitors are required to sign a form, declaring they are not under the influence of drugs or alcohol, they have no weapons, and will not be abusive or violent during their time in the school.

The school is trying to turn around the negative perception held of it in the wider community. There has been negative press about the school over a sustained period of time. Community violence necessitated the video surveillance equipment and the high fence. This had a significant impact in the school, not just in terms of enrolments, but, significantly for the project, in terms of employing relief teachers. Even though this is a primary school, many relief teachers refuse to work at the school, and teachers and the principal had to use their professional networks to recruit suitable teachers. Teacher release time given at the school for professional learning (or sick leave, etc.) was not always able to be utilised if a relief teacher could not be found, and classes would be split to cover the teacher who was away. One teacher reported:

> So many classes have to be split, it's not about funding. If a teacher's away, they're sick, or whatever, the Department pays for them to be replaced. But it's… we can't get them. We can't get the casual teachers to come into the school, and as you can see, it's a little bit difficult, a little bit tricky in some ways. But honestly, it's, it's, it's not as bad as, as the perception out there is'.

By DP2, the principal felt that there was a slight improvement in the general community perception of the school, but she was still having trouble finding relief teachers to release teaching staff.

The integration of ICT is being implemented alongside a positive behaviour program, and teachers and leadership see the engagement possibilities of the technology usage as key in this program. When the principal began at the school, there was a culture of students being sent from classes for poor behaviour and many students were walking around the school, outside of their class. The principal stated that there was school culture of student disengagement when she first arrived. This was evidenced by students just leaving classes at will:

> They just got up and walked out. It was the most amazing thing. And I've heard other schools—they've experienced this. I hadn't before. But the students—if the work got too difficult or they didn't want to do it, they just got up and walked out.

At both DP1 and DP2, the principal talked about this, and the positive changes that were slowly happening. At DP1 the principal said that the focus on keeping the students in the classrooms was 'a big one'. At DP2 the principal said, 'I know this sounds funny, and in other schools it would be, but we've reduced the amount of smashed windows.' These first goals, of keeping children in class, and engaging the students in the classroom, have been documented as reducing the numbers of smashed windows and fights at the school.

Professional context

DP1 and DP2 data showed the strength of commitment to the students from the staff. The principal had been in the role of ongoing principal at the school from the beginning of 2018, but has worked in the area for over 30 years. The principal is very enthusiastic about the school and said, 'I love being here. It's a great community to be a part of'. This principal is leading school renewal with a sense of hope and commitment to the community, focusing on making sure that the community, who are disadvantaged outside, are not disadvantaged inside school. The principal noted the commitment of the staff saying, 'things can be tough—the staff are very committed. They want to make a difference. It helps us get out of bed every day, because some days, as I've said, are quite tough'. Several interviewees have worked at the school for a long time, and we noted in interview the high level of compassion, care and commitment to the students shown. For instance, one teacher has worked at the school for some time, and even after moving house to a location an hour and a half's travel from the school, was determined to remain teaching at the school, despite passing by many other schools on the way to work which were much closer to the new home. This teacher was committed to making a difference for students.

The principal sees the development of positive relationships throughout the school as 'key to everything' and describes:

> That's how you move people along. You can't go into a school and just tell them, 'that's the way it's going to be.' It has to be gradual, it has to engage everybody, but mostly it has to be differentiated because as you know—with technology— we have people from all different ages, all different experiences and we really do have to be mindful and to cater for them because you don't want them left out or to feel inadequate.

The school teacher librarian was the DTiF leader for the program and was being trained through the DTiF. This teacher had become a technology leader by default as the computers and equipment were located in the library. The library was also where the computer lab was, so having carriage over the organisation of the computers meant that the DTiF leader had ended up in the role as Digital Technologies teacher. Although the DTiF leader had no training prior to the DTiF, they had developed their skills through personal interest. Before the DTiF, this teacher had done a small amount of training in robotics, but the DTiF provided a chance to take skills to the next level.

Before the DTiF began, the DTiF leader would begin teaching word processing with every class:

> If I had every class I would do a word processing term where they're learning to type and do things, especially with NAPLAN coming online and everything and students needing to type their writing.

The DTiF leader reported that the students have, 'got very poor typing skills and are very slow.' They used a touch-typing program called Typing Tournament about which she commented that 'Some of the kids really enjoy doing that.' In the second term there was a research project presented as a PowerPoint, the students then spent a term coding and creating games using Scratch. The other term was spent learning about online awareness:

> I sometimes get the local police officer in and he talks about … the dangers online. I teach them emailing skills and stranger danger and a lot of things like that.

At DP1 the DTiF leader stated that it was satisfying teaching the students, but there were issues with the infrastructure in the school:

> I enjoy teaching technology when it works. There have been days when the computers just don't want to log on and I like seeing the kids just discovering, oh, my gosh, what I can do on the— even just emailing each other, oh, my gosh, I can talk and … letters to each other, or when they work out how to make the little whatever move on the screen in the coding, just their world just sort of opens up and they realise, oh, my gosh, I can do so much stuff, so I do enjoy seeing their abilities or their improvement.

The DTiF leader entered the DTiF with a strong commitment to improving the Digital Technologies experience for students at the school. This teacher had very strong support from the principal who was promoting the program and the two assistant principals who were also heavily invested in the Digital Technologies curriculum.

At DP2, the same teachers were involved in the DTiF.

The approach of leadership at Jade was to support the DTiF fully at every level. The principal and school leadership were fully committed to Digital Technologies. Over the course of the project many teachers interacted with the DTiF. Some of this was through whole school professional learning and some involved teaching teams doing external professional learning run off site by the curriculum officer. During these sessions they met up with other teachers involved in the DTiF. These sessions were highly valued by the teachers due to the opportunity to meet with other teachers and share strategies.
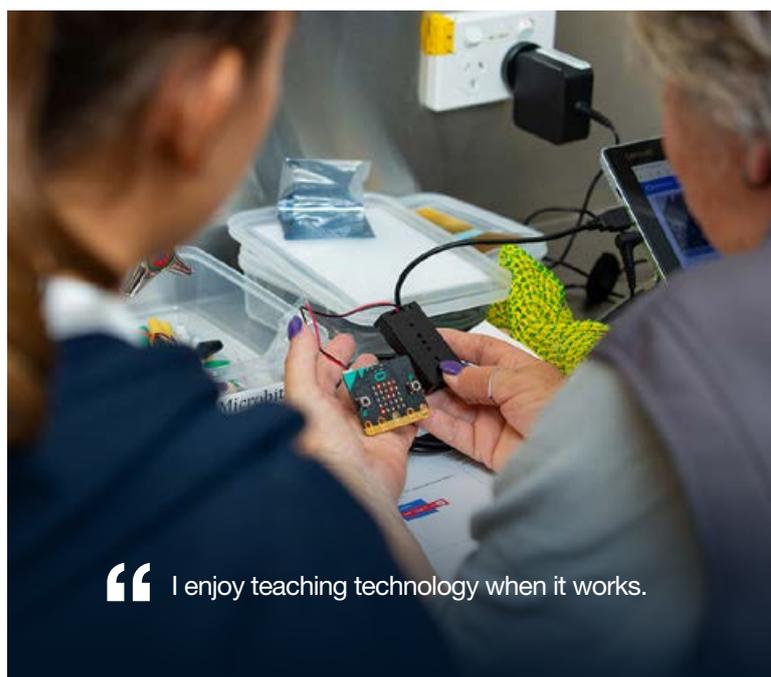
> " I enjoy teaching technology when it works.

Material context

Developing good access to technology and effective approaches to integrating ICT into learning is a key aim for the school. The principal has been focused on improving the technology infrastructure, in particular the wireless access. At DP1, the technology infrastructure at the school was in poor condition. There was no functioning wireless network in the school, and the main digital technology in use was electronic whiteboards in every room. The school is made of double brick and there was very limited wiring infrastructure—an ethernet lab in the school library. JTL2 reported, 'for us it was quite frustrating, because we all want to get in and get on this technology bandwagon, and we've got these kids who go directly to the high school on the same site as us, who are going to have to have all these skills, and we've got nothing we can show them to teach them or to prepare them'. At DP1, the principal had received a series of quotes for rewiring the school and installing wireless points, and these had been completed by DP2.

At DP2 the principal was upbeat about the improvements to infrastructure and student behaviour. The school had been completely rewired and the wireless network points were working well throughout the school. One of the things that the principal noted was that improved ICT infrastructure resulted in the teachers being far less frustrated. Previously when teachers planned to use technology, their preparation would often be wasted due to the poor and unreliable quality of the infrastructure. Since the infrastructure had been so radically improved, this frustration was disappearing and the teachers felt really invigorated with the new Digital Technologies curriculum. The principal felt that this had resulted in a series of positive changes at the school, resulting in significantly fewer students outside of class.

> I can tell you now, the lack of—when I first came, the amount of students that were out of class was just absolutely amazing. I'd never seen anything like it. And now, with teachers with that reinvigoration, that motivation, that support in all different areas—not just technology, but in all different areas, you'd be lucky to find a student out of class.

The teachers felt supported by the principal who took their frustrations with the infrastructure seriously. They were appreciative of the principal's empathy for challenges they faced in teaching the Digital Technologies curriculum in this context. The principal's decision to focus on upgrading the infrastructure had a positive impact on school community.

Project focus, activities and progress

The main project focus of the DTiF at Jade centred on professional learning for the entire school and upgrading the school's network. The school had not updated their technology for some time, so the principal was focused on doing this before beginning work on the project, noting that:

> [The state department] are upgrading … in regional areas. To my knowledge it is coming into suburbia, but they're not sure of the time, and I can't afford to wait any longer. The school's been without wireless connectivity for so long that to the point that people have just put their hands up and said, 'What's the use of having technology in the school when it's not working?'

Settings like this contrast with many other schools across the country, where parents pay for student devices or computers (for example, BYOD). Thus, financially disadvantaged schools carry an additional financial burden in contexts that are already materially disadvantaged. Because the infrastructure at Jade needed to be strengthened before the Digital Technologies curriculum was fully implemented, in the first phase of the project, at DP1, the school took an unplugged approach to Digital Technologies. After the infrastructure was updated, each year level developed their own project around the Digital Technologies curriculum. Some of these projects were linked to other curriculum areas but there was strong support for 'unplugged' Digital Technologies projects as well. At DP1, JTL3 identified:

> …we are hoping to improve literacy and numeracy through the use of algorithmic thinking, so hoping that our students can break down those problem solving things in literacy and numeracy, and support their literacy and numeracy, so that we went that line. So that's part of the reason that we've started unplugged, to show our teachers that you can support our literacy and numeracy without the actual hardware technology. It's getting that thinking happening.

The teachers implemented aspects of the Digital Technologies curriculum through an unplugged approach. Case 1 (below) explains this in more detail.

> " So that's part of the reason that we've started unplugged, to show our teachers that you can support our literacy and numeracy without the actual hardware technology. It's getting that thinking happening.

A feature of the professional learning at Jade was that the principal attempted to send the teachers in their teaching teams to the available professional learning. As one teacher noted of the DTiF professional learning:

> We had lots of support at that training session, with different people coming and sitting with you and helping us form our ideas, cos that's kind of the first, first time we'd been exposed to these documents and we're like, wow what is this? And the more that we talked, the more they could say, 'Oh so you're actually looking at this', and so that was really helpful, so that's what we've tried to do with our staff as well, and we're saying, 'This is what we're doing, this is why and this is what we hope to achieve doing'.

The assistant principals and other leadership had participated in Blue Jeans Webinar sessions with the curriculum officer. When working with the curriculum officer the leadership appreciated the ways in which the curriculum officer supported approaches to get the whole school to participate in the Digital Technologies curriculum. The curriculum officer suggested ways to break down the learning about the content knowledge into 'small chunks'. The curriculum officer had the expertise 'to make it relevant to our school, all of, most of our school goals are all about literacy and numeracy.'

By DP2, the school had also purchased new equipment including a set of HP tablets and a class set of Sphero robots. The DTiF leader had previously noted that the library ethernet meant that things had been centred around a laboratory model of computer usage, as they all had to be plugged in in the library. The new wiring and equipment meant that the technology was being moved 'from the library into every classroom, so that it becomes part of practice'.

One teacher described the ways that the Spheros were being used at DP2, explaining that time needed to be spent teaching the directional language (forward, backwards, side, left, right, etc.) needed for programming the Sphero robots as many of the students did not know any of these directional words. The teaching of the language was built into the curriculum and, as they taught the skills, they made sure that the language was understood and able to be used by the students. The students then programmed the Spheros to make simple moves. The children had been totally delighted by this activity and were very engaged with the Sphero robotics.

> **"** We had lots of support at that training session, with different people coming and sitting with you and helping us form our ideas, cos that's kind of the first, first time we'd been exposed to these documents and we're like, wow what is this?

Outcomes for students and staff

To summarise, the outcomes for staff and students at Jade include:

- Collaborative Professional Learning by teachers on how to utilise fully the new equipment and infrastructure
- Facilitating whole school development of shared goals and values around the Digital Technologies curriculum
- Whole-school professional learning delivered by curriculum officer
- Increased engagement by students in classes
- Reduced incidents of student damage to property (and associated improvement of school climate as indicated by fewer broken windows)
- Integrating aspects of the Creative and Critical Thinking general capabilities into the Digital Technologies curriculum
- Identifying how the Digital Technologies curriculum can be integrated into elements of the school improvement priorities
- The Principal was able to apply prior knowledge about how to support the Digital Technologies curriculum from work in previous schools through the DTiF at Jade

Mini case studies illustrating outcomes

The two cases below offer insights into new practices and positive outcomes for students from the perspectives of a teacher and a principal.

> "And so that's what we've talked about, you know the difference between the use of technology and then the designing of technology, and the design thinking and all of those things.

Case 1 (JT1) —
Developing algorithmic thinking through children's literature

The focus of the action research project at Jade is the development of literacy and numeracy through algorithmic thinking in an unplugged context. JT1 was very enthusiastic about the support received from the ACARA curriculum officer in establishing and developing the project. JT1 described the ways in which algorithmic thinking was being embedded in the curriculum using early years' literature. The class had read, *No Place Like Home*, by Ronojoy Ghosh. This Australian picture book is about a polar bear who lives in the city. His house is too small and he goes to search for a new home, but becomes lost. JT1 described that the class considered, 'How could we redesign his house to make it more comfortable, because he doesn't like the crowds?' In the story, the polar bear searches through a variety of landscapes until he gets to the Arctic, his home. JT1 explained, 'So, well he doesn't like sleeping in trees, how could we solve it? How could we make it more comfortable?' The students discussed design possibilities emerging from the questions asked in the text. Students then engaged with the technological design process to design new homes for the polar bear, including sketching their designs and building models. These 'unplugged' activities supported thinking skills and processes that are foundational within the Technologies curriculum and approaches to designing solutions that are shared across the Design and Technologies and the Design Technologies curricula.

One of the challenges was to support the students to collaborate with each other. JT1 noted:

> The other challenge I got told was the collaboration part. Our kids—and that's, you know that's part of that 21st century learning—we really need to get our kids collaborating and communicating with each other, and that's been one of the challenges.

Across all of the data collection points, participants talked with the researcher about difficulties in encouraging the students to collaborate with each other and communicate effectively. Teachers had a strong awareness of the need to develop oral language skills with the students and the Digital Technologies curriculum often became a site of this language development.

Because the DTiF was rolled out as the infrastructure was upgraded, part of leading the DTiF involved managing the shift in the Digital Technologies curriculum to a context where 'plugged' learning activities were enabled. While some of the thinking and planning is transferrable, the experience for the students and some of the planning for teaching requires more work. JT1 explained:

> I do think there's a lot of work to do, and I also think that it needs to be done in such a way that it's used to engage and actually support learning. I think sometimes we fall back on, you know when you have behaviour, that it's a, 'Oh yes we can get them doing this', but what is the purpose? Is it quality interactions in that technology?—so upskilling our teachers. I think we've got some very enthusiastic teachers that would love to get their hands on it, but making sure that we understand what the purpose is for it.

JT1 goes on to explain that one of the issues is the teachers' expertise around design thinking. JT1 commented that there is still a misunderstanding about Digital Technologies where 'people think it's just put the kids on a computer and that's Digital Technology' and that it is the use of the hardware. JT1 explains:

> Where it's not about—we need to get past that and move into it, so it's also the way of thinking, and I think that's where—and [the DTiF leader] has done some presentations on it, but until the teachers are actually getting in and playing with it, to really embed that thinking. And so that's what we've talked about, you know the difference between the use of technology and then the designing of technology, and the design thinking and all of those things.

The DTiF project provided this teacher with opportunities to reflect deeply on their philosophy of teaching the Digital Technologies curriculum and the relationship between the design and technology that underpins it.

Case 2 (JP) —
Principal as champion of the DTiF:
Whole of school approach supporting
the DTiF with multiple funding sources

At Jade the principal was extremely supportive of every aspect of the Digital Technologies curriculum, and made it a goal to integrate Digital Technologies through the curriculum and to develop the infrastructure to support this. This aligned with a strong professional investment. JP reflected:

> I'm technology—I think technology is wonderful. To be honest, technology really invigorated my teaching after 20 odd years. I found that it did so much, and our world is that now and if we don't make the changes, our children are not going to be prepared for the workforce. And it's not just using computers, it's using collaboration, planning together, it's those relationships together.

JP sees that the integration of digital tools into the Digital Technologies curriculum is ultimately about collaborative relationships. At DP1 there was considerable frustration across the school with the state of the infrastructure and equipment: the lack of a wireless network, the lack of reliable connectivity and old and obsolete peripherals. The principal's commitment to improving all of these issues was connected to wider purposes of reducing the frustration that the teachers felt every time they designed a lesson using digital tools as they faced potential equipment failure. This was a significant disruption to their planning and delivery of the Digital Technologies curriculum. JP also recognised that the thought of equipment failure was a barrier to creative thinking around the equipment and teachers being prepared to utilise it more broadly in their classrooms because the risk of technological failure while the unpredictability for teachers was still there. If the DTiF was to have any purchase in this school, the first thing to do was to address this need.

As a result of the principal's efforts between DP1 and DP2, significant progress was made in providing stable technological infrastructure to support reliable networked learning. This reliability premised the development of a shared language and shared commitment to supporting the professional learning of teachers with the integration of new equipment. Once the network was stable, the principal could focus on professional learning for teachers and developing self-regulated learners:

> So, now that we have the technology, now we need teachers—more PL in that. But also, my next step on from there is looking at the flexible learning spaces. So, now that we've got some—and our goal here is to be—is to make students independent self-regulated learners.

As the stable infrastructure was built, this was one less stress for teachers. It provided a predictable context for innovating with the Digital Technologies curriculum. It reduced the amount of frustration teachers experienced and invited them to take risks with new learning experiences for the students. The principal identified that they were getting more traction with the Digital Technologies curriculum. The principal took a whole-school approach with the Digital Technologies curriculum and noted that, 'research shows and proves that when you have whole school programming, that's where you get the biggest traction'.

Sustaining impacts

Alongside the principal's long-term plans for the school, the DTiF is positioned to play a role in disrupting acute inter-generational disadvantage. The most significant source of disadvantage at Jade was the intergenerational poverty experienced by families that led to a contestation of the purposes of education for the community. This disadvantage played out in many elements of the school—the high fence surrounding the school, the processes for visitors of having to talk into two video cameras before they are allowed entry, and the demands for each visitor to sign a form that they will behave at the school and are not under the influence of drugs or alcohol and do not carry any weapons. It was also signified through the tally of broken windows and materialised in the school's total reliance of external funding for all elements of operation. The identification of the need to create a stable infrastructure as a foundation for disrupting disadvantage was a significant outcome at the school during the DTiF that would support success and sustainability.

The new infrastructure at the school was designed to be sustainable, with a level of connectivity predicted to be adequate for the next twenty years. The whole school approach to the DTiF generated collaborative professional learning that complemented the professional learning offered by the curriculum officer. The invitation extended to the curriculum officer to give a full day whole school professional learning experience also extended the reach of the DTiF to all teachers.

At Jade, this inclusive approach to the professional learning was also designed to strengthen the enactment of the Digital Technologies curriculum across the school and to link it into other areas of school improvement and curriculum. Importantly, the principal was concerned that teachers work together and that they feel supported in their endeavours. The principal structured the DTiF so that teachers and leaders shared new understandings generated as a result of the DTiF with all teachers. The focus on whole-school participation in the Digital Technologies curriculum and whole-school opportunity for learning made the project very sustainable as all teachers developed their professional habitus through these professional learning.

The principal at this school had made significant changes at previous school, and was basing some of the change being implementing through the DTiF on this previous success. This shows the potential for the transferability of knowledge amongst a network of like demographic schools. In particular, the principal's attention to the infrastructure, culture of professional learning, need for self-regulated learning, and a desire to create collaborative open learning spaces, were in the process of being developed throughout the DTiF. Transferability of success in the Digital Technologies curriculum mediated other initiatives for change in the school. Underpinning this change is the confidence of leadership around a philosophy of teaching that is inclusive and generative. The principal stated:

> And what we need here is to get away from that teacher-centred learning and get to that student learning. So, that's a mindset that takes quite a long time to do. And that's what we're working at.

The three-year timeline of the DTiF aligned with the principal's timeline required to change teachers' mindsets.
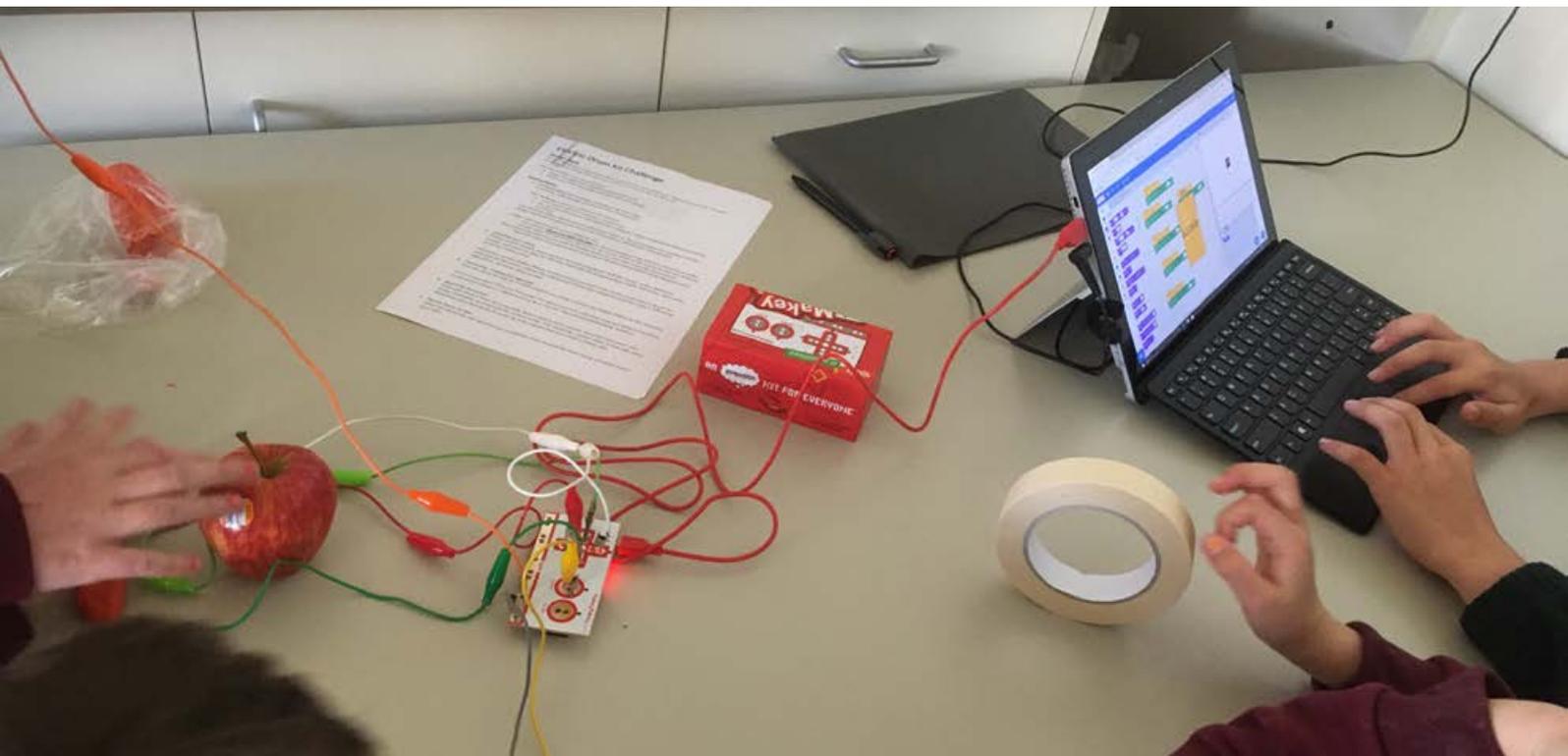
Amethyst Primary School

The Amethyst case study draws on a range of data collected at three data collection points consisting of three site visits and two follow up Skype interviews undertaken by a single researcher; as well as document collection. Eight participants contributed to thirteen interviews including three core participants in the DTiF program: Amethyst's acting assistant principal (the DTiF leader); a senior teacher and an early career teacher teaching a class for the first time. Additional participants include the Year 6 teacher, the Year 6 relief teacher, the Year 6 assistant teacher, a teacher who joined the staff between DP2 and DP3, and the principal. DP1 and DP2 included tours of the school. Three staff members left the school between DP2 and DP3, including two from the core team. DP2 consisted of four on site interviews and two subsequent Skype video interviews of teachers not available during the site visit. Document collection included DTiF professional learning resources; DTiF school action plans; and teaching and learning materials.

Situated context

Amethyst Primary School is a co-educational government primary school located in a regional Australian town. The school is set on a quiet road with a scenic bush setting. The school's student population consists of approximately 130 Foundation-Year 6 students, 60% male and 40% female. The school's ICSEA indicates a value of 785 with approximately 80% of the school's student population coming from families whose parents are in the lowest quarter of Australia's distribution for socio-economic advantage. Just 1% are from the top quarter. Staff estimated that only 40% of households would have a caregiver who is in paid employment. Almost all students were born in Australia, with around 10% with a language background other than English. 60% of the school's population identify as Indigenous.

Two staff members who attended the school as students remember it as having three times the population in the past including students from more affluent backgrounds. Recent years have seen increased enrolment of students living in foster care, an out of home care institution, and children of prisoners. The current school population come from families where adults experience high levels of unemployment, incarceration, mobility and poverty. Student backgrounds were characterised by trauma and disadvantage. As the DTiF leader reflected:

> You are talking domestic violence; violence towards each other—like you watch these kids if there is an issue and they want to solve a problem the first thing to do is to hit someone. You have drug, alcohol, mental health, poverty, incarceration issues that are all—they have difficulty getting help for those things. Attendance is a huge issue for our kids. You hear on the news lately how we're failing a whole generation of students and we need to do individual plans and track them and we are already doing that, but you can't do that if a child is not coming to school.

The school receives financial help from the government due to the challenges the students and their families face. Due to this additional funding, additional staff have been employed to reduce class sizes, so the school has seven classes of between 16 and 22 students.

After a long period of staff stability, the school is undergoing change, including to both principal class and teaching staff, due to retirements and moves to other schools.

Only a very small number of children have fully functional and connected devices. Many, if not most children, don't have access to the internet at home. In the case of those who do have devices, these are often damaged and usage is curtailed by insufficient data and battery life.
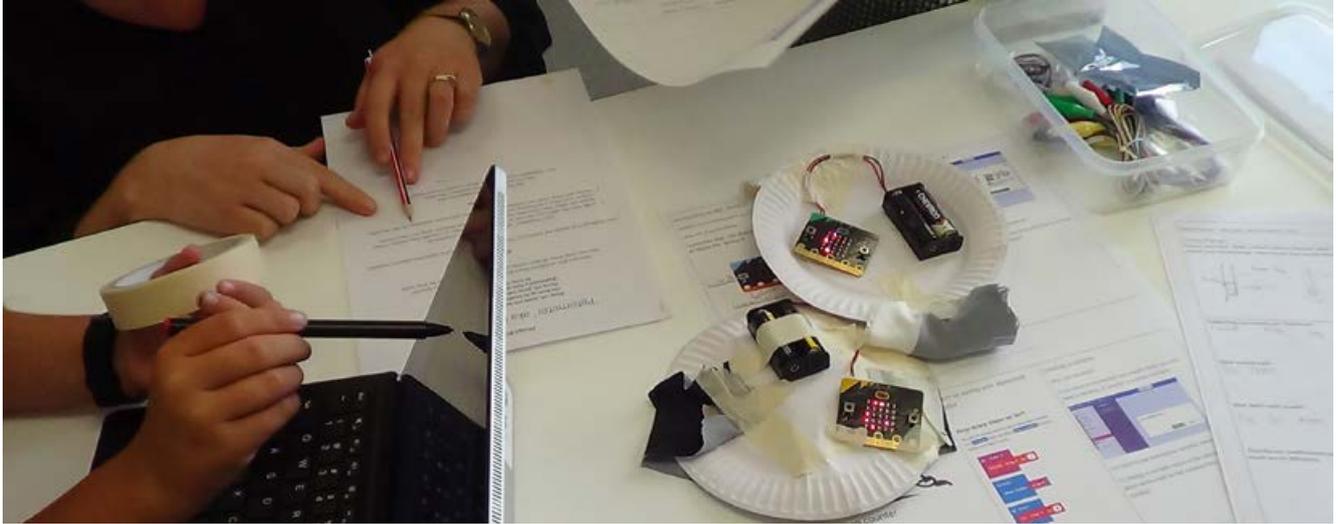
Professional context

At Amethyst, the implementation of the Digital Technologies curriculum was initiated prior to DP1 at the instigation of an ex-principal and the acting assistant principal who was also the DTiF leader. At DP1 and DP2, initial implementation of the Digital Technologies curriculum was supported by a core team led by the DTiF leader, a well-respected senior teacher, who had held multiple leadership roles in the school, including ICT Coordinator at DP1. By DP2 a new assistant principal had been appointed and the DTiF leader had responsibility for a Years 3/4 class and retained the role of ICT Coordinator. The DTiF leader had left the school by DP3.

The team also included an experienced senior teacher who worked across two schools, mentoring teachers, demonstrating small group work with students in classrooms, analysing students' progress in literacy and numeracy and meeting with teachers to construct student learning plans. In the past this senior teacher had been the ICT Coordinator at Amethyst. The third team member was an early career teacher on contract with responsibility for a Foundation class, who claimed not to have technologies as a strength. The acting principal was new to the school at DP1 and was not available for interview at DP1 and DP2 due to illness and competing commitments. At DP3 the acting principal outlined the school priorities in terms of wellbeing of students, and building teacher capacity to manage classrooms and provide literacy and numeracy. This shift in priorities had meant that the momentum of the DTiF project had been lost. A renewed focus was planned post DP3 with employment of a librarian with expertise in Digital Technologies curriculum and STEM.

The Year 6 teacher, another early career teacher, professed a dislike of, and disinterest in, Digital Technologies teaching and learning and usage of digital tools. This teacher outsourced teaching of Digital Technologies to a relief teacher who taught the Year 6s weekly, supported by an assistant teacher. The relief teacher professed strengths and interest in teaching Science and Technology including fundamentals of coding and robotics. The Year 6 assistant teacher was new to Digital Technologies but had a positive approach and interest in learning with the students and worked with the Year 6 relief teacher.

The core DTiF team at Amethyst identified teacher learning in the area of Digital Technologies as a focus for their action research project. The school was undergoing change from a relatively stable leadership and teaching staff due to retirements and moves to other schools. The staff had a number of new early career teachers on contract supported by relief teachers. The Amethyst team developed a focus on developing and supporting knowledge and implementation of the Digital Technologies curriculum as their initial approach to building capacities in teachers and students.

Material context

Due to their low socio-economic status, the school received significant government funding which allowed staffing of seven classes, rather than the five which base funding would have allowed for the size of the school population. These included a Foundation class, a Year 1 class, two year 2 classes, a combined class of Years 3 and 4, and two classes of Years 5 and 6 students. Class sizes ranged between 16-22 students. These classes were taught by 11 fulltime equivalent teaching staff and two fulltime equivalent non-teaching staff. Following a long period of staffing stability, the beginning of the DTiF project coincided with a raft of changes in leadership and teaching staff due to retirements, promotions and moves to other schools. At DP1 only one of the class teachers held a permanent position, the rest being on short term contract or a regular relief teacher.

Each classroom had between six and 10 desktop computers. There was a set of 10 touch screen iPads which were shared across the school and each classroom had an interactive whiteboard. All teachers had their own laptops. Following prolonged negotiation with government departments, the issue of insufficient bandwidth had finally been addressed in the year prior to DP1. The school planned to develop a maker space in an unused classroom which would supplement the existing spatial resources of classrooms, a library, art room and a computer lab with 30 desktop computers.

At DP1, the DTiF leader had successfully applied to the acting principal for $10,000 to resource the maker space including 10 Dash robots; five Dot robots; Dash and Dot challenge cards; and 12 Bee-Bot robots. Twelve iPads were also purchased and lockable cupboards were installed as the room had a history of vandalism. These numbers allowed class groups to work in pairs when programming. The DTiF leader had an allocation of one day per week for the ICT coordinator role, which allowed maintenance of technology, setup of the maker space with associated resourcing and timetabling, and leading of the DTiF project. At DP2 the maker space was operational and teachers from all areas of the school were booking their classes into the space and encouraging students to undertake some simple programming, in many cases surprising both themselves and the team with their enthusiasm. Most of these activities replicated those presented by the curriculum officer. Just before DP2 the ICT coordination allocation was reduced to two 40-minute sessions a week. At DP3 both the senior teacher and early career teacher from the core team had transferred to other schools. A new librarian with a background and interest in STEM had been employed with the role including development of ICT skills.

Project focus, activities and progress

Amethyst's action research project focused on building teachers' familiarity with the Digital Technologies curriculum. At the time the project was conceptualised, the staff were very experienced and many reluctant to teach with computers and there was a pervasive lack of knowledge about Digital Technologies curriculum. As the DTiF leader explained:

> Our proposal was upskilling our staff in Digital Technologies curriculum basically because well number one, before we went to that course [conducted by ACARA curriculum officer] our DTiF team didn't even know about that curriculum coming out, yeah and number two, if we didn't know it no one else back here knew about it and again people just want information.

By the start of project implementation, while many early career contract teachers had joined the staff, none professed strong preparedness for teaching the Digital Technologies curriculum. Subsequently, the Amethyst DTiF core team developed a focus on developing and supporting knowledge and implementation of the Digital Technologies curriculum as their initial approach to building capacities in teachers and students.

The core team participated in face-to-face workshops at regional centres conducted by ACARA curriculum officers, as well as webinars with other project schools. They were introduced to the Digital Technologies MOOC, free online courses conducted by the Computer Science Education Research Group, based at the University of Adelaide. The team decided that all Amethyst teaching staff would benefit from participation and dedicated non-teaching time was allocated. The MOOC was designed to support teachers with implementation of the Australian Curriculum: Digital Technologies. The core school team also organised for the ACARA curriculum officer assigned to Amethyst to visit the school regularly.

Hands-on workshops explicating the Digital Technologies curriculum, such as coding applications and use of digital equipment were conducted with the whole staff including assistant teachers which built enthusiasm and resulted in significant purchasing of class sets of robotics and associated coding materials. As the DTiF leader explained:

> We had [the curriculum officer] come in for three hours which was really good and basically again because this involved the whole staff looking at the curriculum, but yeah we did some fun practical things with some robots so we got some people engaged and sort of looking at the logical thinking and the problem solving behind the curriculum.

The curriculum officer continued to visit the school regularly conducting further professional learning, Digital Technologies learning activities with students and providing support to the core team. The curriculum officer also provided remote support via email and telephone. The modelling, insights and support offered by curriculum officer were very well received. The school also intended to use the Computer Science Education Research lending library at University of Adelaide on the recommendation of the curriculum officer; although, this did not eventuate in any sustained action. Other useful resources included the Digital Technologies Hub, internet searching of other teachers' practices, and the Blockly app.

Data from DP1 and DP2 evidence a narrative of efforts by the core team to embrace learning and further the learning of others through generation of enthusiasm and hands-on use of class sets of new resources. Accounts emphasise teachers' growing knowledge of equipment and confidence in teaching in the maker space, giving students greater access to digital tools. The maker space began to be used as a rewards room at lunchtime for students who have had consistent attendance and complied with school uniform and behavioural expectations.

This work, however, was conducted against a backdrop of upheaval and uncertainty due to ongoing staffing shifts. Evident progress was made in terms of digital resourcing; teacher commitment to professional learning; teachers' pedagogical innovation; and student access to new digital equipment. At DP2, team participants were seeking to further develop their own and other teachers' knowledge and confidence in integrating learning in a range of curriculum areas, rather than positioning the Digital Technologies curriculum as an addition to an already crowded curriculum. They were aware that Digital Technologies curriculum concepts such as computational thinking were not yet being heavily emphasised. They intended to work with teachers to develop scope and sequence charts and other planning resources where Digital Technologies were integrated into literacy and other curriculum areas. The team had planned to have sessions where staff shared lessons they had done in the maker space with links to curriculum planning and outcomes. This was intended to develop familiarity with the Digital Technologies curriculum and confidence in planning to meet outcomes, including through integration with other learning areas.

At DP3 the core team of three had been reduced to one. The senior teacher who had led the project and the early career teacher had transferred to other schools. The maker space was no longer operational, and the resources had been rehoused and the robots were being used by a single new teacher who had an interest in STEM. This teacher had heard about the DTiF project, but hadn't participated in the original program. The principal explained the school priorities were wellbeing of students and building teacher capacity to manage classroom behaviour and provide literacy and numeracy, particularly given significant changes in the staffing profile and an intake of new high needs students. The curriculum officer had returned to the school to conduct workshops with new staff and recommended that they undertake the MOOC.

Outcomes for students and staff

To summarise, the outcomes for staff and students at Amethyst include:

- Conduct of a range of teacher professional learning activities for whole staff
- Securing of funding and purchasing of class sets of robotics, iPads and associated coding materials
- Establishment of a resourced secure maker space where classes can be timetabled and used as a rewards room at lunchtime for students who have met school expectations
- Stimulation of teacher interest in robotics and coding
- Beginnings of professional conversations around teacher planning in light of the Digital Technologies curriculum
- New teacher knowledge and practices in implementing of Digital Technologies lessons
- Valuing of teacher knowledge developed outside of the DTiF project
- Identification by core team of what further learning is needed to support teachers including deeper engagement with curriculum documents and lesson and scope and sequence planning processes, including integration with other subject areas

Mini case studies illustrating outcomes

The mini cases below offers snapshots of two teachers, teacher AT1 who was part of the core DTiF project and who showed changes over the course of the project in terms of expectations of students and teacher knowledge. Student AS1 is discussed in terms of impact of student engagement with Digital Technologies curriculum. Teacher AT2, a relief teacher, was recruited to teach the weekly Digital Technologies classes to Years 5/6 and Student AS2, initially engaged in low level usage of coding, became motivated to commit more fully to learning when teacher AT2 demonstrated the capacity of coding to design game-like sequences.

Case 1 (AT1) — Changed attitudes & professional practice

Teacher AT1 was part of the core team that participated directly in the ACARA DTiF project. After graduating seven years ago, AT1 worked as a casual support teacher including at Amethyst for two to three years before being employed on contract at Amethyst as Foundation teacher in the first year of the DTiF project. AT1's digital learning experiences at university were confined to being shown 'how to make a webpage, to put our portfolio on there', but was 'all for technology' and was prepared to be 'roped in' to the DTiF project. Prior to project involvement AT1 was comfortable using a Promethean interactive whiteboard and iPads for programs such as Reading Eggs, Study Ladder, Just Dance and counting activities as well as using Class Dojo as a communication app.

At DP1 this teacher taught students in Foundation, their first year of school, half of whom had been to preschool. At this point AT1 stated that the crowded curriculum, pressure to teach and assess literacy and numeracy, and a lack of equipment worked against incorporating suggestions made during the DTiF professional learning. Significantly, AT1 also wondered about the Foundation students' capacities for coding and computational thinking given the need to teach students to operate the basic functions of computers, such as logging in. Also, she was aware of her own lack of knowledge in the area, as evidenced in the following:

> When [the curriculum officer] ran the workshop here us staff played with the things basically. The curriculum officer just set up all these activities and… we just went around; the Bee-Bots because we hadn't played with them before. The Sphero, we took that outside and let it go for a little run—crashed into the wall and things like that, because we have no skills… I'd never seen these things before.

However, by DP2 when the school had set up a resourced maker space, AT1 was teaching students to program BeeBots and Dash robots. She started slowly:

> When I took them to the maker space and turned it on and Dash started talking they were like 'how is it talking?' And I was like 'well Dash just talks whenever it wants to because it was just saying hello', and then they were just making it go around them in a circle or backwards and forwards and then they decided they wanted to walk around because they don't understand that they don't have to go near Dash to make him move—they can be like at the other end of the classroom and he will still move.

> **"** The curriculum officer just set up all these activities and… we just went around; the Bee-Bots because we hadn't played with them before. The Sphero, we took that outside and let it go for a little run—crashed into the wall and things like that, because we have no skills… I'd never seen these things before.

When asked how concerns about not knowing enough about the robots before teaching in the maker space were overcome, AT1 clarified:

> The [curriculum officer] came to us twice, and then came to us for a third time, and said 'okay, I'll show you how to program', and we're more like 'no, we just want to know how to play with these things', and [the curriculum officer's] like 'okay', and did a demo lesson and then we just played ourselves, because we only work through playing, so we just have a little go, and we're like 'okay, this, we can do this, yeah'.

AT1 overcame concerns in teaching previously unknown content and displayed resilience and determination in overcoming initial difficulties such as having students pair their devices. AT1 also reviewed initial doubts over the Foundation students' capacities to learn Digital Technologies knowledge. As AT1 reflected:

> Foundation kids are like sponges, once they see it once or twice, that's it, they've got it, and they can just do it. Sometimes they show me, they're like 'did you know this can do this?' I'm like 'oh no, I didn't know that'. So this little boy was making all the lights change colour, and I was like 'well, no one showed us how to do that, how did you do that?' I think because they have the time to sit there and actually do it by themselves, they just make it do things and they're just like 'oh this can do this'.

AT1 integrated Digital Technologies outcomes into literacy learning through pedagogies focused on literacy and numeracy (for example, Bee-Bots robots tracing the movements of characters across different settings from a picture book; and programming Dash robots to assist with learning sight words, through moving to particular words and using recordings to vocalise the words). Digital Technologies curriculum outcomes included capacity to create a range of digital solutions through guided play and integrated learning, such as using robotic toys to navigate maps. AT1 had left Amethyst by DP3.

> " So this little boy was making all the lights change colour, and I was like 'well, no one showed us how to do that, how did you do that?' I think because they have the time to sit there and actually do it by themselves, they just make it do things and they're just like 'oh this can do this'.

Case 2 (AS1) — Productive links between attendance, access to digital tools and learning

Student AS1 started in Foundation in the year of DP1 and was in AT1's class. AS1 had very poor attendance including not coming to school on Fridays until the class started going to the maker space on that day. Other students told AS1 about the work with robots which prompted attendance on Fridays. As AT1 noted:

> So [AS1] missed our first two sessions because they didn't come to school and then the kids were like 'oh we got a robot, and you don't even get to come because you don't come to school'. And then when [AS1] got up there the first time, they started off hesitant, and asked the assistant teacher 'so how do I do this?' And then once [AS1] got clarification, all was fine and all on her own, [AS1] was gone, let's go.

AS1 watched other students program the robots and asked the assistant teacher to demonstrate how the robots worked and quickly learnt to program Bee-Bots and Dash robots independently.

The maker space was also used as a rewards room at lunchtime for students who have had consistent attendance and complied with school uniform and behavioural expectations. Student AS1 had additional access to the maker space at lunchtime due to improved school attendance. AT1 explained:

> So [AS1's] been to the rewards room, I think three times at lunchtime, because I try and give each kid a go, but when I was just like 'no, you can just go because you know, attendance has picked up', and [AS1's] really, very smart. I was like 'yep, let's go, pick a friend', and [AS1] would pick a friend, and off they'd go.

At DP2, AS1 had overcome any initial hesitancy and had developed a range of programming capacities. As AT1 described of AS1's work with robots:

> She can move it, she can make it talk, this is for Dash. They have races, they line them up and they have races and I'm like 'don't do that'. [AS1] can make them play sounds, like all different sounds, and then with the Bee-Bots, AS1 got it straight away, that you know, 'this is how far it goes, it's got to be like five hands', like AT1 would get their hands out and measure it. And so [AS1's] like a group leader kind of, in that sense.

AS1's interest in robotics impacted positively on attendance and engagement. Building confidence and capacities in programming robots lead to positioning as a group leader in the maker space.

> " and then with the Bee-Bots, AS1 got it straight away, that you know, 'this is how far it goes, it's got to be like five hands', like AT1 would get their hands out and measure it.
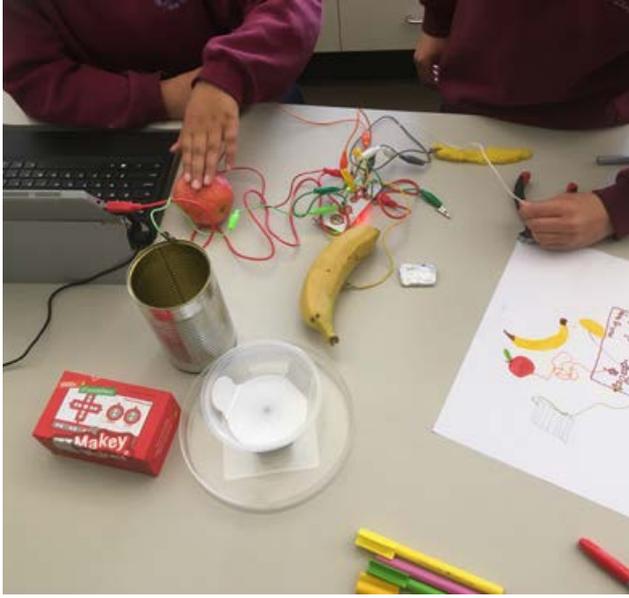
Case 3 (AT2) —
Relief teacher with responsibility for Years 5/6 Digital Technologies Curriculum

Teacher AT2 was not part of the team that participated directly in the DTiF project, but was a relief teacher who regularly taught Science, Technology and Physical Education three days a week at Amethyst. Holding a Bachelor of Science before entering Primary Education, AT2 had strong interest and expertise in teaching Science and Technology. The Years 5/6 teacher at Amethyst, who did not evidence interest or confidence in teaching Digital Technologies curriculum, requested Teacher AT2 take responsibility for weekly teaching of the Digital Technologies Curriculum in a Years 5/6 class when the regular teacher was released for planning. Being casual and part-time, teacher AT2 was only involved in one professional learning session related to Digital Technologies curriculum at Amethyst which engaged teachers in tinkering with robots—a session AT2 found fun and useful for colleagues and the school in coming to the decision to set up the maker space.

Teacher AT2 set up an online classroom on a self-paced coding website and took the Year 5/6 students to the maker space where they have worked on coding the robots to do specific things. As AT2 explained:

> We use the App called Blockly to use our robots for the obstacle courses. What Hour of Code does, it's just a computer based version to give the kids an idea of what coding's about. So when it comes to setting up obstacle courses and things for our robots to travel around, we have iPads with the Blockly App to drive the robots, that we can use those, code the robots to give the robot the direction they need and use that. To make the obstacle course itself, we just have our maker space room, there's chairs and footrests and we've got metre rulers and things like that and essentially just make up a path for them to travel around.

AT2 explicitly taught computer language, and at DP2 described teaching Digital Technologies terminology:

> I'm also trying to teach them computer language so when we start using the word 'algorithm' they know what we're talking about and obviously working on computers we talk about algorithms and programs, things like that, so we start to try and weave that language into our conversations when we are using the robots or talking about computer programming, things like that. I've taken them through a little bit of binary language.

AT2 also connected the learning with other curriculum areas, for example pointing out incidental mathematical learning, especially with coding and using terminology for direction. Interest amongst students varied considerably:

> There are some [students] that just work well all the time, some that because you put them on a computer and it's not exactly what they want to do they just don't want to do it and others that have really taken to it and have come along and you can see that over a period of time.

For students who have engaged deeply:

> Some of them have finished the first course, have moved onto the second, and so they're starting to test themselves with some of the concepts that are a little bit harder… mathematically in terms of just with their positioning, it's not a left turn or a right turn, they've got to turn so many degrees and all of a sudden they're using distances in pixels on the screen.

AT2 also linked Digital Technologies learning with literacy learning through a focus on careful close reading; and integrated computer work into Science education, for example engaging students in making PowerPoint presentations on micro-organisms. AT2 was no longer employed by Amethyst by DP3.

Case Study 4 (AS2) —
Seeing the potential of coding led to motivation

At DP1, student AS2 only wanted to use the computer to play favourite games with friends, regularly playing the same few games. When introduced to coding applications like Scratch, these students would restrict their use to listening to the music that people had uploaded and resisted coding. Similarly, when introduced to an online, self-paced coding classroom with levelled progression, AS2 resisted engagement, perceiving work related to coding as basic, easy and boring, and not seeing the point. When AT2 showed AS2 what students working at higher levels of coding could do, including designing game-like sequences, AS2 demonstrated a marked change in both attitude and capacity. At DP2, AT2 explained that AS2 was mid-way through the sequenced activities in Level 2 of Code.org and showing the capacity to engage and persist in Digital Technologies learning:

> AS2 was moving the little character around a number of different shapes, having to put a lot of loops in to have repeated actions but instead of just moving forward one space, now they're talking in pixels and [AS2] had to put a picture next to where they are, for example, 100 pixels high and the picture … at 70 pixels less and so they've then got to do that mathematics to work it out but then they're putting it in terms of what angle do I have to put in. While the program does give options, [AS2] still had to select the right angle, say, 90 degrees, 45 and so on. AS2 had to work out what the pattern is, to how far it is, what angles they're using, then how do I put it into a loop and then how do I then join those particular pieces of the puzzle together to do it, so there's quite a lot of little problems that they have to overcome to experience some success in it.

After being introduced to what students who had developed initial coding skills could do, and seeing the game-related potential, AS2 was motivated to develop the capacity to design games and became a class leader and advocate in learning coding in order to design games.

Sustaining impacts

The design and implementation of the ACARA DTiF project served to engage first the core team, and then, for a brief period of time, the whole school. Accountability measures such as documentation and peer sharing kept the projects active and strong and varied types of support by curriculum officers (for example, offsite workshops, school to school sharing, resource recommendations, in school workshops, phone and online communications) were appreciated and effective. The project outcomes listed above evidence the strong school-wide impact on teachers, and ultimately students, for a short period of time.

At Amethyst, the initial application for participation in DTiF project and formation of the core team with responsibility for development and implementation of the project was initiated by a principal who left the school at the end of year prior to DP1, and a senior teacher who transferred from the school after DP2 along with a second of the three-person core team. This change of personnel was but one of many which hampered sustained commitment to the project in a school faced with leader and teacher churn and associated shifting priorities and staffing.

The biggest impacts of the project were on the inspired individuals who most fully participated in the out of school program. While others were more tentatively interested and enthusiastic, these traits dissipated without the original leadership, and when staff changed and new students arrived, priorities altered to focus on student wellbeing. These other priorities were required due to an intake of new high needs students and significant changes in the staffing profile with many new teachers unfamiliar with the Digital Technologies curriculum. Commitment to the concept of a dedicated maker space also shifted. The new principal incorporated resources from the maker space into a newly envisioned technology-infused library and employed a librarian with expertise in technologies. DP3 evidenced an intention to re-energise the project, with professional learning of new staff a priority.

Due to the high levels of disadvantage, the school had many opportunities for involvement in a range of projects, sometimes diffusing energies. The priorities of the leadership tended to dominate and change as leaders changed. Long serving teachers were often reluctant to be away from their classrooms to undertake professional learning as this meant they returned to unsettled students, classroom disarray and the need for additional work following up behavioural incidents. Teachers were also slow to make changes to classroom practice which could be seen as unsettling to students, requiring strong external supports in regulating their behaviours. Teacher enthusiasm for, and interest in, Digital Technologies relating to robots and simple coding was apparent between DP1 and DP2. But teacher learning did not progress to include confidence in teaching a range of deepening aspects of Digital Technologies curriculum. Further research is required to see whether professional learning leading to teacher implementation and student learning can be sustained and indeed deepened in contexts of rapidly changing staff.

Emerald Primary School

At Emerald School, six participants were interviewed over the three years of the program. At DP1 and DP2, the same participants were interviewed: the DTiF leader, an Indigenous assistant teacher and three teachers. Only two participants—a teacher and the Indigenous assistant teacher—were interviewed three times due to changes in teachers and school leadership. The first DTiF leader left Emerald after DP2 and the school's new principal took on the role of DTiF leader, and was interviewed at DP3, as was the assistant teacher and a classroom teacher who were interviewed at DP1 and DP2.

Situated context

Emerald School is a co-educational primary school in a 'remote' Australian town a significant distance from the nearest capital city. There are around 150 Foundation-Year 10 students, and almost 10% more male students than female. With an ICSEA value of approximately 350, almost all of the school's student population are from families where parents are in the lowest quartile of Australia's distribution for socio-economic advantage. The school had a very high proportion of Indigenous enrolment with almost all students having a language background other than English.

While the school is located in a town, it services a much wider geographical area, picking up students up to 70 km away and many students are bussed to school. The school values the teaching of Aboriginal languages and culture in the context of a national curriculum framework. Across the data collection points a recurring theme was that students came from disadvantaged homes and this was an important feature of the context that situated the DTiF. Trauma was common amongst the student population as part of this disadvantage. Often this was related to a lack of money, as one teacher noted:

> Well, do I have a phone or do I have something to eat? And that sounds terrible but that's a reality [for families]. I mean most of our kids are not living with parents. They are in care, they are in foster homes. They are in dysfunctional homes. They are traumatised [due to parents] in prison or alcoholism or domestic violence and all these other things.

The school had a strong focus on literacy across DP1 and DP2, programming literacy for the first two and half hours of each day in an effort to address students' low literacy levels through a corporatised literacy program. All of the teachers interviewed commented on the disruptions to programs due to many students' spasmodic attendance. The DTiF leader noted the students who were attending school on a regular basis achieved the same literacy standards as those in middle class schools.

The students who were speaking Aboriginal languages were often approaching the curriculum with English in a second or third language and had limited exposure to and usage of written English outside of school. Because of the intense focus on literacy the Digital Technologies curriculum was mostly taught in the middle of the day.

Professional context

During DP1 and DP2, the DTiF leader was the champion for the Digital Technologies curriculum in the school, coordinating the DTiF and managing the different facets of the program at various year levels. The DTiF leader was passionate about integrating digital tools and media into the curriculum through multiple projects, reflecting a high level of support for building students' ICT capabilities. The support from the curriculum officer was primarily of the DTiF leader who then mentored class teachers implementing Digital Technologies lessons. Classes had one to two Digital Technologies lesson every week (referred to as IT).

The teachers at Emerald School were enjoying success in their own professional growth as a direct result of participation in DTiF. For instance, the DTiF leader supported a media teacher (ET3) in the use of Stickbot in media arts:

> [The DTiF leader] was helpful in terms of first teaching me how to actually use the app so I can then teach it to the kids… it's for stop motion animation and the second time they came in and taught us how to put that into iMovie and make simple edits… and how to upload those onto the school cloud.

The DTiF leader, the principal and two teachers involved in the DTiF left the school after DP2. The new principal took on the role as DTiF leader before DP3 as part of a process of initiating widespread school reforms and DTiF was not a high priority. This change in leadership, staff turnover and resultant program changes, caused considerable disruption to the school programs. The teachers were no longer mentored by the DTiF leader and ongoing technical support became the responsibility of individual teachers. The assistant teacher commented, 'I think they're just adapting their own—whatever works for them, what they understand what they can do and then they're doing it themselves'.

Material context

At DP1, the school was in the process of transitioning from desktop computers to mobile iPads. The DTiF leader maintained a room with desktop computers where teachers could work with their class but more often the DTiF leader worked with the teachers in their classrooms, using iPads in the primary context. As the DTiF leader noted:

> So, these [the desktop computers] hardly get used at all now and I wouldn't even bother replacing. So, I think there are 90 [iPads] in the school now; there's Lego; there's robotics; there's Bee-Bots; 3D printers. We've got more than enough resources.

The school was well resourced with mobile iPads, which offered more flexibility of use. One teacher commented on the value of the mobility and tactile nature of the iPads being used across the curriculum by students:

> Just being able to be mobile with them—you're able to go outside—we're able to use them in the classroom with ease— you know, not stuck to the wall. Obviously… they're just more tactile—the kids just really enjoy engaging with them...

While digital resources were plentiful at the time of the DTiF, the DTiF leader was concerned about the built-in obsolescence of iPads and replacement expenses when updates were no longer supported by the manufacturer. Underlying this concern is unpredictability about whether the program will continue to have the high level of resource support needed for the constant updating of digital equipment in the school.

An important part of the DTiF leader's role was to find solutions to problems around student access and data storage in a context of spasmodic student attendance and often low literacy rates. Where there were insufficient iPads for 1:1 provision, low daily attendance rates meant there were usually enough. However, this situation meant that students were using a different iPad every day, leading to complexities around login processes, and data storage for ongoing work and reporting. A solution was saving student files to cloud storage and a single class login to the iPads. The DTiF leader identified this kind of work as essential if the students were going to have some consistency in completing their work across multiple sessions.

Project focus, activities and progress

At DP1 and DP2 the focus at Emerald was on integrating the Digital Technologies curriculum with the teaching of other subjects after the morning literacy block. Four programs existed across the school: a focus on 'Machines' in the secondary years; a language program with the assistant teachers; stop-motion animation with the upper primary classes; and robotics using the Bee-Bots with the lower primary classes.

The DTiF Leader worked closely with the curriculum officer, gaining new ideas for teaching and specific information about technologies, such as 3D printing and small programmable robotics. The DTiF leader valued the curriculum officer's knowledge of specific items of equipment from the myriad on sale that have different functions.

The DTiF leader identified the need to provide professional learning for the teachers as a priority in implementing the Digital Technologies curriculum at Emerald. While the iPads were celebrated for their mobility, simultaneously, the school was 'locking them down' and the only games allowed were 'serious games' that specifically taught curriculum outcomes. In the DTiF leader's words:

> Now it's just getting teachers up to speed to use those resources… the issue we have with iPads… is to get away from a childminding tool … they are getting onto Study Ladder; they are more now into apps. … We have taken [the games] all off … If there are games on there, they are maths games or language games.

At DP2, teachers recounted the success that they had with the Digital Technologies curriculum for a school event, where they showcased work that the students had completed. However, the reallocation of teachers' responsibilities between grade levels had disrupted the program:

> The original plan was to have a senior project, a language project, I think [one teacher's] was a Year 6 project—she is in Year 2 now but that's finished and we are going to do some work with Year 4. So, I think we had four projects originally. One is finished, the language one is just about finished. The Year 4 is an ongoing project and the secondary is an ongoing project as well.
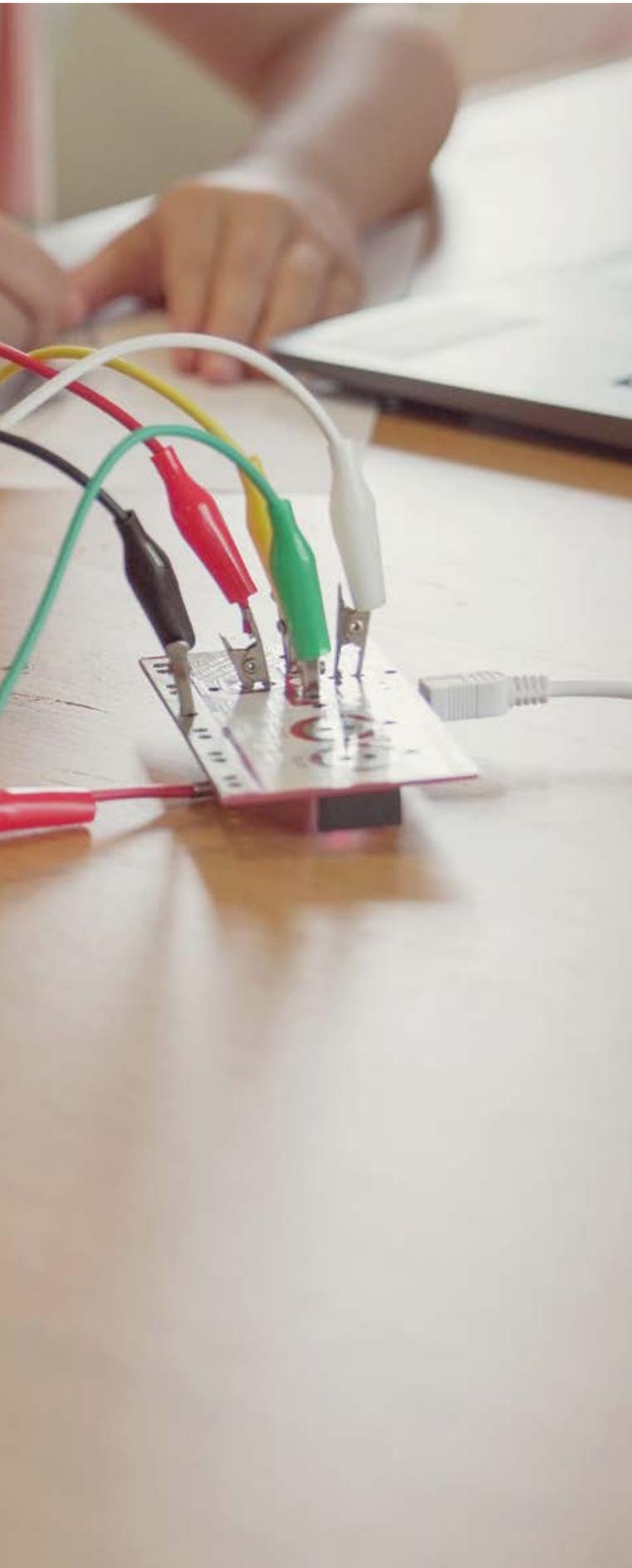
The changing staffing of grade levels disrupted the action research plan which became more about growing ICT skills rather than a specific set of curriculum outcomes for the project. The DTiF leader described:

> So, to me the action plan is just an outline. So, I suppose the bottom line the action plan says that IT skills are here [gesturing to the plan] and we want to get onto here. How we do that may not necessarily follow what happens on the action plan.

This highlights the ways in which the action plan reverted to an outline of teaching skills, but was not necessarily embedded in the overall school curriculum.

The student performances in the Digital Technologies curriculum were based on their strengths and ownership of their learning. Students often worked in groups towards a common goal with open-ended approaches to integrating their learning. Teachers commented on how the project provided them with examples of relevant knowledge to extend their teaching for the specific needs of their classroom context. The Digital Technologies curriculum was seen to be extending students' understandings of design, drawing on the teachers' pedagogical expertise with ICT.

The approaches to teaching were based on normalising the use of technology in the curriculum so learning can be extended. One teacher mentioned that the iPad usage became normalised in the classroom and the students were no longer distracted by them. This gave the teachers opportunities to begin to focus on work that could be scaffolded from the iPad to other aspects of the curriculum.

At DP3, after the 'champion' DTiF leader had left the school, the DTiF was enacted by the teacher and assistant teacher who were part of the core team. Both had shifted classes at DP3 and felt more confident in their usage of ICT, and continued to teach aspects of the Digital Technologies curriculum. The teacher noted how using the iPads had resulted in pedagogical change and made it easier to differentiate curriculum learning, noting, 'So, the lower and the higher tended to miss out, whereas now it's—I think it's easier to plan for everybody'.

Outcomes for students and staff

To summarise, the outcomes for staff and students at Emerald include:

- Providing life skills for students with the Digital Technologies curriculum for real world application
- Valuing of the students' expertise and opportunities for students to teach teachers Digital Technologies skills
- Increasing teacher knowledge about the content and pedagogy of the Digital Technologies curriculum
- Supporting the teaching of multimodal text composition
- Improving literacy and numeracy concepts through robotics
- Raising teacher confidence through collaborative discussions in planning for the Digital Technologies curriculum
- Initiated a robotics program in the primary school
- Made animated movies showcasing student learning

Mini case studies illustrating outcomes

The mini case studies below outline implementation of the Digital Curriculum at Emerald from the perspectives of the 'champion' DTiF leader (ET1); a media arts teacher (ET2); and an assistant teacher (EAT1).

Case 1 (ET1) — Championing the Digital Technologies curriculum for general capabilities

The DTiF leader (ET1) was heavily invested in the Digital Technologies curriculum and had much experience teaching technology, bringing a wealth of experience and knowledge of the curriculum as well as managing ICT programs. ET1 saw DTiF as an opportunity to build connections with perspectives and practices outside of the school.

ET1 was highly motivated to collaborate with the curriculum officer and to further their professional learning because they could see that the structure of the DTiF was supportive of their personal vision for ICT in the school, which included using ICT and the Digital Technologies curriculum to promote the general capabilities of students. ET1 saw the Digital Technologies curriculum as a site for promoting the Critical and Creative Thinking General Capability and inquiry-based approaches and skills, emphasising designing appropriate solutions to open-ended problems. ET1 thought this capability was important for social change in disadvantaged communities:

> You're getting them to question or find answers to questions and so hopefully some of that then will rub off to when they go home if they need to find out information about things.

The curriculum officer and ET1 teamed up to work with individual teachers in their classrooms and supported projects initiated for the DTiF:

> [The curriculum officer] had a yarn to me and then did some work with Bee-Bots and some work with high school students in using simple machines and some Lego. I think we did some work with [one of the teacher's] stop-motion as well.

ET1 took part in some webinars offered by the curriculum officer and found these to be collegial and reassuring and was also involved in a professional learning program offered by a private provider that gives Indigenous students opportunities to extend the Digital Technologies curriculum knowledge. ET1 also attended an ICT conference in Sydney through another program. This was also an opportunity to investigate equipment for potential use at the school, for example, learning about a 3D printer that was promoted at one of the conference stalls.

Thus, ET1 actively championed the Digital Technologies curriculum and the integration of ICT at Emerald, seeking opportunities to learn, to acquire new equipment, and to support teachers and students to develop new skills. At DP2, ET1 enthusiastically described a school event, were digital media and equipment were used to share the texts from each class with the community. ET1 saw digital tools as a means to connect with community and to promote skills that were important in the community. For example, he commented on how oral language was being developed in the lower primary classes through hands-on experience with robotics. At DP3 the DTiF had a reduced profile at the school without ET1's enthusiasm and facilitation.

Case 2 (ET2) — Engaging and differentiating curriculum via Digital Technologies and Media Arts

ET2 was one of the upper primary classroom teachers at DP1, working with a class of low attending students. While the classroom learning in the morning was based around a structured literacy program, the Digital Technologies curriculum provided the students and the teacher with a creative classroom enterprise. ET2 developed students' understandings of film production initially by analysing the production of the series, Bush Mechanics before students developed their own storyboards for their collaboratively produced stop-motion films using the Stickbot app on iPads. This use of digital media supported the students to work on their strengths in visual meaning making.

ET2 used storyboarding with the students to map out scenes before making the characters and props for the movies they made, and described one student's success enthusiastically. The student had drawn a three-panel story board; made a clay character to animate; and used a prop toy truck.

The use of the Stickbot app provided inspiration for the students, evidence for reporting on the Digital Technologies curriculum for the teacher, and a text to showcase to the community during a school event. Through these media activities, the students performed the voices of the characters in the animation, providing a voiceover or reading a text as the soundtrack of the video. They also shared recording of subtitles, contributing to a shared construction of the subtitled script, so integrating literacy into the Digital Technologies curriculum in manageable ways. ET2 noted that the authentic purpose and audience in the production of videos that were shared with the school community made the project more meaningful.

ET2 was impressed with the student engagement with the app, and commented on their sense of achievement as they saw the text coming together through their persistence. This task engaged everyone in the classroom regardless of level of achievement:

> " I think the thing that stood out the most was how engaging this app was even at the simplest level for even my lowest achievers, and even the ones with normally quite challenging behaviour problems as well, even if they weren't quite sticking to the task that I had set, they were still engaged in the app itself and in making their own little creations of their own, like little videos…I think it's just sort of like the magic of being able to create something so quickly and so easily like that for them as well.

The 'magic' of the animation production permeated the classroom, with all of the students engaged in their schoolwork.

ET2 came up with innovative solutions to managing this activity with students whose attendance was irregular, using strategies suggested by the curriculum officer:

> …we were able to work on it with whatever kids were there at the time. And we did short clips at a time, and then at the end of the week due to time constraints, I had to sort of edit it all together. I was going to get the kids to help with the editing process but we ended up running out of time for that.

The ongoing support from the curriculum officer enabled ET2 to learn the processes necessary to run this project successfully. This support was available throughout the process, from conception to production and distribution of the final texts:

> … [the curriculum officers] come in and helped to organise [Stickbot] on the iPad … so it was helpful in terms of first of teaching me how to actually use the app, so I can then teach it to the kids… and during the second visit, [the curriculum officer] taught us how to put [the stop-motion animations] into iMovie, and make simple edits and things like that, and how to upload those onto the school cloud from there.

ET2 moved from Year 6 to Year 2 a few weeks before DP2. In this Year 2 class they were using Bee-Bots with the students to support an oral program of literacy and numeracy. At DP3 this teacher had left the school.
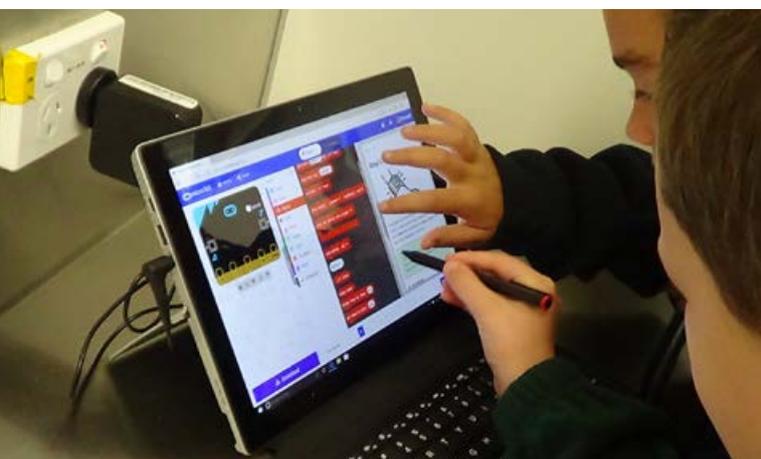
Case 3 (EAT1) —
Learning with and from the students

At DP1 and DP2, EAT1, an assistant teacher in a Year 4 class, working alongside a qualified teacher, described the role as follows:

> I just basically just help out in the classroom, whatever [the teacher] wants me to do. I do bus runs in the school, yeah, anything that anyone, I just sort of help everywhere, and everyone. Been here 10 years.

EAT1 was the longest-serving school employee involved in Emerald's DTiF project. EAT1 had a deep knowledge of the students and their communities. Unsurprisingly, the role as an assistant teacher capitalised on these relationships to provide additional support for students who needed it. EAT1 described various ways of working with the irregularly attending students to engage them in aspects of the Digital Technologies curriculum:

> …it takes them a bit longer, because there's a few that have, they know the ins and outs of an iPad now, but a couple of them still struggle. So, I sort of work with those kids and help them. … [As] the program rolled out, it actually helped me to be able to help them, so it taught me a few more little things.

EAT1 remarked a number of times that while the DTiF leader taught the students in the classroom, it was the students who taught EAT1:

> …[the students] just picked it up—they knew what they were doing. They went straight to the desks and did what they needed to do. And so, it was a big difference from hearing that they weren't getting it. When I was in here, and they were teaching me, showing me how to record and what to do and how to replay it.

EAT1 was really enthusiastic about the amount of learning that the students had done and was open to learning from the students, enabling them to develop their explanatory capacities. One of the outcomes of the DTiF for this assistant teacher was the confidence developed as working in the DTiF; first with learning new content, then teaching the students through the Digital Technologies curriculum with a mentor in the school to support their learning:

> I'm a bit more confident… I'll look at that or I'll press that and see what happens. … I guess just [the DTiF leader] showing me and doing it with the kids. I think it's easier for me when I'm doing it with the kids because at the end I'll be like, 'Oh, I just did that.' And at the start that's what I was worried about not being able to do.

Once the DTiF leader from DP1 and DP2 had left the school, EAT1 identified that some students were missing out on learning opportunities with the Digital Technologies curriculum. EAT1 commented on the discontinuation of the robotics program, providing insights into the impact of ET1's departure on other teachers and on the program:

> When [the DTiF leader] was coming in with the Bee-Bots and all that sort of stuff and… showed our kids how to write a story and put it on to this and upload it to there and all that sort of stuff. So, that kind of stuff isn't happening as much... Some of the teachers try to continue it on but if they don't know what they're doing they can't—they can't really do it.

At DP3, EAT1 had been working in multiple roles as an assistant teacher and also in the front office in times of need. Since the DTiF leader left, EAT1 has taken on a more central role planning for the Digital Technologies curriculum in the school. EAT1 described how they helped the teacher in Foundation to locate and load apps onto the iPads and provided advice about suitable apps to use as part of a collaborative endeavor. EAT1 identified that before the DTiF, advising on aspects of the Digital Technologies curriculum would not have been possible.

Sustaining impacts

Emerald Primary School had invested heavily in a literacy program in terms of budget, timetabling and staffing with all other curriculum areas, including Digital Technologies, needing to fit around this decision. Issues of sustainability at Emerald concern staffing and infrastructure. At Emerald in DP1 and DP2 the 'champion' approach to the DTiF highlights the risks when one person is in control of the knowledge and resources for the Digital Technologies curriculum, and is particularly at risk when this role has not been institutionalised in the school staffing. The DTiF leader at DP1 noted the need for a dedicated position to cover the professional learning and maintenance of the devices, and explained that much time was taken up by this work. The skills and confidence developed by the assistant teacher who had greater continuity at the site partially ameliorated the loss of knowledge when the DTiF leader left the school.

The infrastructure at Emerald was becoming unstable at DP3, with regular updates being required on the ageing iPads. One of the disadvantages identified by the DTiF leader was the lack of ongoing resourcing to create a stable technology infrastructure. This is in contrast to budgets that are acquitted around project completions. The DTiF leader had played the role of researching and initiating the procurement of technology such as robotics, 3D printers and Lego and their departure meant that a lot of this knowledge left the school before other staff had a chance to benefit from the investment through the DTiF.

Opal School

The data collected for the Opal case study covered three data collection points from three site visits that included interviews and collection of documents. Seven participants were interviewed over the three years of the program. Only one participant, an assistant teacher, was interviewed twice due to multiple changes in staffing and leadership of the DTiF program at the school. At DP1 the assistant teacher, a Homelands teacher participant and the assistant principal/DTiF leader were interviewed. The same assistant teacher was interviewed at DP2, with a replacement Homelands teacher; and the new DTiF Leader, a teacher based at the town campus. At DP3, the principal, who was by then also the DTiF leader, and a secondary teacher were interviewed. Documentation collected at DP3 included the school professional learning plan.

Situated context

Opal School is an F-12 co-educational government school in a 'remote' Australian town, offering education from early childhood through primary, secondary and vocational education to the local community and surrounding small communities. The school services a number of Homelands schools that were begun in the 1970s for Indigenous Australians wanting to live away from settlements as part of a growing Indigenous self-determination movement. They continue to cater for families who prefer not to live in the town. The school's student population consists of more than 500 students, with similar male and female student enrolments. Nearly all of the school's students are Indigenous and speak at least one language other than English. English is a third or fourth language for many. The school's ICSEA value is approximately 600, with most students in the lowest quarter of Australia's distribution for socio-educational advantage.

One of the features of Opal School structure is the governance that encompasses both the main school site and the Homelands schools which are up to two hours' drive from the main school campus. There are diverse and complex agendas in the provision of education across the Homelands and main school site, including discourses of standardised teaching and culturally responsive pedagogy provided to Indigenous students living in town and in Homelands. As a result of this, the time and places of education are often more negotiated in the Homelands centres, but, according to the teaching team at DP1, the expectations of quality outcomes are the same.

The staffing at the school is fluid, however there are some teachers who commit for a long period of time. Staff at the school are frequently granted leave and move between roles. The Indigenous assistant teachers often commit to the school for a long period, with many giving over a decade of service. Throughout the DTiF all registered teachers were Non-Indigenous and all the assistant teachers were Indigenous. A feature of the Homelands is the Indigenous and Non-Indigenous teaching team partnership.

Professional context

The DTiF was one of many programs administered by the leadership that received funding on a program basis. The school received a substantial amount of funding through administering these programs in addition to government-allocated funding. Because Opal's leadership and teaching team changed at each data collection point, the values presented by the school leadership and the priority given to the DTiF changed throughout the project. Over the life of the DTiF project at Opal, the multiple programs operating in the school appeared to have been rationalised around the annual school improvement plan.

At DP1, the implementation of the Digital Technologies curriculum was offered to the school and found to be a close match to the values and aspirations of one of the Homelands teachers. This teacher and the Indigenous assistant teacher formed the teaching team for the DTiF and it only operated in the one Homelands school where they were based. The teacher had many years of experience teaching in Homelands with strong relationships into the communities and their relationship with the Indigenous assistant teacher had been curated over years of working together.

At DP2 the project had effectively stalled. The Homelands teacher had left and had been replaced by a new teacher who was not an advocate of the use of ICT. At this time, the project was being renegotiated to include the main school site. The only consistent DTiF team member from DP1 was the Indigenous assistant teacher.

By DP3 the project had been reframed and was based at the main school site. The principal, previously a senior teacher at the school, had taken on the role of DTiF leader along with leadership of a suite of other projects. At this point, teachers were engaged with the professional learning opportunities via the ACARA curriculum officer. The secondary teacher interviewed was just one of many teachers who interacted with the curriculum officer in the DTiF, both through their on-site visit and through the remote support. The teacher had also participated in some of the on-line learning offered through the DTiF.

The Digital Technologies curriculum was competing with reportable outcomes for literacy and numeracy improvement for students across the school, evidenced in the priorities outlined in the School Improvement Plan and teacher interviews. Reporting Digital Technologies curriculum outcomes against the standard ACARA levels was problematic at the secondary school. Many of the students came from a LOTE background and while they may have had understandings of the concepts, had limited skills in report writing and subject-specific language, and no specific background in the Digital Technologies curriculum. For the secondary Digital Technologies teacher, these external pressures created a complex dilemma as the curriculum assumes competent literacy levels in the reporting of student outcomes.
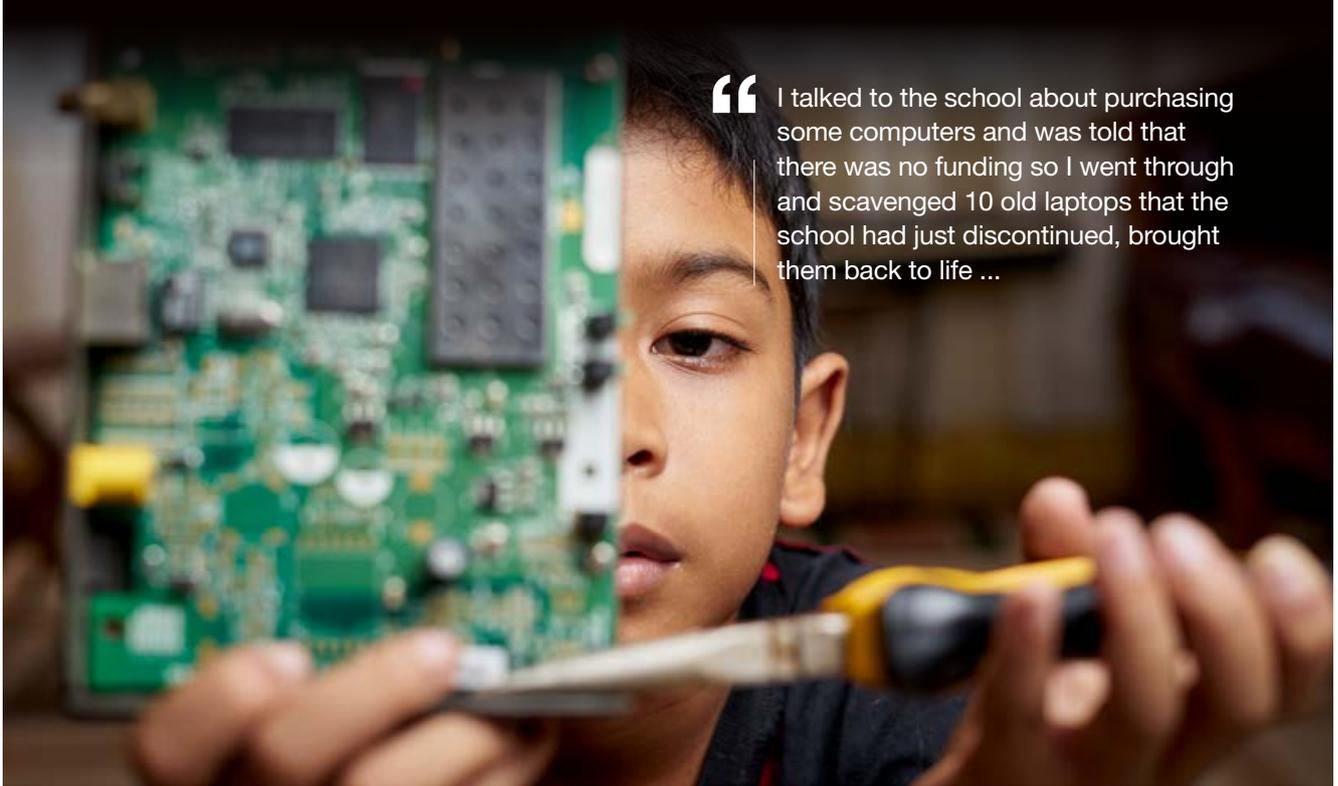
Material context

The material context varied between the school site in the township of Opal and the Homelands. The Homelands teacher lives in Opal and travels to Homelands schools in a four-wheel drive where they stay for the school week. The assistant teacher works with the Non-Indigenous Homelands teacher, who spends at least one day a week with the assistant teacher and students at that Homelands site before visiting another Homelands site. The students and assistant teacher live at the Homelands. The infrastructure is not as well developed in the Homelands school site as in the classrooms in the main school at Opal. The Homelands teacher at DP1 mentioned the issues of funding more broadly in Homelands and how infrastructure spending in Homelands is competing with other priorities in the school.

The Homeland community involved in the DTiF at DP1 has four houses, some with solar panels. There is no mains power so if there is no sun the water pump doesn't work. There was no mobile coverage or fixed line internet provision as part of the infrastructure at the Homelands community where the DTiF was run and the public phone in the community often doesn't work. According to the Homelands teacher at DP1, the mobile phone signal began to fail around two minutes' drive out of the township of Opal. Paradoxically, on any given day most students living in the Homelands have access to a mobile phone.

In the Homelands the devices often travel with the teacher, and connectivity is spasmodic and marginal. This Homelands school had a purpose-built trailer set up for satellite access to the internet which needed computers and devices that were configured with Department of Education settings. However, at the time of DP1 the Homelands teacher was not using the trailer deciding instead to collect computers for the DTiF project with the offline version of software. As the Homelands teacher explained:

> I talked to the school about purchasing some computers and was told that there was no funding so I went through and scavenged 10 old laptops that the school had just discontinued, brought them back to life, got them reconfigured, and brought them out and installed Scratch and the other software we needed onto those so we could actually start using computers.

There were, however, a series of ongoing issues including logging into these computers outside of a stable internet connection. Even though the teacher was running the programs offline, the program was constantly trying to connect to the internet to update, and became unstable. The teacher was frustrated that even though, 'we try not to be reliant on the internet but when it doesn't work, it does pose issues but even to run Scratch you need computers'. At DP1 the project relied on personal mobile phones as a BYOD solution from the students and community to capture videos. The Homelands teacher and assistant teacher saw this as a sustainable use of technology which was already in the community.

The Homelands teacher valued the visit the curriculum officer had made to the Homelands school, which enabled the curriculum officer to learn about the material context of the school. As the Homelands teacher explained:

> [They] witness some of the frustrations that come with our location as well because even little things like some of the computers even when they were there, we had issues with logins and because we're still running through the Department's structure, and sometimes things aren't achieved as easily as they would be if you were outside of that umbrella, but it's just the way it is.

Internet connection in the Homelands relies on an assemblage of infrastructure that is often unstable because any one part of the assemblage—such as a device, operating system, third party software, power or institutional logins—can prevent internet access. The chance of all elements of the assemblage operating as they should at the same time is remote.

By DP3, the project had shifted to the senior primary and secondary classrooms at Opal School main site. These classrooms are well-resourced with computers and/or iPads. The school provides all of the technology used during school sessions. This typically includes iPads and laptops for older students. The school has reliable NBN Wi-Fi and the devices connect to it. There is a range of additional equipment for usage such as a 3D printer, drones, Micro:bit kits and software such as Adobe Photoshop and Scratch.

Project focus, activities and progress

At Opal the project focus had changed at each visit, reflecting the changes in staffing and the positioning of the project relative to other projects in the school and the developing school improvement plan. At DP1 the project focus was in the early stages of designing and testing the use of Scratch software in an offline environment in a Homelands school site. A proof of concept around mapping locations of cultural sites of significance onto a Scratch image of the Country had been developed by the teacher and assistant teacher in collaboration with the ACARA curriculum officer. The assistant teacher and the Homelands school community played a role in developing the videos and the location of sites on Country.

The Homelands teacher felt inspired by this project, and the opportunities to link the community to the design thinking in the Digital Technologies curriculum. They said:

> It's close to home, it had a lot of familiarity for the students already in the regards to the sites that we went to, significance I guess. I guess, for me, that's the hook, is using something like that to then introduce something like Scratch. You've got to have something, I think, that the kids or the adults are already familiar with and have—they're comfortable with as well. We know this stuff, no worries. You want us to use this to be able to show that then we can do that.

The Homelands teacher was using the importance of community sites and Country to scaffold the students' learning in this project. The assistant teacher used a focus on these sites of cultural significance to embed the Digital Technologies curriculum with opportunities of self-determination and sovereignty. As a block coding program Scratch was seen to be a good way to link the students' new understandings of coding to their Indigenous Knowledges.

At DP2 the project had stalled. The new Homelands teacher was given training by the ACARA curriculum officer who demonstrated the use of robotics, Scratch programming and Micro:bits in the Digital Technologies curriculum. The new Homelands teacher reported that:

> I could proceed if I was sufficiently motivated and had the time and resources [but]… I would be honest that the digital side of the curriculum seems to be low in that order of priorities… Like our priorities appear to be numeracy and literacy and I have felt that we've all been pushed for time—they've changed the routine from being out bush four days a week and having one day in town to sort things out. So now we're out Monday to Friday and there's inadequate time to prepare anything, I'm afraid.

This Homeland teacher found the workload unmanageable and with continued implementation of the DTiF contextualised by this large workload, it was not seen as a priority by this teacher. However, the Indigenous assistant teacher reported that the community were still making videos about significant events around the Homelands. However, these videos were no longer being used as part of the DTiF.

> " I would be honest that the digital side of the curriculum seems to be low in that order of priorities… Like our priorities appear to be numeracy and literacy and I have felt that we've all been pushed for time—

By DP3 the DTiF was recontextualised to fit the priorities of project-based learning and secondary subject-area teaching. The project was reworked to fit the context of the senior primary and secondary STEM curriculum at the main school site. The teacher interviewed at DP3 had developed a teaching focus on Micro:bit programming, 3D printing and working with software despite not having high-level digital technology skills. Using the design processes of the Digital Technologies curriculum and with face to face and online support from the ACARA curriculum officer, within a gardening program, the students were able to use the Micro:bits, for reading temperature and humidity and had entered their DTiF project in a Science competition.

> " The teacher interviewed at DP3 had developed a teaching focus on Micro:bit programming, 3D printing and working with software despite not having high-level digital technology skills.

Outcomes for students and staff

To summarise, the outcomes for staff and students at Opal include:

- Conduct of a range of teacher professional learning activities for specific teachers who were involved in the DTiF and also teachers who had an interest in communicating with the ACARA curriculum officer about learning opportunities
- Some increased teacher interest in digital media and equipment
- Further developed collaborative professional discussions amongst teachers at Opal about the Digital Technologies curriculum.
- Increased content knowledge in topics related to the Digital Technologies curriculum such as coding, terminology, design thinking
- Increased pedagogical knowledge around enacting the Digital Technologies curriculum in complex linguistic and culturally diverse contexts
- Beginnings of the integration of Indigenous Knowledges into the Digital Technologies curriculum as culturally responsive pedagogy
- Deeper teacher engagement with the design aspects of the Digital Technologies curriculum
- Connecting the general capabilities of literacy through the Digital Technologies curriculum

Mini case studies illustrating outcomes

The two mini case studies of the Indigenous assistant teacher in a Homelands school and a STEM teacher illustrate some of the outcomes of the project.

Case 1 (OAT1) —
Valuing the assistant teacher

The Homelands where DP1 took place were less than 10 km from the Indigenous assistant teacher's Country. This connection, along with the opportunities of education away from town, give choices to the Indigenous communities around Opal. While the Non-Indigenous Homelands teacher spends a day a week with the assistant teacher and students at the Homelands site before visiting another Homelands, the assistant teacher stays in the Homelands and continues working with the students after the Homelands teacher leaves.

Like the rest of the Homelands community, this assistant teacher, OAT1, preferred to speak several minority Aboriginal languages over English. English is usually the second, third or fourth language that is spoken. One of the roles of the assistant teacher was to translate and ask for feedback from the students and adults in the community about instructions and learning when listening to English. This assistant teacher would do this in the lingua franca of the community, which was a minority Aboriginal Language.

When the ACARA curriculum officer visited the Homelands at DP1, OAT1 was central in translating the instructions and concepts from English into a language that the students and the community members could understand. Without this translation, the Digital Technologies curriculum would not have been enacted and the DTiF would have limited impact in the community. At DP1, the Homelands teacher identified a large part of the role as mentoring OAT1. The DTiF became a site of this mentoring, both on the ground in the Homelands as well as a visit to Darwin when they were inducted into the DTiF with the curriculum officer. The Homelands teacher also valued the place of OAT1 in terms of continuity of the work:

> " At the end of the day, [the assistant teacher's] always going to be here. I'm not, so the more [the assistant teachers] and the other teachers understand the project, the more chance it's got of actually continuing.

The assistant teacher's role in education includes integration of contextually made resources from the community into the broader curriculum context. In this case, the community created videos on Country that were meaningful and purposeful to them which could also be integrated into the purposes of the Digital Technologies curriculum. When the ACARA curriculum officer came out to the Homelands they modelled how the contextual resources could be linked to the abstract ideas of coding in Scratch.

OAT1 brought the extensive language expertise needed to give purpose and meaning to the Digital Technologies curriculum. If the curriculum was delivered solely in English, student engagement would be limited. The relationship between the Indigenous assistant teacher and the Homelands teacher underpinned the success of the DTiF in the Homelands context. One of the challenges of delivering the DTiF in the Homelands school at Opal concerns the translation of the metalanguage used in the Digital Technologies curriculum. At DP2, the assistant teacher was working with a different Homelands teacher who had a focus on other aspects of the curriculum, so the opportunities for continuity in the DTiF were disrupted for the assistant teacher. With the shift of the DTiF from the Homelands to the main school at Opal, where there was a STEM focus, this assistant teacher was no longer part of the project.

Case 2 (OT2) —
Developing fluency with Digital Technologies curriculum content and pedagogy

This case study highlights the learning described by the digital technology teacher, OT2, interviewed at DP3. OT2 described ways in which their engagement with the DTiF had become familiar with the Digital Technologies curriculum, both in terms of content knowledge and pedagogical practices. OT2 had been at Opal for a number of years and had recently become a STEM teacher, reflecting OT2's initial teaching qualifications. OT2 had not taught in the STEM area for some years and was new to the Digital Technologies curriculum.

OT2 noted that the students were very engaged by the Digital Technologies curriculum. This teacher valued opportunities to make the curriculum relevant to the students and said that:

> " I need to find more suitable tasks which are relevant to their daily life, rather than finding something very sophisticated which has no meaning to their life.

Through a 'trial and error' methodology, OT2 developed new pedagogical practices that were meaningful and purposeful to the students. This learning related to areas of the curriculum such as 3D printing, relying on just in time support from the curriculum officer. OT2 gave an example of how appreciative they were of the high quality and timely support the curriculum officer provided when making a solenoid:

> I thought Micro:bit could be applied because Micro:bit can switch on … and switch off or even to reverse. Then I was working with that one, then I got stuck. I flicked an email to [the curriculum officer]. [The curriculum officer] said, '… don't directly connect to the Micro:bit because the amp there is different, so it would blow off.' Then [the curriculum officer] said, 'Probably you are looking for a relay.'

The curriculum officer also updated the teacher with relevant opportunities for professional learning and, as a result, the teacher completed the eSafety course delivered by the eSafety Commissioner. OT2 commented that feedback from the curriculum officer was instantaneous:

> That is happening immediately, almost immediately. 'Here is the link, you just go through this one.' So, any technical issue … I can approach [the curriculum officer] very resourceful, a confident person…can deliver things.

OT2 was learning about scaffolded learning in the Digital Technologies curriculum and looking for new ways to engage students with hands-on experiences that also covered some higher order thinking, something OT2 had previously found disengaging of students because of the cognitive demands and limited applicability:

> As a teacher, when I'm considering next time what task is appropriate for these kids that is meaningful and relevant to their life, that makes them more engaged or … to this technology. Yeah, that is the most challenging thing for me.

The DTiF provided the teacher and with both content and pedagogical knowledge that was relevant and engaging to the students. Although the teacher was only involved in the DTiF in the final year, they were hopeful that the DTiF was transforming their teaching practice:

> And I'm quite happy with… the training that I have received and I'm confident eventually I will be independent and a fluent teacher in this domain.

OT2 self-identified their growing independence with the Digital Technologies curriculum:

> I feel like I've grown up and I know where to look for information and I know how to get help. So, yes, as a teacher, at some stage I have to be independent and I feel that I'm moving towards that. I don't say I'm really quite a confident teacher who can just pick something and start working on but eventually I reach there because of the involvement of this project.

The DTiF has provided this teacher with the confidence to further integrate the Digital Technologies curriculum into STEM teaching. The project gave the teacher more agency and choices over their pedagogy.

> " I feel like I've grown up and I know where to look for information and I know how to get help. So, yes, as a teacher, at some stage I have to be independent and I feel that I'm moving towards that.

Sustaining outcomes

At Opal School the cultural and linguistic diversity at the school intersected with an approach to program delivery that required a substantial amount of organisational expertise to deliver. Because the project constantly changed due to staffing, focus, context and connectivity, the action research aspects of the DTiF were not fully realised at this school.

The Homelands context identified the fragility of the enactment of the Digital Technologies curriculum. At DP1 the DTiF was based on collaborative partnerships between teaching staff and the community, with a foregrounding of community interests. Significant material challenges were addressed through an off-line solution, but were still dependent upon on-line connectivity which was not available in the Homelands school without overcoming a raft of hardware and software issues.

Despite challenging issues, the community-based resources of language, technology and the purposes of everyday life were strong assets to the DTiF in the Homelands. The community members in the Homelands have ways of using technology for social purposes important to them. The mini cases show the potential of transferring resources, skills and values from the community to the curriculum.

The change in personnel following the departure of the Homelands teacher who had an interest in the Digital Technologies curriculum led to a stalling of the project due to competition with other school priorities, before it shifted from the Homelands setting to the main school site at Opal. However, even when the DTiF was embedded in a STEM teaching context at the main school site, the Digital Technologies curriculum was competing with other school priorities. While the material context was more stable at DP3, the staff were learning about Digital Technologies curriculum content at the same time as they were teaching it.

An experienced teacher commented that the sustainability of the program was dependent upon staff motivation and skills. This was critical in times of staff turnover. They said:

> It's a remote thing in general anyway. Unfortunately, things live or die depending on the people that are running it, and if you've got somebody with the right skills and the right passion and things like that, then that's when it worked really well. But… having said the 'live and die' comment—you also don't want it to die… How do we make it sustainable after it's gotten the traction and momentum to start? …I'm pretty sure that the person that was in the role previously would have had those skills and that…sort of go get it kind of attitude. The person that's currently in that role doesn't quite have the same attitude and skills with regards to technology and things like that. So, it's definitely hit a bit of a road bump.

In the complex context of disadvantage at Opal, the delivery of Digital Technologies curriculum is fragile. However, there are opportunities of hope where this complexity is acknowledged in curriculum design to include Indigenous Knowledges and a wealth of other resources in the community.

Pyrite Secondary School

The data collected for the Pyrite case study had three data collection points. Five participants were interviewed over the three years of the program. The DTiF leader, who was the school's Digital Technologies Co-ordinator and the only person who was involved in the DTiF, was interviewed at each data collection point. The DTiF leader was well-established at the school, having been a prior student and school student leader and had been a teacher there for five to ten years. At DP1 the principal was interviewed informally, as having served a long term at the school, and was about to retire, did not want to do a formal interview. The school has positioned Digital Technologies within Science, rather than with the other technology subjects, which were conflated with the arts. The Acting Science Co-ordinator was also interviewed. At DP2 and DP3 the newly appointed Science Co-ordinator was interviewed. At DP3 the new principal was also interviewed and the DTiF leader/Technologies teacher was shadowed for the day, and two double classes were observed in addition to call-outs for IT help. The documentation collected at DP3 included the current school curriculum.

Situated context

Pyrite is a co-educational government secondary school for Years 7-12. It is located in an outer regional town, but the school services a much wider district, with many students travelling in to town to attend. The region in which the school is situated has a mix of farming and tourism, with some light industry nearby. There are more than 500 students with almost equal numbers of male and female enrolments. The school has an Index of Community Socio-Educational Advantage of over 950 with around 75% in the lowest two quartiles. It has almost 15% Indigenous students and over 10% students from a language background other than English. No statistics were provided about the numbers of Indigenous students who spoke Indigenous languages, but the local primary school taught a local Indigenous language, which had been improving the relationships between the Indigenous community and the schooling system.

Staffing at the school was very stable apart from a change of principal. The former principal was retiring at DP1 after serving for a long time, and the new principal had a strong commitment to the school and could see value in the continuity of the DTiF. When the DTiF leader started teaching at the school, there was minimal time spent on Digital Technologies, and this time tended to be focused on basic skills such as using Word and graphs. DTiF has enabled the DTiF leader to build the technology culture at the school and to strengthen this curriculum area.

Professional context

The DTiF leader was the only teacher at Pyrite who participated in the DTiF project and taught Digital Technologies as a stand-alone subject from Years 7-9 Seven to Year Nine as well as Maths and Business Studies. The DTiF leader was also in charge of the ICT systems for the school, which is a commitment greater than the allocated hours, and is on call when teaching. The aim of the school through the DTiF was to introduce the Digital Technologies Curriculum and to build the take-up of Digital Technologies at the school. This teacher was extremely interested, committed and engaged, and the program at the school relied heavily on good will, weekend labour and enthusiasm to keep the school infrastructure up and running. Being a former student, the DTiF leader had a strong commitment to the region and school community.

Throughout all the data collection points, the DTiF leader was extremely enthusiastic about the level of encouragement from the DTiF project, appreciating the one to one support from the curriculum officer, the professional learning opportunities, and, especially, the professional networking. The teacher valued, 'just having someone to ask, "Hey, do you know anybody who is into this?", or "Do you know anybody who is struggling with this?"'. Being from a relatively small and isolated secondary school, having the opportunity to network with others was invaluable, as evidenced through this comment:

> " It's just, it's so comforting as a teacher to just not be in your own little, especially where we are—we're [over 50] k's from the closest high school—you're just not in your own little world trying to email people that you have no idea who they are, and you've just got a face, someone to talk to and sort of point you in the right direction.

The DTiF leader felt highly supported by all levels of leadership to implement the Digital Technologies curriculum. Digital Technologies was located within the Science Curriculum at the school and he was appreciative of the support of the Science Coordinator. At DP1 it was well supported by the outgoing principal who had been extremely supportive of the development of the Digital Technologies curriculum and had forged strong links between the regional Education Department office and the school. This had resulted in a series of opportunities for the school to develop their Digital Technologies infrastructure and equipment as well as their Digital Technologies curriculum capabilities.

With the long-serving principal leaving, the project was delivered in the shadow of leadership change. Initially the teachers were concerned about what this might mean more broadly beyond the scope of the program, however, by DP3, the DTiF leader and other staff were satisfied and felt supported by the new principal who valued the continuity of existing programs and the work of the DTiF leader, particularly the deep commitment brought to the subject and the work done on physically maintaining the internet and Digital Technologies infrastructure. The principal noted the DTiF leader's deep subject knowledge and that the students really loved the classes.

Throughout the project, the DTiF leader and the Science Coordinator discussed ways that the Digital Technologies curriculum was being integrated across other subject areas with other teachers. The DTiF leader was very keen to build collaborative practices with other teachers around the Digital Technologies curriculum and had a commitment to build resilience, motivation and ambition amongst the student body. The teacher saw that the Digital Technologies curriculum and electives could help to do this through harnessing the students' outside of school interests and bringing these into their school studies. Both teachers felt that this led to increased student engagement and commitment to school. Many of the approaches that were undertaken over the course of the project, such as visiting a regional university, developing an outreach program where the Year 9 students worked with children from the local primary schools and peer mentoring and support within the school, were designed with the multiple purposes of developing, promoting and extending the DTiF and wellbeing for students. DTiF can be integrated into projects beyond just the subject area of Digital Technologies. The DTiF leader was always open to and looking for members of the community and institutions outside of the school who were prepared to collaborate.

The DTiF leader was extremely appreciative of the work of the curriculum officer:

> This whole process—that is the DTiF milestone process—the key success or the key reason I think for this being successful is having one person from start to finish, that's [the curriculum officer] being involved with this—[is] awesome… But [they are] the one that I think should be commended for making this work. The structure's great but if you don't have somebody like [them] behind the scenes, touching base and giving you little bits of information and updates… it would soon lose momentum.

Apart from the Digital Technologies curriculum, the school was struggling with the changes required to the technology curriculum overall with the implementation of the new Australian Curriculum. In particular the principal noted the focus on 'technology' in subjects such as 'Food Technology' and 'Manual Arts and Design' as being a big shift in how the subjects need to be taught and that teachers were struggling to make them engaging and meet the requirements of the Australian Curriculum.

In contrast, the Digital Technologies curriculum, being new, was advantaged as it was easier to introduce something new than to rework something that was established This meant that the ACARA curriculum officer was attending the school on a more regular basis to support other curriculum areas.

The school had some regional support for the development of the ICT general capabilities, but the ACARA project was the most sustained support. At DP3, the new principal noted that it would be helpful to have support available across the curriculum in a range of areas to develop the general capabilities and a deeper awareness of Digital Technologies across the school. Regional support around Digital Technologies and the implementation of the ICT cross-curriculum priorities has become less over time. The DTiF could be seen as an opportunity to support the cultural change in the school. The principal noted that for some subjects there was a lot of displacement of teachers and the new focus for them has caused some pain and lack of confidence. The principal was appreciative of the ACARA curriculum officer in this regard. The curriculum officer had been very supportive of all of the areas of technology at the school.

Material context

Across the three data collection points, the DTiF leader returned to the material contexts of the infrastructure, technology, space within the school, and allocated time for teaching Digital Technologies as recurring issues. The school did not receive adequate funding for Digital Technologies infrastructure and struggled to supply the appropriate resources and number of devices needed. The Digital Technologies curriculum requires a certain amount of infrastructure to run in a secondary school context and one of the mitigation strategies tried by the school was to encourage students to bring their own devices.

The Bring Your Own Device (Laptop) program had a low take-up rate, which frustrated the school leadership, as families were willing to purchase phones but not laptops, citing that the laptops were too expensive or that they were philosophically opposed to the use of technology. This led to the BYOD program having a limited impact on the requirement for school provision, as noted by the DTiF leader:

> There's no classes here where the kids have to provide their own device for that class and that's goes back to that whole equity thing. I've literally had parents on the phone almost screaming down the line saying that is not fair. Like when it was—there was a push on for elective subjects in senior for kids to bring their own devices and these parents couldn't afford it, you know?

Some parents were opposed to the BYOD program, which was frustrating for the school.

The school had some computers in a lab style arrangement and these were used in classes. Many of them were 'Rudd computers' from the global financial crisis stimulus package. There had not been very much investment in the technology in the school. These 'Rudd computers' were looked after, reimaged and kept going and, while the original allotment were not all working, in late 2019 there was still enough working for one computer lab.

The small peripheral equipment (such as micro:bit toolkits) was supplied for the Digital Technologies classes, however there were not enough for all students, so some equipment had to be shared. In the Year 9 elective Digital Technologies class, in every lesson a group of students does not have access to equipment so they follow a roster system and change who is sitting out of the class due to a lack of equipment. The students sitting out write up the next steps—for instance, they write the Arduino code—and then try it the next lesson. In the class observed, the students were very accepting of this arrangement, and the reminders and negotiation were minimal. The students impressively all entered, checked who was working on bookwork and began.

In addition to teaching, the DTiF leader also had oversight of maintaining the school's network and computers and is allocated three periods a week for that work. This role is a technology maintenance role and the trouble shooting involved in the role takes far longer than the allocated time. The principal appreciated that the teacher utilised his Digital Technologies skills through this role supporting the computational infrastructure in the school. During the Year 9 Digital Technologies class observed, the DTiF leader was called out to deal with an infrastructure issue, and the students kept working. Additionally, the teacher was called out during lunch break to fix some Bluetooth speakers in the school hall. This technological maintenance work took away from teaching work and it was burdensome, despite the praise and reliance from the principal.

Project focus, activities and progress

The project and its successes at Pyrite has given the DTiF leader status and a platform from which to request more time in the school program and a dedicated classroom for Digital Technologies. The sole aim of the DTiF at Pyrite was to establish the Digital Technologies curriculum, so from this perspective the DTiF has been very successful. Since the beginning of the DTiF, Digital Technologies is compulsory for all students in Year 7 and is an elective for Years 8-9. The Digital Technologies elective class has been very popular with the students, and the DTiF leader and Science Coordinator are planning for the elective to continue into Year 10, with the hope that in a few years Digital Technologies will be offered from years 7-12.

At the beginning of DP1, with the principal about to leave, the Acting Science Coordinator and DTiF Leader were concerned about the internal support that they would receive for their plans to fully implement the DTiF.

Outcomes for students and staff

- Initiated the complete cohort of Year 7 students studying Digital Technologies
- Initiated a Digital Technologies elective for Years 8-9
- Supportive mentoring for the DTiF Leader to teach the Digital Technologies curriculum
- ACARA curriculum officer provided support for all areas of the Technology curriculum at the school
- There has been significant progress in establishing and developing the Digital Technologies curriculum at this school
- The DTiF Leader has been raising the awareness of the Digital Technologies curriculum in the broader community through running high-profile community activities. This has helped to cement the standing of the Digital Technologies curriculum in the school and community

The Digital Technologies teacher and Science coordinator continued to campaign to have a dedicated room and storage space for Digital Technologies and for Digital Technologies to be a compulsory subject in Year 8. While the program was supported in many ways, these were the two areas identified where they were hoping to make progress. The room and storage area, in particular, were raised throughout all data collection points as a source of frustration in terms of delivering the Digital Technologies curriculum. By DP3, there was a storage area, but no dedicated classroom, so the equipment had to be carried from classroom to classroom. The DTiF leader noted:

> It's a logistical nightmare to sort out teachers and classes and classrooms and all that sort of stuff. So, it is what it is, but this is that whole continuing to stake out our territory—Because when I started it was no digital tech offered for any electives at all and then the Head of Department at the time would come down and fight the fight and then it would come back and a new elective thing would come out and it would be on there—It was like that continually—but now at least some space is staked out, but it just needs to be stretched and staked out a bit further.

In many ways, the 'staking out' of a dedicated Digital Technologies classroom represents consolidation of the subject in the school curriculum. The provision of space and time—the dedicated classroom and a shift from elective status to a compulsory subject—would stabilise the Digital Technologies offerings in the school and enable the DTiF leader to have a solid base from which to progress the curriculum to the senior years.

Mini case studies illustrating outcomes

Pyrite school illustrates some of the features of the DTiF when run in a secondary context. For instance, as we have seen, the DTiF leader had responsibility for the governance, teaching, finances, reporting and delivery of the Digital Technologies curriculum. The DTiF leader was the sole collaborator around Digital Technologies with the ACARA curriculum officer, and was the champion of building the Digital Technologies curriculum. This case exemplifies what is possible when a teacher is entrusted with the responsibility of the program in contrast to the other case study schools where the DTiF was generally governed by principals and assistant principals, who had their own multiple agendas. The mini-cases described below are not of people but of practices.

Case 1 —
Year 9 Technology Showcase and student-led community outreach

Since the beginning of the DTiF project, the school has held a technology 'Showcase' day once a year. The action research project is about improving ICT capabilities across the whole community, not just the students in school, so this day provides outreach to the broader community.

The day is run by the Year 9 Digital Technologies elective students and aims to showcase the Digital Technologies curriculum work being completed in the school. Primary school students from the area, family and other community members are all invited to the school for the Showcase. Year 9 students train the junior students or teach the primary students about a technology. The Year 9 students are given eight weeks to prepare. They are told that the choice of technology is up to them. This provides for a very open and creative approach and the DTiF Leader noted that, 'all of the stuff that comes out of the woodwork through that process is really amazing'. The Year 9 students worked together in groups to run a 60-minute session on their topic. At DP2, 120 primary school students came to Digital Technologies Showcase Day, and the students offered the topics of drones, virtual reality, information management systems and building computers.

The DTiF leader, and the Science coordinator reported the many positive benefits of the project, including the benefits for the primary students transitioning into high school. The DTiF leader said:

> It's really good for the students who actually host it because they—most of them have some idea or some interest in that technology to start with so they're pretty good at it—but when they get tasked with having to actually teach it and develop a challenge for little kids, they've got to become, I guess, the masters of it.

As well as mastering the technology, they also develop public speaking skills and it is a 'really good confidence booster'. The DTiF leader describes this as particularly being the case for the 'techy, geeky type kid who doesn't really like talking', and reported that these students have become more engaged with the school.

Because there is only a very small budget for the showcase, it requires a considerable amount of work on the part of the teachers to set it up and bring together the resources to enable it to function well. The showcase takes two days on the weekend for DTiF leader and other colleagues to set up. At DP3, the showcase was set to go ahead. Because the school was in a flood-prone region flooding in the third year of the project caused a significant disruption to the showcase. It was set up over a weekend, but then had to be dismantled and rescheduled due to extensive flooding in the region. Over the flooding season, the school was closed four times due to the flooding. The teachers packed away the showcase and then reassembled it later in the year. Despite this frustration, The DTiF leader and the Science coordinator both felt that it had been worthwhile. Resilience in this case study was demonstrated by the DTiF leader's interactions with the school community, the innovative ways of resourcing the DTiF and the workaround for the Showcase Day because of the constant flooding.

Case 2 —
Technology connections between home and school

The DTiF leader noted the connections that the young people were making between their out-of-school interests and skills and the Digital Technologies curriculum. There were a group of Year 9 students from farming families who brought their own drones to school, together with footage that they had made themselves. The footage was of racing, flying over landmarks and photography of beautiful natural landscapes. The DTiF leader was enthusiastic as that:

> …stuff has got nothing to do with us at the school, that's just their own passion that they have at home and this sort of allows them to bring that into the school and just show it off, and all the kids are really, really excited by that because it's sort of a lot more authentic.

Another student, who had high level skills and interest in Virtual Reality (VR) technology, had been given the role as the school expert on VR. When the technology classes used the VR in class, this Year 10 student was called in as a guest speaker. His role is to explain to other students how he uses it, and he brings in his laptop to demonstrate video games that use VR and provides information about other aspects of VR, such as how to wear the goggles properly. The DTiF leader was always looking for these kinds of connections that students would make between their out-of-school interests and the Digital Technologies curriculum. He saw promoting students in this way as building up their capacities and skills as well as demonstrating what was possible to the rest of the school community.

Case 3 —
University-based Digital Technologies challenge

Pyrite students have also been involved in a Digital Technologies challenge based at a regional university. Twenty-five students from the school went to the university and completed a series of eight design challenges, including, for example, building towers to survive earthquake simulations and building vehicles to navigate Martian terrains. The DTiF leader was very proud of way the students worked together at the challenge and said, 'our kids were outstanding'.

The DTiF leader described that many of the schools who were involved in the Digital Technologies challenge were wealthy private schools. These schools were extremely well resourced, in terms of both equipment for the Digital Technologies curriculum and top-quality computing infrastructure at the schools. With both government funding as well as parental fees, these schools would typically also have support from technical officers who would take care of all of Digital Technologies infrastructure, freeing up the Digital Technologies teacher to focus on teaching.

> **Pyrite Secondary School finished in the top three schools in the challenge. The DTiF leader explained that students benefited from seeing that they could achieve great things in this area. He also thought that this involvement would help them to succeed at the university, by going to the campus to look around and imagine themselves studying there in the future.**

Through the involvement with this program, the DTiF Leader had also been running a Digital Technologies camp in collaboration with a regional university. He described that they had access to some additional equipment and technology through the university. At the camp they:

> … utilise[d] some people from the uni already to help us do the activities that we are used to do, but now with some of this other equipment and technology I think that we will start to be able to contribute to some projects that they are going to be doing which will be good because that's another connection outside of the school.

This partnership with the university was fruitful in terms of providing some additional support for the teacher.
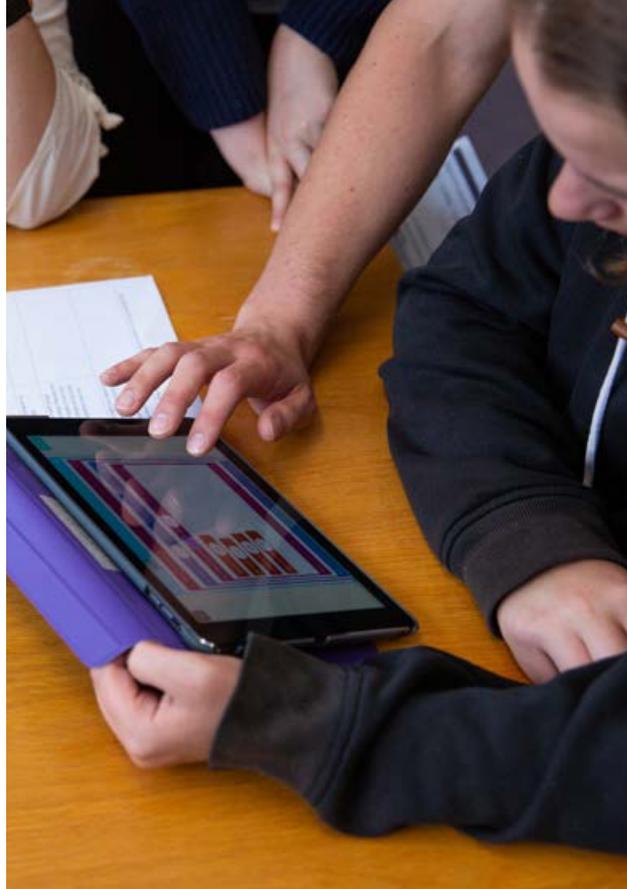
Sustaining outcomes

The sustainability of this program was dependent upon the staffing. This case had a very stable staff, as evidenced by the one DTiF leader who was teaching the Digital Technologies curriculum over the entire life of the project. This led to innovations, development and curriculum expansion. This DTiF leader was central to the Digital Technologies professional learning in the school. They were a champion of the subject area and ever ready to promote the subject and expand the understanding of Digital Technologies into the broader community. They were also well positioned to make use of any opportunities that came their way, through the networks that were made available to them through years of being at the same school, and the connection they had to the community more broadly.

The Science Coordinator and the DTiF leader had been advocating for a dedicated classroom for Digital Technologies. While they had been successful to date to obtain a storage area for equipment, the necessity for a dedicated teaching space was an ongoing request. They believe that were the school to provide a dedicated classroom that this would enhance the sustainability of the Digital Technologies program. The provision of such a room would also reduce the burden of having to constantly collect and return the Digital Technologies equipment to the storage locker throughout the day. The logistics around resourcing the Digital Technologies lessons took up significant amounts of teaching and learning time each session. The supply of the space would also be a significant acknowledgement from the school leadership of the value placed in the program, as it is with other dedicated spaces in the school as is typical in secondary schools.

Analysis Across Case Study Schools

Complexities, fragilities and successful strategies

The challenges, opportunities and successes evident in the case study schools are discussed with respect to the three dimensions of context used to introduce each case study:

- Situated context (such as locale, school histories, demographics and settings)
- Professional context (such as values, teacher commitments and experiences, policy management, and approach of leadership)
- Material context (such as staffing, budget, buildings, technology and infrastructure) (adapted from Braun et al. 2011)

Under each dimension the complexities and fragilities involved in undertaking school-based action research to support implementation of the Digital Technologies curriculum are identified. In addition, responses to these complexities and fragilities by school-based DTiF stakeholders are discussed including the ways responses speak to the specificity of the contexts of each school at the time of the DTiF. These responses include innovative approaches that the DTiF stakeholders have developed and implemented with support from this project. The stakeholders included members of the school leadership teams, teachers, assistant teachers, and students, who were all guided by or variously impacted by the support from the ACARA curriculum officers.

Structural disadvantage and ongoing disruption

In each case study school, intersecting sources of disadvantage were evident. Consistent with this disadvantage, the case studies revealed multiple complexities and fragilities related to the locale, school histories, demographics and settings at each site. In this section we revisit the cases and consider structural disadvantage that framed the DTiF in each case. This is not an exhaustive analysis for each case, but gives an indication how structural disadvantage intersected with local fragilities to create significant challenges for each school with respect to engaging with the DTiF.

The postcodes of many of these school sites are stigmatised in the public domain due to their disadvantage for reasons such as: locations that are close to correctional facilities, housing commission estates and towers, disadvantaged rural communities, and Indigenous communities. Despite this, we noted the high levels of hope and commitment in the school communities amongst leaders, teachers, students and families. At Jade, while the principal was focusing on developing community relationships, the site had a long and strong legacy of violence that had resulted in the fencing of the school, usage of video cameras, and establishment of a good behaviour contract for each visitor. Similar security measures existed at Quartz, where theft and vandalism had previously affected the site and where there were concerns that some children might leave the site without permission. Flooding at Pyrite disrupted the school timetable and community engagement. The teacher turnover at Opal and Amethyst—with key DTiF staff leaving the school across the life of the project—meant that programs and student learning activities were sometimes disrupted or inconsistent. Intergenerational trauma beseeched Emerald, Amethyst and Quartz. Both Amethyst and Jade were impacted by bush fires during the project. These aspects of the situated contexts have an ongoing impact on the schools in this project, and this structural disadvantage is beyond the scope of the DTiF. However, to enact the DTiF in all the case study schools required DTiF leaders, teachers and students to negotiate aspects of disadvantage that foreshadowed learning success.

The histories of disadvantage at each site are ingrained in the situated context of each school, and present teachers with a complex set of challenges where curriculum and teaching plans are fragile, and subject to ongoing and emergent local happenings. While the targeted support of the DTiF made a very positive impact in all cases, each project required a nuanced approach that responded to the specific disadvantages and emerging situations at each school. For example, each site experienced random events that brought chaos from time to time, demanding immediate attention, and usurping the curriculum. The teacher at Pyrite—

who also provided technical support across the school— on one occasion had to leave class to close the school email server as a parent was sending abusive messages to school community members. At Jade, the school was dealing with students who broke windows. At Amethyst, the inability to secure relief teachers to teach the classes of teachers who were ill meant that teachers and leaders taught crowded classes. At Emerald, the DTiF leader was also the relief teacher. While these individual situations and instances seem manageable, they are examples of interruptions that occur regularly in disadvantaged schools and demand urgent response, and they impacted the continuity of the schools' engagement with the DTiF. Much of the time these local fragilities were beyond the control of DTiF leaders and teachers. In more financially advantaged schools, funding reduces these types of interruptions. For instance, at Pyrite, if technical support was funded via a dedicated position, the Digital Technologies specialist teacher would not have leave class to respond to urgent technical issues. Where structural disadvantage intersected with the fragilities of the specific school sites, discontinuity of school programs becomes normalised despite the DTiF leaders' commitment and innovation towards delivering the Digital Technologies curriculum.

Community partnerships, general capabilities and student engagement

In this section we discuss successful strategies used by teachers and leaders through the DTiF to respond to the fragilities and complexities arising from the situated contexts. While the DTiF was not designed to address these historical and structural problems, the case studies revealed that DTiF leaders and teachers were positioning the DTiF program alongside other programs intended to address pressing needs at each location. Teachers and DTiF leaders brought a high level of expertise, local knowledge, perseverance and commitment to the development of strategies for negotiating disadvantage at each site. The DTiF aligned with this commitment, providing additional impetus and support that complemented and extended existing school-level agendas.

> " The curriculum officers were not only supporting the teachers' professional understandings of the curriculum, they were also working with DTiF leaders to develop a strategy of how the DTiF could be negotiated within the specific context of disadvantage at each school.

The DTiF was implemented in schools that already had successful strategies in place to negotiate specific aspects of disadvantage. Some of these programs were ongoing and had links to the general capabilities of the Australian Curriculum. Far from constructing deficit notions of student learning, leaders were looking at communities as rich resources that could be integrated into the DTiF. The three-year project design of the DTiF aligned well with schools that had long-term strategies for addressing disadvantage. The project offered opportunities to form relationships with the ACARA curriculum officers, who in turn supported the teachers' and DTiF leaders' journeys in addressing these structural issues of disadvantage as they built conditions that would support successful implementation of the Digital Technologies curriculum. The curriculum officers were not only supporting the teachers' professional understandings of the curriculum, they were also working with DTiF leaders to develop a strategy of how the DTiF could be negotiated within the specific context of disadvantage at each school.

Partnerships beyond the schools with organisations and communities were resource for promoting Digital Technologies. For instance, at Pyrite the Digital Technologies teacher organised for the secondary students to work in collaboration with the regional university. The aims here were both to promote the Digital Technologies curriculum and to expose the students to a university, including the threshold crossing experience of walking through the university spaces and imagining that they might one day attend there. Thus, via this partnership, the teacher was both

delivering aspects of the curriculum and trying to expand the imaginary of students' life choices. At Opal, the teacher and the assistant teacher worked in partnership to embed Indigenous Knowledges in the curriculum. Through the DTiF this partnership was nurtured during a shared trip to the capital city for professional learning facilitated by ACARA. The curriculum officer collaborated with the teacher and assistant teacher in ways that continued their respectful relationship with each other, the foundation of their successful teaching. The school community welcomed the opportunity to embed Indigenous Knowledges into the curriculum. The DTiF was strengthened through respecting the partnership between Indigenous and Non-Indigenous teachers.

> " The DTiF was strengthened through respecting the partnership between Indigenous and Non-Indigenous teachers.

As an integral part of their professional practice of knowing their students' learning strengths (AITSL Standards 1.1 and 1.3), many teachers provided highly contextualised resources that produced high levels of student engagement and interest in the curriculum. Teachers used their own agency to weave the opportunities of the DTiF into the general capabilities. A common example was the links that teachers made between strategies to build students' general ICT capabilities and opportunities for Digital Technologies curriculum learning. Literacy was also a common focus. At Amethyst, efforts to embed use of robotics in literacy learning supported both the literacy learning of traumatised children in non-family care situations as well as promoting attendance and engagement of students who proved difficult to engage due to disconnection with schooling and transient and sporadic attendance. At Jade there was a positive behaviour program in place to negotiate the intergenerational low socio-economic disadvantage. The students' engagement in the Digital Technologies activities became a feature of this program to support the reinvigoration of the school. The wellbeing program at Jade was linked to Personal and Social Capabilities. Some of the tasks completed by the students in the DTiF at Jade promoted self-management and self-awareness of their own learning and potential. This was highly valued by the principal as forwarding aims of the strategic plan.

> " efforts to embed use of robotics in literacy learning supported both the literacy learning of traumatised children in non-family care situations as well as promoting attendance and engagement of students who proved difficult to engage due to disconnection with schooling and transient and sporadic attendance.

Cross-curriculum priorities were also an important consideration at some schools. For example, teachers at schools linked to Indigenous communities expected students to learn all aspects of the STEM curriculum without stereotyping the cultural and linguistic resources that the students brought to school.

Many of the approaches developed across the DTiF were context specific. At all of the case study schools, data suggests that involvement in the DTiF had promoted student engagement in schooling, with the teachers developing new knowledge about how the Digital Technologies curriculum might offer ways of engaging particular students. Teachers provided examples of how Digital Technologies learning provided a vehicle for engaging students who were previously marginalised in the classroom. For example, at Emerald creative design opportunities in the Digital Technologies curriculum, such as stop-motion animation, were engaging for the students. Additionally, there were numerous opportunities for self-directed learning in the Digital Technologies curriculum at Emerald for students who had spasmodic attendance. At this school the teacher described how the StickBot app was used by students in ways that drew high levels of engagement and interest in a project-orientated approach towards the Digital Technologies curriculum. This case highlighted benefits beyond Digital Technologies learning, such as identity, wellbeing, building commitment to schooling, enjoyment and, as one teacher described, 'magic!' At Amethyst, the lure of robotics dramatically impacted on student attendance and engagement, with formerly marginalised students becoming curriculum experts and peer tutors. In both schools, students with histories of low attendance were included in the project in meaningful ways that motivated them to come to school. At Pyrite the Digital Technologies curriculum was developed to be inclusive of everyone, and the teacher described how the cohort included students who were not engaged generally with their schooling. However, many of the activities, such as developing skills with drones and programming the Arduinos, were engaging for these students. Similarly, at Quartz, the Digital Technologies curriculum was used as a vehicle for engaging previously disengaged students and building inclusion and positive classroom identities. Students with additional needs, and those who for other reasons had not previously found a productive place in the classroom, were often described as meaningfully engaged in the Digital Technologies curriculum compared with other learning they were doing at school.
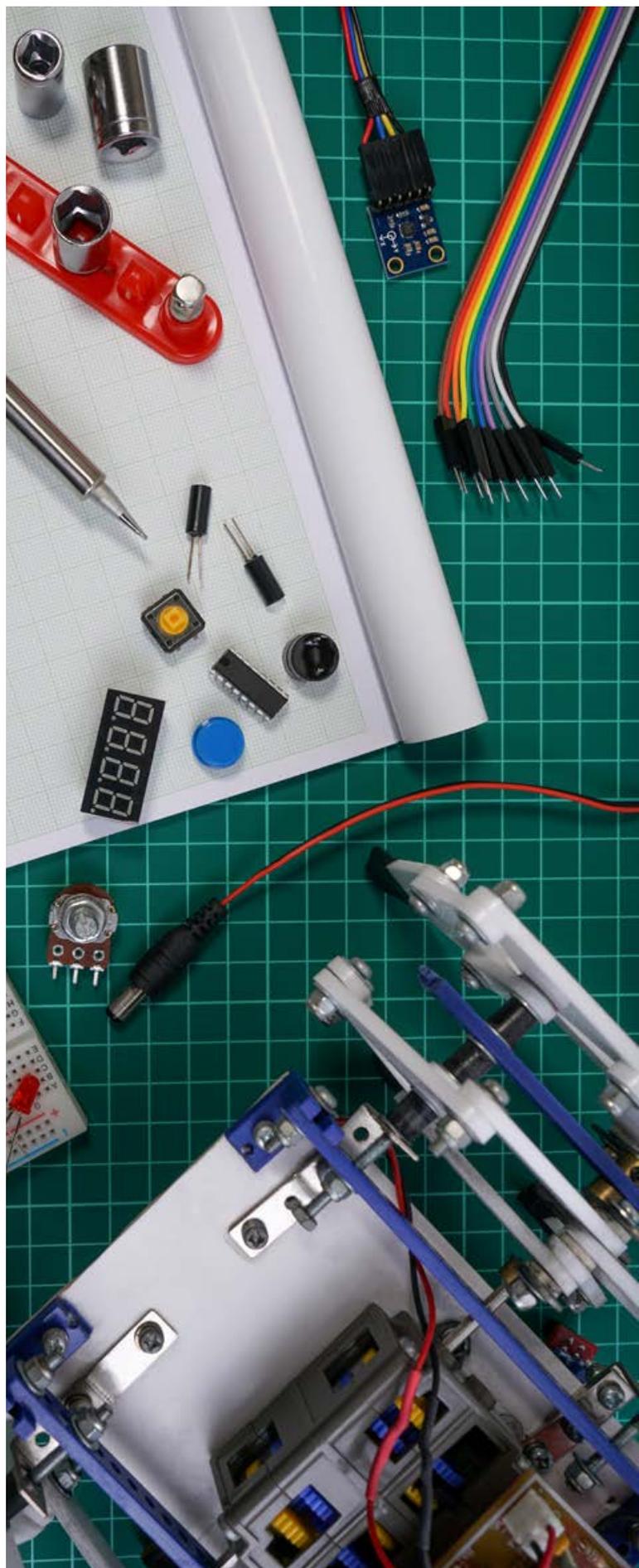
Competing priorities and teacher ICT capabilities and dispositions

The DTiF project revealed how the professional contexts—including teacher commitments and experiences, policy management, and approach of leadership—were intricately linked to both the situated and material contexts of disadvantage at each site. In this section we discuss some of the complexities of the professional contexts that impacted the work of teachers and principals in the school during the DTiF and influenced the approach to and continuity of engagement with the DTiF. Sources of professional complexity included schools' engagement with numerous (sometimes competing) interventions and projects—some of which were positioned as more urgent or were more highly monitored than the DTiF—and professional fragilities related to teacher ICT capabilities and dispositions which were influenced by the material contexts of the schools. These professional complexities and fragilities impacted commitment to the DTiF and the ways in which the project was run in the schools, with the action research part of the DTiF being particularly vulnerable to shifting priorities and demands.

In the primary settings, we noted that not every teacher in the school was interested in implementing the Digital Technologies curriculum. Teachers bring to school varying histories and dispositions towards ICT that influence their views on Digital Technologies. There were examples of teachers who were becoming more familiar with the curriculum and learning how specific devices and peripherals might be used to support it immediately before teaching it to their students. At Opal the professional context of 'just in time' learning created a fair degree of unpredictability and stress on teachers in addition to restricting the pedagogical approaches. Supporting teacher ICT capabilities were seen as an important part of implementing the Digital Technologies curriculum in primary settings. For example, teacher professional learning in Digital Curriculum was the focus of Amethyst's action plan. Some teachers resisted this opportunity, for example in the case of Amethyst, one teacher allocated responsibility for weekly implementation of Digital Technologies curriculum to a relief teacher. At some schools, whole of staff development of skills and confidence in the use of ICT was a deliberate strategy to support the implementations of the Digital Technologies curriculum.

For example, this was seen at Quartz where all teachers were supported to reflect on their skills, to use digital tools in professional learning sessions and to develop and implement lesson plans that used digital equipment. In this school, teachers reported significant growth in their skills and confidence across the period of the DTiF.

In secondary settings there is not the same impetus for all teachers to implement Digital Technologies because of the subject-specialist approach to curriculum in secondary schools. At Pyrite, for example, the Digital Technologies teacher was allocated to this subject and had majored in this area at university. Even if teachers are teaching out of field in the secondary context, there is a strong motivation to develop knowledge in a subject that is part of their teaching load. While in secondary contexts, Digital Technologies teachers are highly motivated to develop and implement Digital Technologies curriculum as a function of their professional position, in small regional schools these teachers need to look outside of their schools for professional networks and can also be allocated other technical and leadership roles related to technological infrastructure, as was the case at Pyrite.

DTiF leaders identified the complexity of their role in managing multiple projects. The DTiF had varying priority amongst other school projects during the three-year evaluation, in part because the school reporting of the Digital Technologies curriculum did not hold the same status as literacy and numeracy. In some schools the Digital Technologies curriculum did not have a central place in the school's professional learning agenda and improvement plan, and in some cases the positioning and valuing of the DTiF was disrupted due to staffing changes. At the beginning of the project at Opal, the DTiF project was one of a myriad of programs in the school but was supported because it had a particular good fit to the interests and expertise of a specific teacher in the school. This investment by one staff member at Opal led to disruptions when this teacher later left the school. This contrasted with Jade where the DTiF was a central priority for the principal, aligned with wider school agendas. Staffing changes and the variation of leadership commitment across schools is one of the complexities and potential sources of fragility in delivering the DTiF.
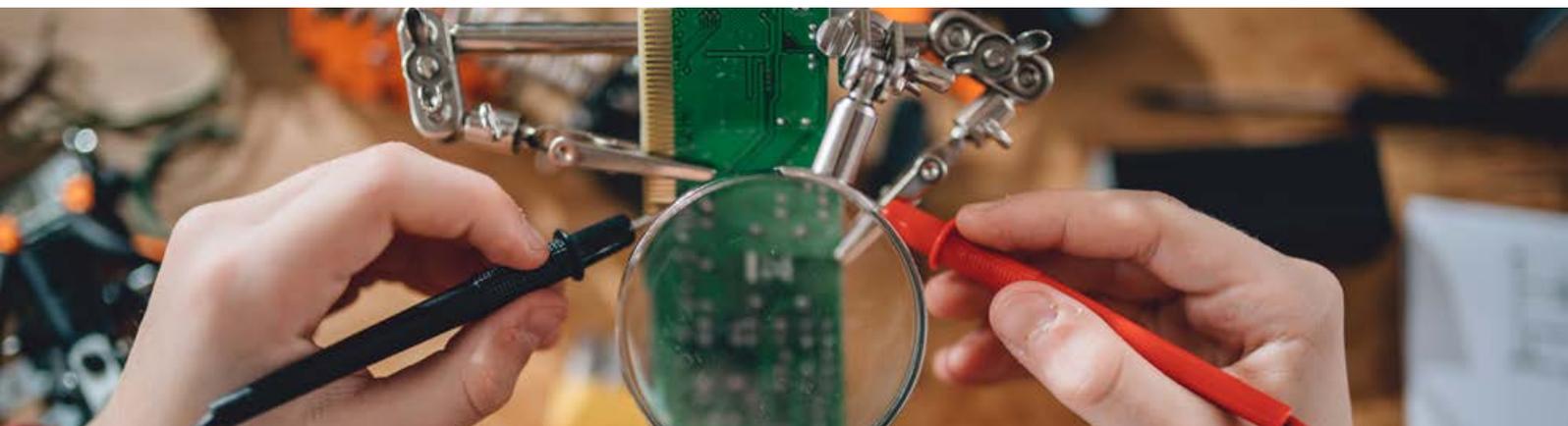
In the case study schools, the action research component of the DTiF was particularly vulnerable to the complexities and fragilities of the professional contexts. The action research projects were difficult for schools to develop and maintain, and they didn't articulate in clear ways with the institutionalised processes and documentation of the schools. This made it difficult for teachers to value and resource the work required for the action research projects. Across the case study sites, we saw little evidence of the action research projects being fulfilled as research projects, even though many positive and impactful projects were conducted under the DTiF. Where action research data was collected, this was viewed as a performative aspect of the DTiF work. The systemic issues of disadvantaged schools, such as frequent staff turnover and impermanency of leadership, also disrupted the action research projects because it was difficult for new teachers and school leadership to pick up action research projects that other people had started. This is partly because action research is nuanced and particular to the person undertaking the research. Across the cases, the teachers and DTiF leaders were much more interested in developing the Digital Technologies curriculum resources and associated pedagogies than researching their process and collecting evidence of outcomes. Teachers reflected that they had other pressing priorities that overshadowed the action research requirement of the DTiF. Much of the reflective practice function of an action research project was fulfilled through the opportunity to have frequent and focused pedagogical discussion with the curriculum officers.

There were fragilities in the professional contexts in the case study schools that relate to the breadth of generalist knowledge expected of primary teachers. To many teachers the primary curriculum is crowded with content and the Digital Technologies curriculum is often picked up by teachers with interest in technology and design outside of school. Personal device use varies significantly from person to person and does not necessarily provide all teachers with the skills, understandings and confidence needed to use digital media and tools to support student learning. Additionally, in some cases a focus on building teacher ICT capabilities sat ambiguously with respect to the project aims. While basic ICT skills were seen as an important prerequisite to working effectively with Digital Technologies curriculum, a focus on ICT capabilities and the use of digital tools across the curriculum distract from other aspects of the Digital Technologies (for example unplugged approaches and the emphasis on thinking skills and problem-solving processes) in some schools.

We noted in some schools that the knowledge of the Digital Technologies curriculum was unofficially assigned to one interested teacher. Where this happens in a primary school context the professional knowledge is fragile—put at risk should that teacher leave the school. It also does not ensure that the Digital Technologies curriculum is offered more broadly across the school or that programming across levels is attended to, as happened when there was a more distributed and collaborative approach to professional learning. This was particularly the case at Amethyst in the Year 8 area, where all responsibility for teaching Digital Curriculum was delegated to a relief teacher with a STEM background and strong personal interest in technology and design, while the class teacher took little responsibility for either their own professional learning in this area, or the learning of students.

We noted the wide range of devices used and media created in the Digital Technologies curriculum, particularly in the primary years. For example, in middle years the teachers were using Dash and Dot robots at one school and 3D printing at another. The DTiF leader at Emerald commented on the specialist knowledge associated with different 3D printers. Technical knowledge is often dependent upon the make and model of the device being used. The diversity of digital devices and media used in schools brings richness and opportunities, but it also means that the technical expertise needed by teachers is not standardised with teachers needing to constantly upskill. Where teachers are integrating Digital Technologies into their general classroom teaching, it can be difficult to use unfamiliar devices that need specific skills and knowledge. In the DTiF project, the curriculum officers played an important role supporting teachers with this technical knowledge and the confidence needed to use unfamiliar equipment.

Strategic alignment, networking and mentoring, teacher professionalism, and integrating curriculum

There were many innovative practices and successful strategies noted in the case studies pertaining to the professionalism of teachers and principals and the flexibility and responsiveness of the DTiF project methodology that promoted positive impacts and outcomes in the face of the specific challenges at each school. Of particular note were instances where success was built on alignment of the DTiF to other school priorities and programs; where features of the DTiF methodology promoted flexible and responsive networking and mentoring; and where curriculum strategies leveraged and enhanced teacher professionalism and knowledge of place and students.

> " When the DTiF began at each school it intersected with agendas of school improvement that were already in operation. Principals who could see links between the opportunities of the DTiF and these reportable school improvements had a stronger buy-in to teacher professional learning in the Digital Technologies curriculum.

During the period of the DTiF, there were multiple projects and agendas at each school site which directly competed with the DTiF for resources, time and attention. Some of these projects were taken up by principals as a mechanism balancing the financial burdens of disadvantaged schools. The level of commitment and governance of projects can be difficult to maintain as the number of projects grow. To negotiate these opportunities amid the complex contexts of disadvantage experienced at each of the case study schools required highly skilled principals and teachers. A successful strategy that we noted that school principals used in the DTiF was to align the project with the school's improvement plan. These improvement plans were made at each site, but their frequency and naming depended on the state/territory jurisdiction. When the DTiF began at each school it intersected with agendas of school improvement that were already in operation. Principals who could see links between the opportunities of the DTiF and these reportable school improvements had a stronger buy-in to teacher professional learning in the Digital Technologies curriculum. At Jade, the principal's strategic plan was closely aligned to the Digital Technologies curriculum and this principal had a deep commitment to improving all aspects of Digital Technologies and ICT at the school. In this case the strategic plan involved a priority to upgrade the infrastructure so that future professional learning and implementation could take place effectively. The DTiF therefore

became embedded in the school improvement plan. At Opal, the project leader in the third year of the evaluation (who was also the principal) integrated the DTiF into the school's annual improvement plan. This was also the intention of the principal at Amethyst, who intended aligning the Digital Technologies curriculum with a newly envisioned library program with a focus on STEM. The robotics program and associated resources purchased as part of the DTiF were to form a central part of this plan. At Quartz the principal was proactive in aligning the DTiF with other school level priorities from the onset of the project, and over the period of the project worked the Digital Technologies curriculum into the schools' strategic documents and whole school plans for professional learning. Where the priorities and work of the DTIF were explicitly aligned with school-level strategy, there was a high chance of success of building a whole-school narrative and long-term cultural change.

The project provided opportunities for networking among DTiF leaders and teachers. This was supported by the mentoring offered by the curriculum officers. Through both the networking and the support of the curriculum officers, teachers reported that they engaged in professional learning in ways that were highly purposeful and that involved numerous aspects of teaching, from planning and assessment through to implementing particular learning activities and working with specific equipment and apps. The DTiF project, with its focus on encouragement of flexibility, responsiveness and site-specific plans, was very enabling of teachers and DTiF leaders to develop their professionalism. The DTiF leaders and teachers who were involved in the ACARA-facilitated professional learning activities appreciated how this enabled them to network with other teachers outside of their school. At Pyrite the DTiF leader noted that the community of practice around the Digital Technologies curriculum was highly beneficial and supportive. This DTiF leader developed connections with teachers that were maintained outside of the project. Similarly, at Amethyst, connections made through the curriculum officer, such as an arrangement with the University of Adelaide's Computer Science Education Research Digital Technologies Lending Library and the giving and receiving of feedback from participants from another school during face-to-face and online workshops, built a supportive informal network. This promotion of a professional learning ecosystem was a deliberate strategy of the DTiF. Internal relationships were also strengthened. As noted in the Opal case study, the professional relationship between the teacher and assistant teacher grew as a direct consequence of the DTiF. They were learning about innovative ways to deliver the curriculum while developing culturally responsive pedagogy in dialogue with each other.

DTiF leaders and teachers spoke highly of the relationship that they had with the individual curriculum officers who were designated to their schools. The curriculum officers were recognised as Digital Technologies curriculum experts by principals, DTiF leaders and teachers across all of the case study schools. A successful strategy that principals used was to identify and promote the wealth of knowledge that the curriculum officers brought to their school to support teacher professional learning and student engagement in the Digital Technologies curriculum. The DTiF leaders, teachers and assistant teachers stated that the curriculum officers were integral in providing support for successful enactment of the Digital Technologies curriculum in areas of content knowledge and pedagogy and suggestions about how to negotiate the specific context of disadvantage in the school. The curriculum officers were admired for both their theoretical knowledge and pragmatic expertise. Their invitational approach and flexibility in responding to school and individual staff requests was greatly appreciated. They mentored teachers in how to teach the Digital Technologies curriculum while also enhancing student learning of ICT capabilities.

This mentoring extended beyond pedagogy and content knowledge to inclusive pedagogies. Then curriculum officers provided teachers with understandings of project- and design-orientated approaches towards the Digital Technologies curriculum that promoted groupwork and celebrated strengths that individual students brought to their learning. Many teachers commented on the success of showcasing these projects and the engagement that students had as a direct result of the curriculum officers' support. We noted that the curriculum officers were very flexible across a range of situations. For instance, on a visit to Opal, the curriculum officer was providing support for Design in Year 1 Food Technology before modelling for Micro:bit programming in the senior school. At Amethyst, the curriculum officer was prepared to organically shift focus and delivery of professional learning sessions in line with requests from teacher participants. At Quartz, the curriculum officer facilitated whole of school hands-on professional learning sessions using specialist equipment, led demonstration lessons to students, and was supported the DTiF team at the school to engage in the learning via the project MOOC. Overwhelmingly, the professionalism and depth of support provided by the curriculum officers through the onsite visits and follow up communication was the most valued aspect of the project. The level of accessibility to curriculum officers (via email, for example) and their willingness to provide support was highly praised by project participants.

Across the DTiF we noted numerous examples of teachers enacting the AITSL standards. In particular, Standard 1.3: Demonstrate knowledge of teaching strategies that are responsive to the learning strengths and needs of students from diverse linguistic, cultural, religious and socioeconomic backgrounds. At Quartz teachers used digital tools to enable students with low levels of literacy in English to participate in the Digital Technologies curriculum. The teachers saw the coding of the robotics as a level playing field. Through the coding activities, some of the students who were not always successful in English-led areas of the curriculum had the opportunities to shine in this area and show their skills and capabilities. At Opal and Emerald teachers were demonstrating knowledge of Standard 1.4: Demonstrate broad knowledge and understanding of the impact of culture, cultural identity and linguistic background on the education of students

from Aboriginal and Torres Strait Islander backgrounds; and 2.4: Demonstrate broad knowledge of, understanding of and respect for Aboriginal and Torres Strait Islander histories, cultures and languages. Teachers at both schools had an understanding that teaching Aboriginal students involved both respect for Country, language and culture, while having high expectations for the students' achievement in the Digital Technologies curriculum. The DTiF spanned learning about the students' everyday practice in their homes and communities and extended opportunities of specific learning required for many STEM-related professions.

> " Over the life of the DTiF, this assistant teacher grew from a technology novice to a mentor of other teachers. Other examples of teacher professionalism include the development of highly contextualised resources by teachers to enact the Digital Technologies curriculum.

Indigenous assistant teachers commented on the Digital Technologies curriculum supporting their professional knowledge about teaching. During the case study interviews at Amethyst, Opal and Emerald they gave evidence of how they were learning new skills and pedagogies associated with the Digital Technologies curriculum. Due to staff turnover at Emerald, the assistant teacher took on the role of mentoring and leading the Digital Technologies curriculum for teachers who found this teacher's knowledge and approach useful. Over the life of the DTiF, this assistant teacher grew from a technology novice to a mentor of other teachers. Other examples of teacher professionalism include the development of highly contextualised resources by teachers to enact the Digital Technologies curriculum. For example, although not fully completed, the Homelands teacher and the assistant teacher at Opal were developing a prototype to include a resource in Scratch that integrated multimodal resources of text, sounds and images about sites of cultural significance that were highly valued by the community.

There were numerous examples of schools linking the Digital Technologies curriculum to the general capabilities and of integrating with other curriculum areas in ways that indicated their understandings of the particular needs and strengths of their student cohorts. At Emerald a teacher commented on the opportunities to develop the students' oracy in early years giving instructions to robots and in upper primary discussing planning for Digital Technologies curriculum projects. These oral learning opportunities provided students with English as an Additional Language contextual experience which linked to the Literacy general capability. The case studies also highlighted the potential for using computational thinking to enhance student oracy. This attracted particular comment at Quartz and Emerald. At Amethyst, the integration on the programming of robots aligned with a focus on procedural text in the early years' literacy curriculum, and links were made with critical literacies in an upper primary class. These instances of effective curriculum integration reflect the teachers' professional capabilities and their growing familiarity with Digital Technologies curriculum, making connections between the specificity of their students and the opportunities presented by the Digital Technologies curriculum and associated pedagogies.

Material contexts of the case study schools

Equipment, infrastructure, time, and staff turnover

In disadvantaged schools, the material context is an obvious fragility for the DTiF with material circumstances in the schools directly impacted by historic and persisting structural disadvantage. There is no national provision for infrastructure, Learning Management Systems, computers and devices and professional learning. Due to this, there are variations across states and territories due to the fact that some states have invested more heavily in this over time. Fragilities are associated with the establishment and the maintenance of equipment and infrastructure, and with pressures on time where teachers need to invest large amounts of time in managing and maintaining equipment and preparing resources needed for learning activities. Instability of staffing is also a source of fragility at disadvantaged schools, where high levels of staff turnover is a perennial challenge that pose a risk to the professional knowledge available in the schools.

Across the case study schools there was variation in connectivity and provision of equipment due to differential funding models and priorities that they were subjected to. At some sites this was compounded by material implications of their geographical locations. The schools had different grades of infrastructure and equipment, and varying levels of technical support to maintain the integrity of these resources. This aspect of the material context impacted every school in some form or another, with some schools prioritising this before addressing the pedagogy and curriculum of the DTiF. The material context was a marker of disadvantage in these schools compared to other schools the authors have visited in other projects. Teachers in the DTiF were spending considerable amounts of time to negotiate the fragilities of the material contexts in their setting.

The infrastructure at Jade was such that improving it was necessary before the teachers could even begin to fully implement the DTiF. As detailed in the case study, poor connectivity, a lack of wireless infrastructure and few pieces of equipment were significant obstacles to implementing any form of Digital Technologies curriculum. We noted across the cases that even when the infrastructure and equipment were working to some extent, there was still a higher and more intense requirement of teacher time and energy in preparing for the teaching and learning of the Digital Technologies curriculum. At Opal, the Homelands school had no connectivity, so much of the teacher time was spent in developing offline workarounds. Even these offline workarounds required considerable teacher investment, with the DTiF leader at that school spending an enormous amount of time sourcing outdated laptops and trying to get them working offline to support the Digital Technologies curriculum in a Homelands context. At Pyrite, the school used 'Rudd era' computers and storage facilities for the equipment were some way from the classroom, so in this secondary school the equipment had to be constantly managed. The peripherals had to be picked up by the teacher and taken to a number of timetabled classrooms. Additionally, there were not enough sets of equipment for the numbers of students who were in the classes, so the teacher had to organise a rostering process. The 'Rudd era' computers had to be reimaged frequently, and this was done by the Digital Technologies teacher in their 'spare time'. Many computers and devices in use in disadvantaged schools would be seen as being well past their use-by date in more advantaged settings. The fragilities of the everyday context added to the burdens faced by teachers and principals across these schools and disrupted the student experience in the Digital Technologies curriculum.

In Australia the provision of student computers and devices is generally privatised across all sectors of schooling, with families baring the associated costs. Because privatisation of individual devices has been normalised, lower socio-economic schools, where families do not have the resourcing to engage in this can be problematic. At Opal, Emerald and Quartz, all the computers, devices and peripherals were provided by the school. In very disadvantaged schools, this is often the provision model of choice because families cannot afford to purchase devices and student-owned devices where they do exist often fall into disrepair or are poorly maintained and cannot be replaced. In some schools, collections of devices needed to be gathered together from different locations to create a class set for learning activities, as seen with the computer provision at Pyrite. This practice brings complications as each additional type and model requires specific knowledge on the part of the teacher to ensure usability within particular Digital Technologies learning activities. Teachers in this setting were in a never-ending cycle of upskilling their knowledge about devices that takes time away from their curriculum planning and teaching.

Staffing is an important aspect of the material context of schools. Staff turnover was a significant challenge for maintaining project focus and momentum across the case study schools. While the DTiF project enabled schools to build teacher ICT capabilities and Digital Technologies curriculum knowledge and skills, staff turnover makes whole of staff development more difficult, particularly in the case of primary schools where the generalist teachers are expected to deliver the Digital Technologies curriculum. Each of the case study schools saw staff members leave at some point across the project period. At Opal the DTiF leader changed over the three years, and this resulted in the DTiF project changing direction. Changes in leadership at Amethyst resulted in a loss of project momentum and disbandment of a recently established maker space. In the case of Jade, the new principal at the beginning of the DTiF was faced with a school that did not have adequate infrastructure, so the teachers at the school had not received professional learning in the use of digital and online tools that they believed were integral to the delivery of Digital Technologies curriculum. Added to this the teachers were used to technology being unreliable in their classes, so tended to avoid it to reduce disruption. This meant that the work to be done in the professional context was significant, as it involved adjusting attitudes and dispositions which had developed due to insufficient and poor quality equipment and infrastructure. When a new principal arrived at Emerald the DTiF was not a high priority in the new strategic vision. Thus staffing—a feature of the material context that was subject to significant ongoing change—had serious ramifications for the professional context of the DTiF in these schools. In contrast, when the principal changed at Pyrite—a high school—the DTiF leader who was a curriculum specialist remained the same and there was no impact on the DTiF, and although Quartz experienced staff departures during the project, a new appointment also brought significant expertise with digital tools.

Staff turnover resulted in the loss of specialist knowledge of the Digital Technologies curriculum and, in some cases, resulted in a re-orientation of the projects that had been started. At Opal there was a different DTiF leader at each of the data collection points, and this was reflected in a change in the project focus each year. When the DTiF teacher left the school at the end of DP1, the teachers' highly contextualised knowledge of implementing the Digital Technologies curriculum in this Indigenous context was lost and not replaced. This highlights that it is not just the general knowledge of the curriculum that is needed, but also the specific knowledge of how to enact the curriculum at this specific school. Even when teachers are replaced it takes time to learn the material specifics of the local context. At Emerald, after a long period of consistency with the DTiF, the leader who was passionate about the Digital Technologies curriculum left the school resulting in the DTiF being severely disrupted at that school. At Amethyst, the principal who established the DTiF, the DTiF leader and another member of the core team had all left the school by DP3. The relatively new Principal decided to disband the recently established and resourced maker space. At this point the project, devoid of dedicated leadership, lost momentum and the recently required resources fell into disuse. Focus shifted to wellbeing strategies which did not capitalise on the gains made in the DTiF project. At DP3 plans were underway for the resources to be incorporated into a newly envisioned high-tech library.

DTiF successes in material contexts

Innovative resourcing, equipment sharing, specialist spaces, and distributed approaches to knowledge

The DTiF directly supported the establishment and stability of the material context at some schools. Teachers came up with innovative solutions to negotiate the limited resources of the material context in their specific location. The DTiF provided teachers and school leaders with opportunities to share resources and learn about the fit for purpose of peripherals to match the Digital Technologies curriculum in their school, which informed the sourcing and provision of equipment. The curriculum officers provided ongoing support and specialist knowledge about specific devices and how to use these to deliver the curriculum given the material limitations.

Teachers innovated to overcome the limited and outdated resources. Unplugged learning from the Digital Technologies curriculum was integrated into teaching design while infrastructure was being built or upgraded at Jade. At Emerald, the classes were structured around student attendance. Some classes had large numbers of students enrolled with few students attending. This meant that a 1:1 iPad ratio was not feasible because of the large numbers of students enrolled in that class. The DTiF leader configured the iPads with single class logins and individual cloud platform storage of each student. This meant any student could use any device in the same class each day as the data was not stored on devices. This was seen as a successful strategy to provide resources for use with classes of spasmodic attenders. In the same school, students collaborated around devices to develop a class presentation using the SkipBot app. The cloud storage meant the teacher had access to all the data that was uploaded on the cloud.

One successful strategy that teachers and school leaders engaged in was sharing resources across schools. Teachers learned to use auxiliary programmable equipment during DTiF sessions and discussions with curriculum officers. Schools were introduced to the University of Adelaide's Computer Science Education Research Digital Technologies Lending Library via the project. The Lending Library was seen as a particularly useful resource allowing teachers to 'try out' different equipment, develop familiarity and skills, and incorporate equipment into short units of work where purchasing would not be possible using school resources. At some schools, project participants used borrowed equipment to showcase the possibilities with their colleagues and to run professional learning activities, supported by curriculum officers. The breadth and depth of the knowledge the curriculum officers brought to the myriad of devices was highly appreciated by the teachers and assistant teachers in the DTiF. The expertise of the curriculum officers gave teachers and assistant teachers opportunities to compare and discuss with others the resources, and specialised knowledge needed to enact the Digital Technologies curriculum using the various specialised material resources.

Designated spaces within schools are a marker of the value placed on subject areas within the school curriculum. The disbandment of the maker space at Amethyst was a major interruption to the momentum of the DTiF project as teachers could no longer easily timetable their classes into the space which had adequate room for a class to program and manipulate Bee-Bots and Dash and Dot robots. At Pyrite the ongoing campaign for a designated space was closely linked to the fragility of the subject in the curriculum. Both the Digital Technologies teacher and the Science Coordinator at the school understood this claiming of physical space to be strongly linked to the positioning of the Digital Technologies subject area in the school. The room itself would be a symbolic representation of the important of Digital Technologies in the school, particularly as the subject area becomes an elective after Year 9. The designation of a dedicated space gives permanence to the subject area and denotes sustainability, as well as bringing important affordances with respect to management and maintenance of resources. At Quartz a whole school approach was taken to equipping classrooms and a specialist Digital Technologies classroom with devices. At this school a part-time specialist Digital Technologies teacher was employed and this teacher had some time allocated to maintain equipment and to help classroom teachers with the technology.

A strategy enacted at some schools to ameliorate the risk of posed by staff turnover was the distributed model of teacher professional learning in the Digital Technologies curriculum. For example, at Jade, the principal had a strategy of rotating teachers through the professional learning offered around the Digital Technologies curriculum with the objective of upskilling all staff members. Such an approach in disadvantaged schools offsets the impact of staff turnover. At Opal the availability of the professional learning shifted from a focus on one teacher and assistant teacher to a more distributed model when the Digital Technologies curriculum was part of the School Improvement Plan at the end of the project. In this model, teachers could opt in to professional learning opportunities offered by the curriculum officer. At Quartz, the learnings of the DTiF team were shared with other classroom teachers via collaborative planning and team teaching, where generalist teachers were gradually supported to operate more independently with the Digital Technologies curriculum. These distributed models meant that value derived from interactions with the curriculum officer were more widespread leading to opportunities of cultural change towards innovating in the Digital Technologies curriculum in disadvantaged schools. In terms of long-distance travel and logistics this represented a good use of resources.

> " The Lending Library was seen as a particularly useful resource allowing teachers to 'try out' different equipment, develop familiarity and skills, and incorporate equipment into short units of work where purchasing would not be possible using school resources.

Results of the Cross-Case Analysis

Continuing, sustaining and transferring impacts and outcomes within and beyond DTiF schools

The points below summarise the key findings and implications of the cross-case study analysis with respect to impacts and outcomes for schools.

Positive outcomes of the DTiF

1. Positive outcomes for student engagement, inclusion and achievement were reported at each case study school. Impacts on student engagement were supported variously by the use of inquiry and design pedagogies, the incorporation of inspiring Digital Technologies equipment and apps, building on community strengths and resources, and promoting the general capabilities. For Indigenous students, positive impacts on engagement and general capabilities were noted and supported with accounts of particular examples of successful practices and specific students. At schools with high proportions of Indigenous students, alignment with the cross-cultural priority of ATSI Cultures and Histories was an important consideration with learning activities making connections with community cultural and linguistic resources.

2. Positive impacts on teacher professional knowledge were reported at each case study school, including strengthening ICT capabilities, familiarisation with Digital Technologies curriculum, familiarisation with Digital Technologies pedagogies, increased technical knowledge and skills in the implementation of specialist equipment and apps, and new insights about how to manage devices and digital media. The DTiF stimulated and supported much teacher-led innovation. Enhanced professional networking between schools and collaboration within schools was a positive outcome for teachers at some schools.

Importance of local knowledge in disadvantaged schools

3. Structural disadvantage and ongoing disruption to programs at the case study schools required strategies for developing resources and expertise that respond to the specific contexts of each school, their local histories, circumstances and conditions, community resources and strengths. Teacher and principal knowledge of local students and communities was integral to the development and implementation of successful strategies for implementation of the Digital Technologies curriculum. In some disadvantaged schools, in a context of high staff turnover, teachers provide continuity as a critical source of this knowledge. This was particularly the case at schools with high proportions of Indigenous students.

Complementarity of Digital Technologies, the general capabilities, and engagement priorities in disadvantaged schools

4. Successful strategies took advantage of alignment between the Digital Technologies curriculum, pedagogies and equipment; the general capabilities; and strategies to promote student engagement and inclusion. Complementarity between these three areas was evident at each school. These strategic alignments manifested in different aspects of schooling and teachers' work, including school-wide documentation and processes, teacher professional learning, curriculum planning and within units of work and learning activities. Sites where these strategic alignments were evidenced across these different aspects reported the greatest success and the most optimism regarding sustainability.

Importance of school-level strategic alignment

5. The case study schools were all subject to multiple projects and agendas that targeted aspects of disadvantage. This presented both opportunities for alignment and potential for competing priorities, requiring highly skilled leadership to manage the governance of projects and to fully leverage potential impacts. Frequent staffing changes added another layer of complexity and at some sites put gains made at risk and threatened sustainability.

Building teacher capability

6. General ICT skills and familiarity with specialist Digital Technologies equipment was a focus at each school. Teacher capability with ICT requires skills, confidence and resources. Building teachers' skills and confidence was challenging but important in sites where historically problematic infrastructure, outdated devices and lack of equipment had not supported positive dispositions towards using digital tools and infrastructure. In the context of high staff turnover and attrition of knowledge, building capacity in individual teachers puts school programs at risk, particularly in primary settings where the Digital Technologies curriculum is less likely to be allocated to a particular role in the school. Sustainable, school-wide capacity building required careful consideration of how distributed models of professional learning could be implemented, and this was not easily done in schools already experiencing financial hardship or where the impacts of disadvantage overwhelmed opportunities for strategic planning.

Establishing infrastructure and equipment

7. Establishment of robust infrastructure, suitable devices, inspiring specialist equipment and in some cases specialist Digital Technologies spaces was an important aspect of the case study schools' implementation of the Digital Technologies curriculum. Significant gains in this aspect of the material context were made at most case study schools. However, challenges related to storage, access, and ongoing maintenance were difficult to manage. In disadvantaged settings where financial resources are scarce, these challenges are often met by teachers rather than specialist technical staff and detract from time spent curriculum planning, which is not a sustainable practice.

Transferring aspects of the DTiF project methodology to other initiatives

The following points summarise the key findings and implications of the cross-case analysis with respect to the transferability of the DTiF methodology to other curriculum implementation and teacher professional learning initiatives.

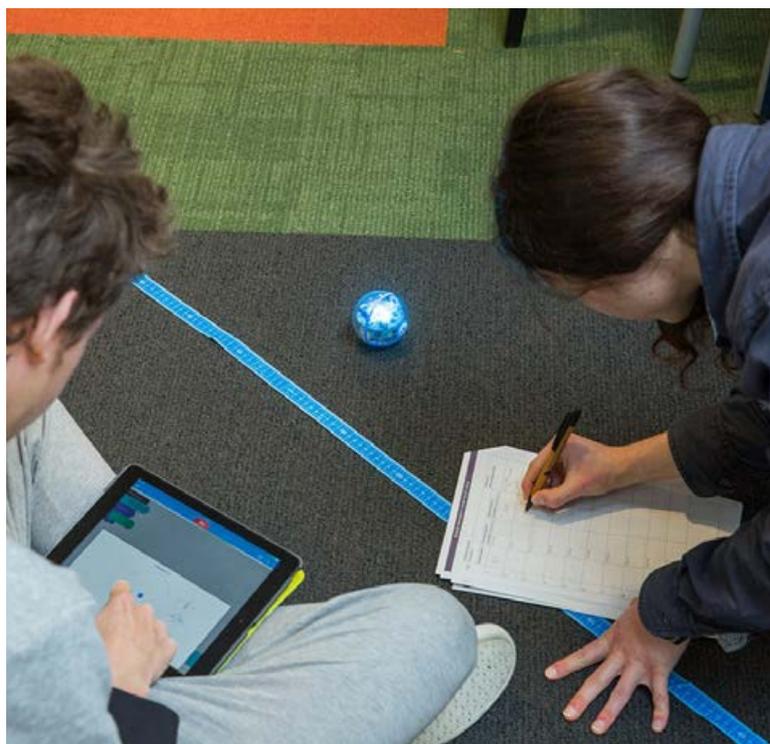## Successful mentoring and networking

8. Effective mentoring and networking was central to project successes in the case study schools. The ACARA curriculum officers were key to this, and their flexible and responsive approach to providing support was the most lauded aspect of the DTiF. Mentoring by the curriculum officers took many forms, including formal whole school presentation, demonstration teaching, by-the-side in-class assistance, help with programming and assessment planning, as-needed remote support (via telephone and email), and resource sharing. The DTiF project methodology also supported networking across schools (both virtual and face-to-face) and opportunities to nurture collaborations within schools. This combination of mechanisms for support was highly suited to disadvantaged sites whose capacity to engage in the project work was sometimes tenuous and subject to fluctuations.

Action research and promoting teacher professional reflection

9. The school-based action research projects were the most vulnerable aspect of the DTiF project in the case study schools. The work associated with the action research projects did not align well with teachers' work and the established processes in the schools, and at all of the case study schools was seen as an add-on to the main work of learning about, resourcing and implementing the Digital Technologies curriculum. Professional reflection did take place at each site, but this was not positioned or enacted as research. Interactions with the curriculum officers was an important site for professional reflection on the success of strategies and resources. The practice of audit and review was viewed as important for sustaining schools engagement and accountability in the DTiF, as were the timelines and milestones associated with these processes.

Potential for multimedia legacy products

10. Across the schools, the DTiF has supported a wealth of experiences related to how to implement Digital Technologies curriculum in disadvantaged settings. Many successful pedagogies and resources have been developed, and many accounts of success for students and teachers have been relayed. These experiences and associated materials, assumed to be reflective of the richness at other non-case study sites, is a source of knowledge that would be valuable to disadvantaged schools outside of the project if packaged and disseminated in ways accessible and valuable to teachers. Potential high-value artefacts might include short video cases of learning activities, packaged together with unit and lesson resources and examples of whole school planning documents.

Continuity of support

11. Given the high level of value actualised via relationships between the ACARA curriculum officers and the case study schools, consideration should be given to how this site-specific support might be continued, particularly because some schools are still in the early stages of leveraging learning to benefit all teachers and face ongoing challenges.

Unknown legacies

12. Given the high level of staff turnover evident at the case study schools, it is likely that teachers and school leaders who left these schools to move into other school settings will bring benefits to their new schools through the new professional knowledge they developed as consequence of their involvement in the DTiF.

Conclusion

The data in this independent case study evaluation show clearly that DTiF brought many benefits to participating schools and staff, including supporting positive outcomes for student engagement and learning, and for teacher professional learning. Student learning outcomes extended beyond the Digital Technologies curriculum to include the general capabilities (particularly ICT Capability; Critical and Creative Thinking; and Literacy) and other curriculum domains. Within these very disadvantaged contexts, impacts on student engagement in school learning was noted at each school, as were positive impacts on inclusion with numerous accounts of positive experiences and growth for previously marginalised learners.

Teacher professional learning outcomes included increased familiarity with the Digital Technologies curriculum, including associated pedagogies. Teachers gained awareness and skills in the use of specialist equipment (for example, programmables) and apps (for example, for coding) as well as building their general ICT skills and confidence. Teachers experienced success in the use of design and inquiry pedagogies to implement aspects of the Digital Technologies curriculum; integrating general capabilities into Digital Technologies learning; and integrating Digital Technologies with other curriculum areas. Teachers also gained knowledge about programming and assessing for Digital Technologies.

The DTiF provided impetus and support for professional networking between schools, as well as promoting new collaborations within schools and strengthening existing partnerships. These impacts were seen as particularly valuable in small schools, those that are geographically isolated, and those where one staff member is responsible for implementing Digital Technologies curriculum. The strategies used in the DTiF for promoting networking allowed teachers and schools to affirm and build on local strengths.

Schools benefitted via impetus and support to establish and improve Wi-Fi infrastructure, provision of digital devices, implementation of cloud storage and cloud media tools, and use of specialist equipment. In some schools, local legacy documents were also established such as assessment plans, and approaches to curriculum and pedagogy pertinent to the Digital Technologies curriculum were built into school-level strategic documentation and reporting.

Features of the DTiF supporting these outcomes and impacts include support for developing school-specific foci for professional learning and change; flexible and generous support from the ACARA DTiF curriculum officers allocated to each school; the three year period of the project with periodic reporting requirements promoting engagement and continuity; and the promotion of a multimodal, multi-faceted professional learning ecosystem that include on-site support, remote support, online resources, both face-to-face and online networking opportunities with other schools, and ongoing opportunities for professional reflection.

> " These features provided the DTiF with traction in very disadvantaged schools, setting the DTiF apart from other, shorter term, less responsive professional learning opportunities, and supporting outcomes that would otherwise be very difficult to achieve in these contexts.

The project speaks to the level of commitment and amount of time needed to support disadvantaged schools to engage local strengths and resources in ways that promote authentic and sustainable cultural change. In many ways, Digital Technologies is an area of curriculum ideally suited for identifying how disadvantage manifests in schools in multiple, interconnected ways; and for promoting a raft of interrelated strategies (material, professional, curricular, pedagogical) for promoting school-wide improvement. The DTiF engaged schools in all of these ways.

Considerations for school leaders

1. **Align Digital Technologies** implementation with other school priorities, including through inclusion in school-wide strategic documentation and processes, for example school improvement plans. Strategic alignment is particularly important in contexts that are subject to multiple overlapping and sometimes completing agendas and programs.

2. **Support robust digital equipment and infrastructure** as a foundation for successful implementation of Digital Technologies curriculum by generalist classroom teachers. Recognise that use of specialist equipment can be inspirational in Digital Technologies learning, promoting high levels of engagement and potential improvements of student inclusion, but that incorporating this equipment into programs requires additional time.

3. **Develop resourcing strategies** that recognise the high demand (time) involved in sourcing, managing and maintaining digital equipment and infrastructure and associated spaces in schools.

4. **Develop strategies early** that anticipate risks in contexts of high staff turnover, including building knowledge in numerous staff members and across different types of roles (for example, targeting roles with histories of continuity such as assistant teachers).

5. **Provide opportunities for all staff to consider and reflect** on evidence and strategies when developing whole-of-school professional learning and curriculum implementation goals—including assistant teachers and technical staff.

6. **Provide opportunities and support for the development of whole school planning and assessment** documents that map Digital Technologies progression and the development in students of enabling ICT skills.

7. **Encourage interested teachers** to formally upskill in Digital Technologies through Higher Education and MOOCs.

8. **Provide opportunities for staff to play** with specialist Digital Technologies equipment.

9. **Promote novel collaborations** within school, and support networking with like school.

Considerations for Digital Technologies teachers

1. **Integrate Digital Technologies curriculum** with other curriculum areas, including high priority areas of Literacy and Numeracy (for example, to explore the potentials for coding and robotics to promote oral language).

2. **Strengthen the general capabilities** through Digital Technologies curriculum (for example, for promoting Critical and Creative Thinking through design pedagogies).

3. **Use pedagogies that support differentiated curriculum** and that enable students to discover and build on diverse strengths (for example, pedagogies employing design or inquiry processes).

4. **Reach out to staff members and community members** who have knowledge about local strengths and community resources, including the cultural Knowledge of local Indigenous communities.

5. **Access online repositories** (for example, Digital Technologies Hub) for successful strategies and resources that can be adapted to your context and the strengths and community resources of your students.

6. **Establish classroom workflow and file management** processes (for example, cloud storage and cloud tools) suited to the technological setup at your school that will enable student access to the artefacts they create and continuity of learning.

7. **Find a collaborator** within your own school to support ongoing professional reflection.

8. **Reach out to teachers in other schools** who might be facing similar challenges or contexts or who might have experienced success in the implementation of Digital Technologies learning.

Considerations for programs promoting Digital Technologies implementation in disadvantaged schools

1. **Provide generous access to curriculum experts** (in this case ACARA curriculum officers) across a period of time suitable for nurturing relationships of trust and deep knowledge of local contexts.

2. **Work with school leaders to build strategic alignment** between Digital Technologies curriculum implementation and the broader priorities and goals of the school as articulated in school-level documentation and report (for example, the school improvement plan).

3. **Promote and enable diverse models for teacher Professional learning**, including by-the-side support in planning and assessment, in-class support with new learning activities, and informal forums for building teacher familiarity and confidence with specialist Digital Technologies equipment (for example, programmables and coding apps).

4. **Promote teacher knowledge and language** around distinctions and relationships between ICT Capabilities and the skills and knowledge of the Digital Technologies curriculum (for example, types of thinking and problem solving processes).

5. **Promote teacher research** within models that accommodate intermittent and as-needed engagement and that deploy the language of reflection and evidence and alignment with the Australian professional standards for teachers.

6. **Link teacher learning** in the Digital Technologies curriculum and related pedagogies to the AITSL professional standards.

7. **Disseminate multimedia case studies** that illustrate opportunities to enhance engagement of and differentiate curriculum for marginalised students via Digital Technologies learning.

8. **Promote strategies and showcase examples** of connecting with communities and activating community resources via Digital Technologies learning.

9. **Support strategic curriculum alignments** and integration by disseminating curriculum resources and multimedia case studies showcasing how Digital Technologies curriculum can complement the general capabilities.

10. **Compile strategies for school leaders** who want to promote cultural change, focused on how Digital Technologies can articulate with this work.

11. **Compile strategies for teachers** that make explicit links between Digital Technologies learning activities and differentiation and engagement of 'at risk' students.