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The Impact of Professional Learning and Development on Teachers' Digital Technologies Implementation

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Abstract

This article examines the long-term impact of Digital Technology Professional Learning and Development on teachers' implementation of the Digital Technologies portion of the Technology Curriculum and explores the challenges they face when implementing this content. Focussing on the empirical experiences of six individual primary and intermediate teachers, the findings showed implementation of key Digital Technologies skills was more intentional after the Professional Learning and Development, the provision of familiar lesson resources gave teachers the confidence to begin implementing Digital Technologies lessons, and that participants wanted long-term Professional Learning and Development but lacked the time to undertake this.

Keywords

21st-century capabilities, elementary education, improving classroom teaching, Professional Learning and Development

Introduction

The rapid rate at which technology is transforming our world, alongside the range of complex societal problems we are facing, has seen most Organisation for Economic Cooperation and Development (OECD) countries develop policies focusing on preparing students to live and work in the 21st century (van der Vlies, 2020). Much of the responsibility for achieving these goals has fallen to our education systems, resulting in countries including Computer Science (CS) learning in their curricula, focusing on ensuring students are digitally literate problem solvers with the skills to become productive members of society (Cai et al., 2020).

Although dated, Tucker et al.'s (2003) CS definition is still widely recognised, it defines CS as "the study of computers and algorithmic processes, including their principles, their hardware and software designs, their applications and their impact on society" (p. 6). An integral part of the subject is students' development of computational thinking (CT) skills (e.g., algorithmic thinking, decomposing problems, representing data) and the ability to apply these skills both digitally and non-digitally to solve a range of problems (Dong et al., 2019).

While preparing students for their futures is the common goal of these curricula, there is little consensus between countries on what to call the learning area, e.g., Computing in England, Informatics in Estonia, Digital Technologies in Australia; or when students should be exposed to this learning, e.g., pre-primary/elementary school, primary/elementary school, secondary school (Varoy et al., 2021). Additionally, there are a range of opinions as to what knowledge/skills students should be taught within these learning areas and whether the curriculum should be taught as a separate subject, as part of other subjects (e.g., mathematics) or as a cross-curricular subject taught throughout all learning areas (Stupurienė et al., 2023).

In 2017, the New Zealand Ministry of Education (MOE) updated the existing Te Marautanga o Aotearoa (Indigenous Māori-medium) curriculum and the New Zealand Technology curriculum (English-medium) to include digital technologies content (Crow et al., 2019). The content ('aho') is named "Hangarau Matihiko" (HM) in the Māori-medium curriculum; this is further broken down into two parts (Whakaaro Rorohiko – computational thinking, and Tangata me te Rorohiko - People and Computers). The Digital Technologies (DT) content in the English-medium curriculum, is broken into Computational Thinking (CT) and Designing and Developing Digital Outcomes (DDDO). The term CS is used throughout this article to reference the wider content in a general sense, while Digital Technologies (DT) is used when referencing the content of the New Zealand English-medium of the Technology curriculum that participants in this research were implementing.

Globally, implementation of CS curricula has been slow (Larke, 2019) and inconsistent (Mertala et al., 2021), raising fears that students are leaving school ill-prepared for the society and labour market of their futures. Given many teachers' limited exposure to this learning area (Geldreich & Hubwieser, 2020) and the critical role they have in the effective implementation of CS curricula (Meissel et al., 2016), many countries have invested heavily in Professional Learning and Development (PLD) to develop teachers' understanding of CS curricula and the required pedagogy (Reinsfield, 2016).

Computer Science Implementation

Systematic alterations in curricula mean teachers are faced with numerous reforms and curriculum changes throughout their careers, with the major responsibility for successful implementation falling to them and their ability to overcome any associated challenges and enact the change within their classroom (Vivian & Falkner et al., 2019). Correlations have been found between teachers' response to change and factors such as self-efficacy (Vivian et al., 2020), level of school support (Vrasidas, 2015), value beliefs (Rich et al., 2020) and curriculum fatigue (Hargreaves, 2005).

The uniqueness of CS curricula requires teachers to (1) implement a technical curriculum that many of them have little experience with (Bartholomew et al., 2022), (2) adopt a 21st-century pedagogical approach (Geldreich & Hubwieser, 2020) and (3) be digitally literate and comfortable teaching with Information and Communications Technologies (Education Review Office, 2019). Additionally, misconceptions surrounding the learning area (content in New Zealand) and uncertainty about the role of CS in education have been seen to negatively influence teachers' CS implementation (Varoy et al., 2021). Resourcing in terms of Information and Communications Technologies, PLD and support has also been seen to directly influence CS implementation (Sentance & Csizmadia, 2017).

Digital Technologies in Aotearoa/New Zealand

When the new Technology curriculum was launched late in 2017, the expectation was communicated that all students in Years 1–10 would be exposed to the Hangarau Matihiko and DT in the Technology curricula through cross-curricular learning, and all students in Years 11–13 would be given the opportunity to specialise in these areas by the beginning of the 2020 school year (Education Review Office, 2019; Kellow, 2018). The content is

written in general terms without links to specific year levels, allowing teachers and school communities to adapt the learning to the needs of their learners (Crow et al., 2019). Between 2017 and 2020, the MOE funded a support package that included a range of DT/HM PLD opportunities (Kellow, 2018), aimed at raising awareness of the new content and supporting teachers' DT implementation.

Current study

The research project forms part of a larger-scale investigation into the impact of PLD on teachers' DT efficacy and implementation. It fills an identified research gap by following six primary and intermediate teachers over a six-month period to learn from their empirical experiences as they undergo DT PLD rather than taking a wider look at the impact of CS PLD, like researchers such as Kong et al. (2020) and Rich et al. (2021). The research questions guiding this study were as follows:

- How does participation in Professional Learning and Development models influence teachers' implementation of the Digital Technologies content of the Technology curriculum?
- How does participation in Professional Learning and Development models influence the challenges teachers face in implementing Digital Technologies content?

By taking an in-depth look at teachers' perceptions of their experience undertaking DT PLD, we attempt to answer Celepkolu et al.'s (2020) open question by shedding light on teachers' needs and best practice PLD strategies. These findings help us understand how teachers can be supported to raise DT implementation and prepare students to live and work in the 21st century.

Methodology

Convenience and clustered sampling practices were used to recruit participants through school principals, educational entities and social media groups. Following a mixed-methods design, data were collected through an online survey at three distinct points in time. In July/August 2022, the 48 teachers who had signed up for the research were invited to complete the first questionnaire prior to beginning their PLD according to their chosen PLD model. In September/October 2022, approximately two weeks after completing the PLD, participants were asked to complete the second questionnaire. Finally, in February/March 2023, approximately six months after completing the PLD, participants were asked to complete the third questionnaire. Although participants were provided with a $20 gift voucher for each questionnaire they completed, there was a small amount of attrition over the research period, with 33 out of the original 48 participants completing all three questionnaires. Six participants (two from each PLD model) from this 33 were randomly selected for analysis within this article.

PLD models

Participants self-selected one of three DT PLD models when signing up for the research.

Online Self-Led

From 2018 to 2020, the Kia Takatū ā-Matihiko/Digital Readiness Programme consisted of self-directed online pīkau (short online lessons) and workshops (online and in-person) designed to upskill teachers to embed DT in their teaching. In 2020, this programme was officially closed, though many of the online resources were transferred to an open platform at the request of teachers in the sector. Participants were able to access these remaining resources and work independently through the pīkau.

In-Person

Delivered by an MOE-accredited facilitator, this PLD option consisted of two 1-hour workshops delivered at a primary school in New Plymouth, New Zealand. This PLD introduced participants to the DT curriculum and involved hands-on activities (both non-digital and digital) that participants could implement within their own

classrooms. After completing the PLD, the teachers were given access to a range of activities to adapt within their own teaching programme.

Online Facilitated

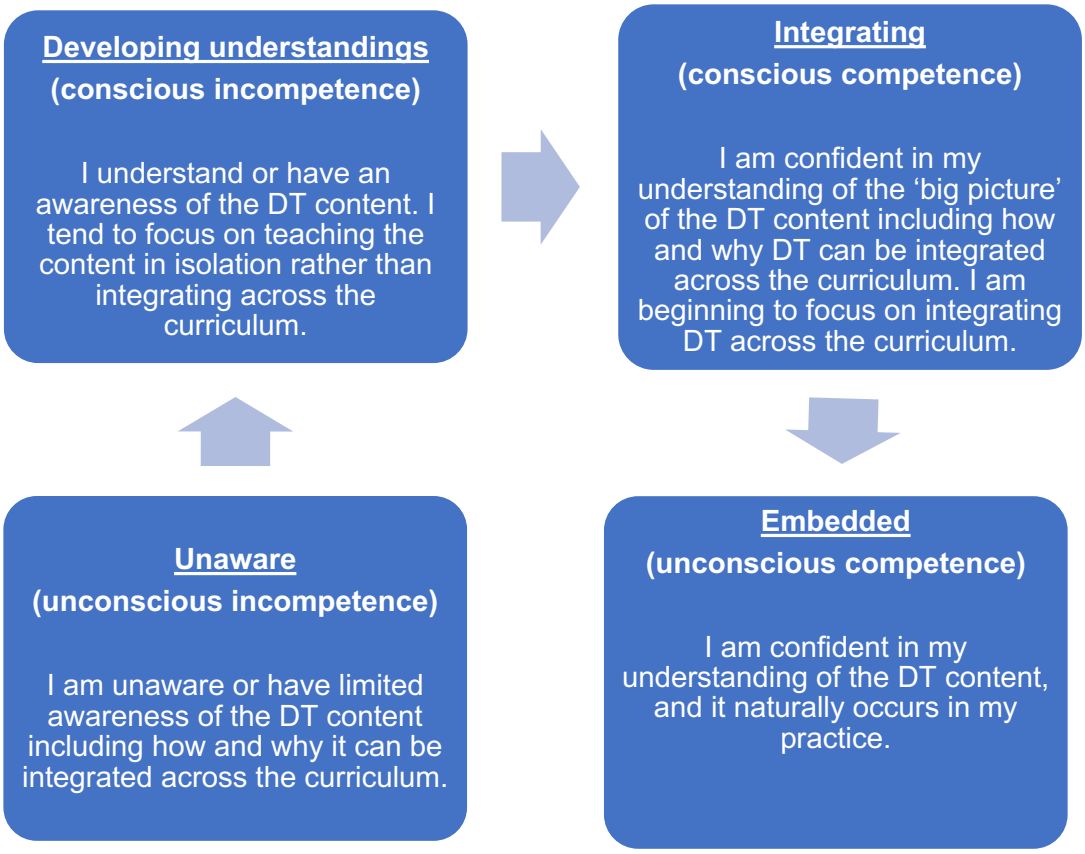
Delivered by the same accredited facilitator as the in-person workshops, these two 1-hour workshops were delivered online through Google Classrooms. Again, this PLD introduced participants to the DT content, and teachers undertook a range of hands-on activities, providing them with access to various resources to use within their own planning.

Instrument

The online, confidential, descriptive, longitudinal survey was designed to measure the impact of the PLD on teachers' DT implementation and the challenges they face in implementing it over three data collection periods. The qualitative dataset included open-ended questions regarding areas in which participants felt confident, areas they were less confident in, goals they had set for themselves, and any challenges they and their school faced in implementing DT. The quantitative dataset consisted of three parts, measuring how teachers implemented DT, how often they implemented it, and the factors they felt most impacted their implementation of it.

The Raranga Matihiko Kaiako framework (Te Papa, Waitangi Treaty Grounds & Auckland Art Gallery, 2018) (Figure 1), based on Howell's (1982) conscious-competence model, was used within the questionnaire as it illustrates the four stages that teachers progress through as they learn new DT skills and master integrating DT throughout other curriculum areas (Te Papa et al., 2018). A ranking was given to each component of the model, and changes in these rankings were measured across the research period.

Figure 1:
Raranga Matihiko Kaiako Framework



Note. Adapted from *Raranga Matihiko Kaiako Framework* by Te Papa et al. (2018, p. 3).

Using a seven-point scale, the implementation construct measured how often the participants taught five key DT skills outlined within the DT curriculum and comparable CS research (Rich et al., 2020). Using factors collated from the findings of Sentance and Csizmadia (2017) and Shin and colleagues (2021), the final construct asked participants to rank ten factors from the most supportive of their DT implementation to the least supportive. These rankings were given a value from 10 (most support) to 1 (least support), and changes in these rankings over the research period were analysed.

After pre-testing with a group of educators, the instrument was adjusted to ensure the accuracy of the questions asked. It was then distributed to participants through the secure Qualtrics platform.

Analysis

A validating quantitative data model approach was followed by using the qualitative dataset to deepen the primary quantitative analysis (Plano Clark & Creswell, 2018).

Results

The results section is described in reference to each of the six participants and each of the data collection periods (pre = approximately two weeks prior to the PLD; mid = within two weeks of completing the PLD; post = approximately six months after completing the PLD).

Individual analysis

Participant 1: In-Person PLD

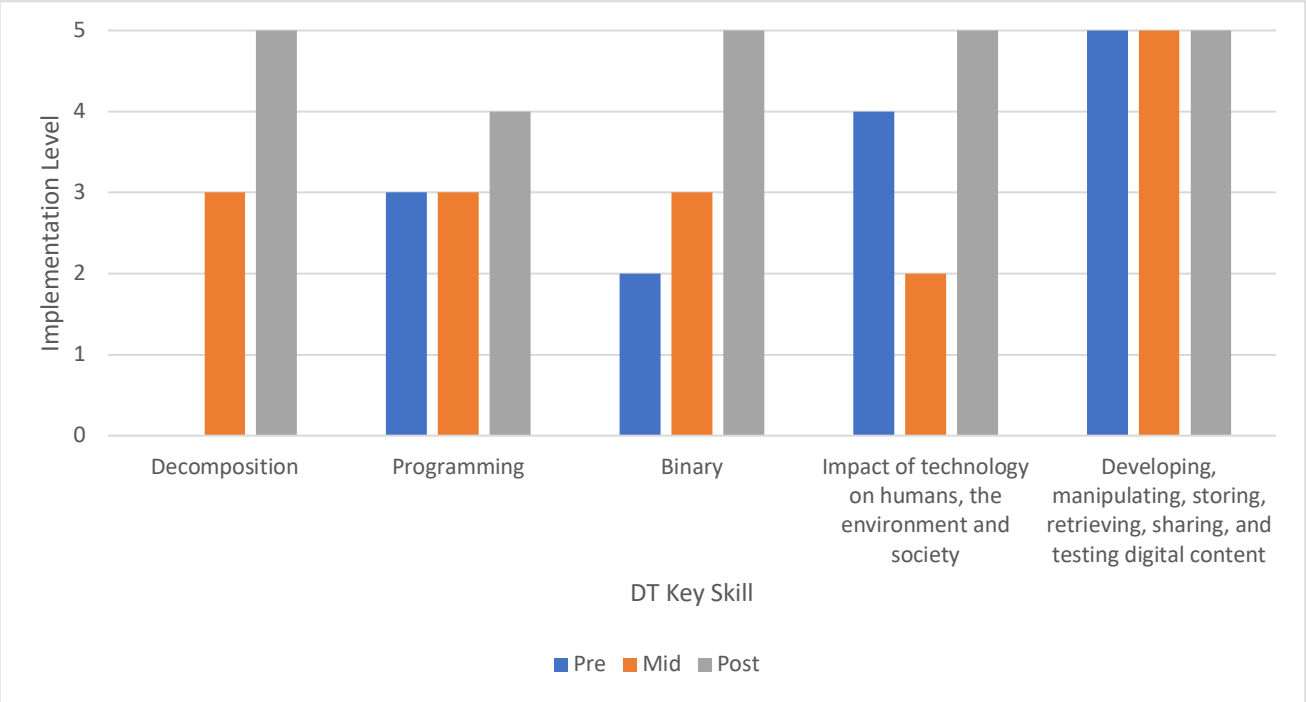
The basic background information of Participant 1 is shown in Table 1.

Table 1:
Participant 1's Background Information

Age	40–49 years
Gender	Female
Age of students (years)	2022: 7–9; 2023: 6–8
Highest education qualification	Graduate diploma
CS qualification	No
Previous DT PLD	Yes
Research PLD completed	1–4 hours DT PLD
Intended to complete further DT PLD – mid-mark	Yes
Intended to complete further DT PLD – post-mark	No

Participant 1's level of DT implementation is graphed in Figure 2.

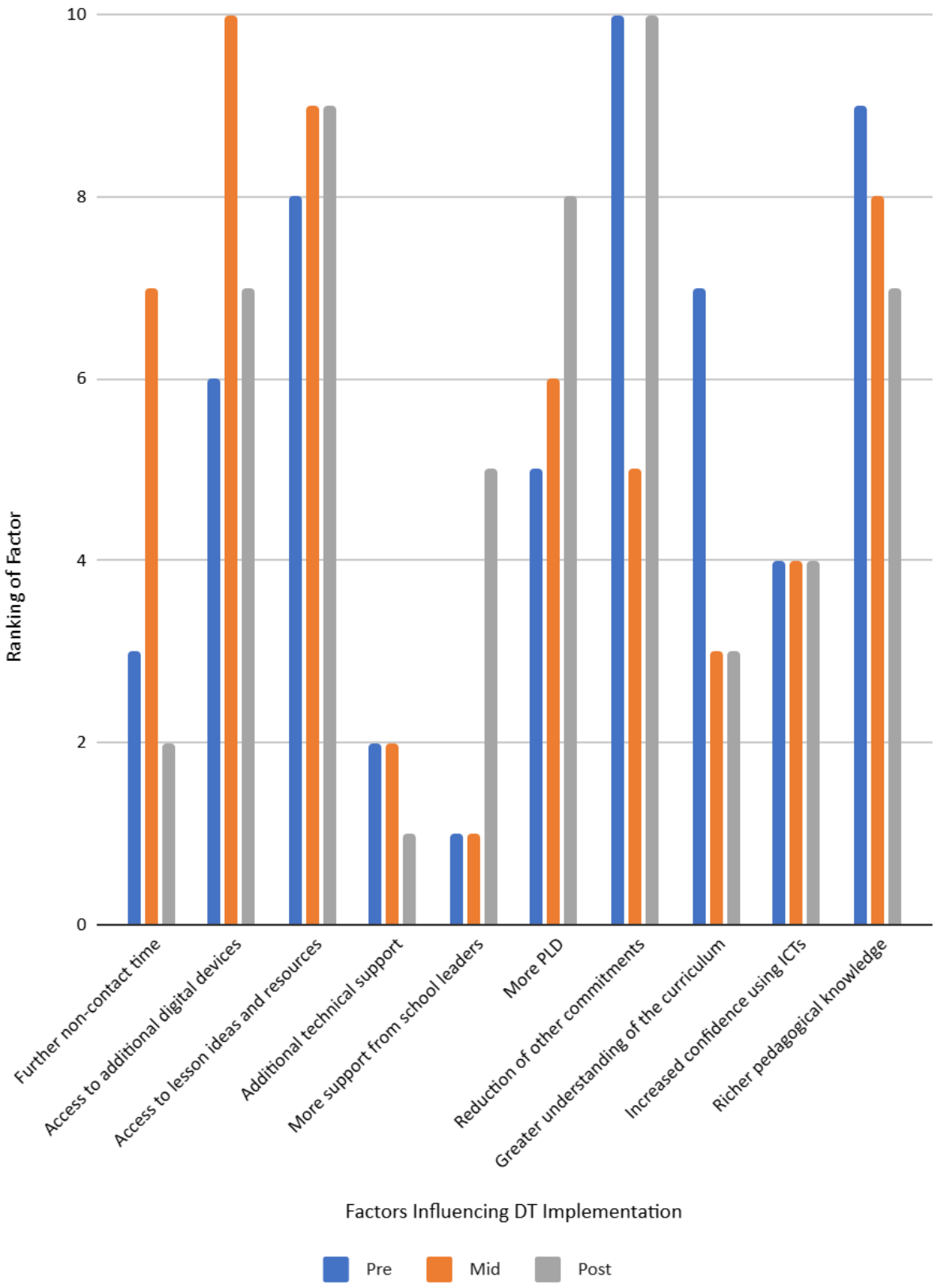
Figure 2:
Participant 1's DT Implementation Over the Research Period



Note: The following values were given to each level of implementation: I'm unsure of the task = 0; never = 1; less than once a term = 2; about once a term = 3; about once a month = 4; about once a week = 5; almost daily = 6.

Participant 1's rankings of factors they felt supported their implementation are shown in Figure Three.

Figure 3:
Factors Supporting Participant 1's DT Implementation Over the Research Period



Note: Values from 10 (most support) through to 1 (least support) were given to the participant's ranking of each factor.

There was no increase in Participant 1's Raranga Matihiko Kaiako framework ranking (pre-/mid-/post- = integrating) or implementation of the final DT skill, which may be attributed to the ceiling effect, in which initial high levels mean there is less scope for improvement. Participant 1 described how they had initially underestimated their implementation of some skills, which explains the large jump in decomposition at the mid-mark. A steady rise in their perception of the importance of more PLD was seen over the research period, yet, at the post-mark, their major challenge was the need for a reduction in other commitments, with reference made to an overcrowded curriculum. Although Participant 1 felt overwhelmed with other PLD at the end of the research period and did not intend to complete any additional DT PLD, they did show increases in their implementation of four of the five key skills and remained dedicated to supporting their school-wide DT implementation.

Participant 2: In-Person PLD

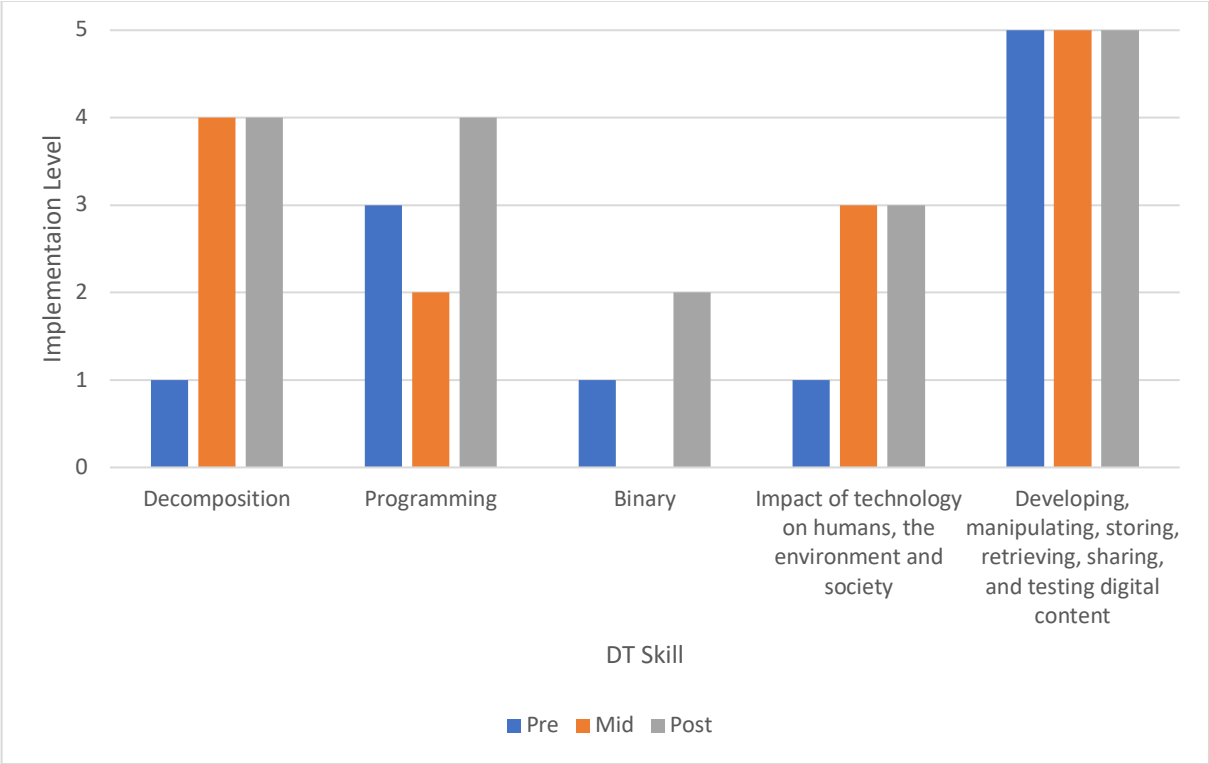
The basic background information of Participant 2 is shown in Table 2.

Table 2:
Participant 2's Background Information

Age	40–49 years
Gender	Female
Age of students (years)	2022/2023: 8–10
Highest education qualification	Degree
CS qualification	No
Previous DT PLD	No
Research PLD completed	4–8 hours DT PLD
Intended to complete further DT PLD – mid-mark	Yes
Intended to complete further DT PLD – post-mark	No

Participant 2's level of DT implementation is graphed in Figure 4.

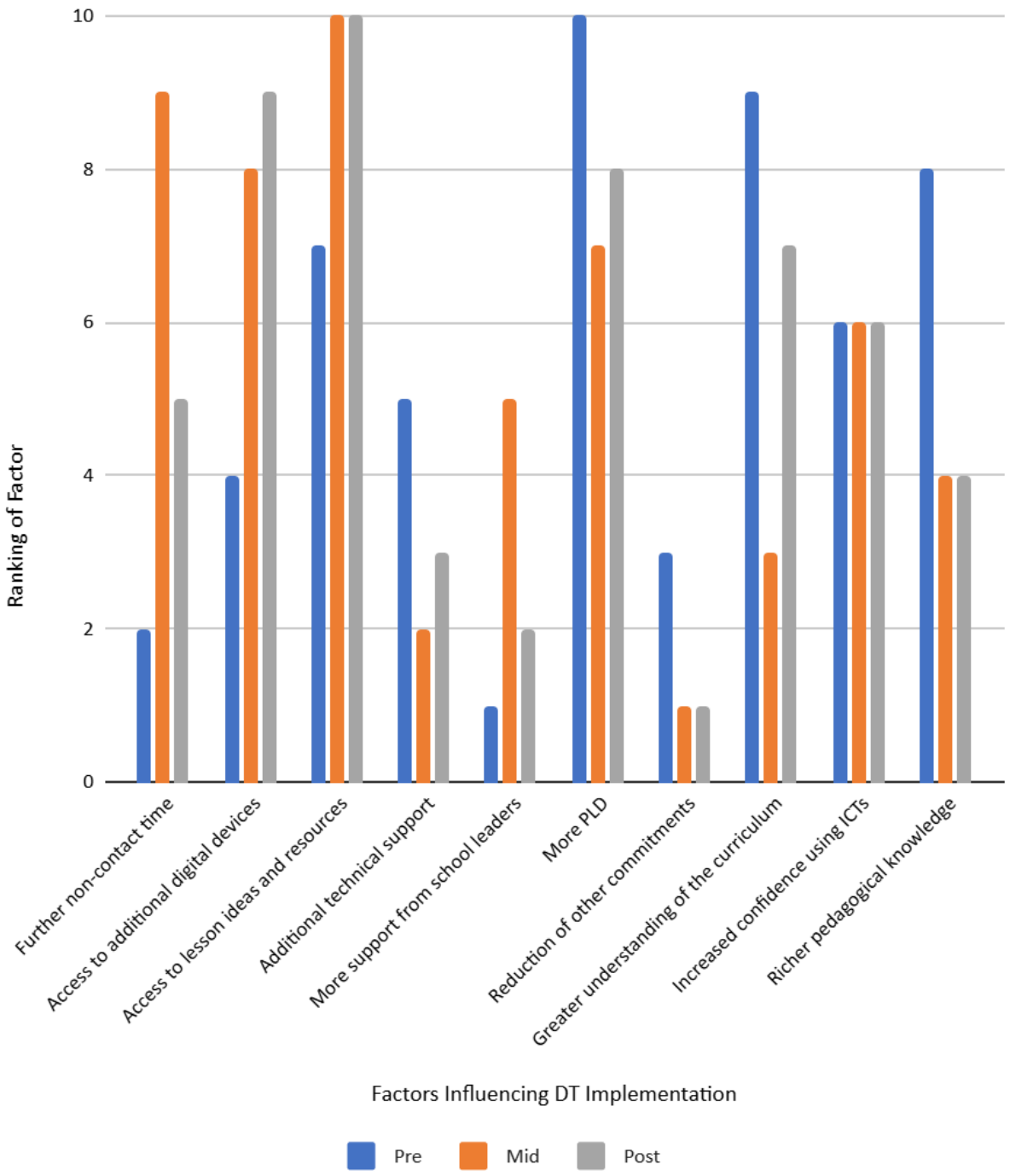
Figure 4:
Participant 2's DT Implementation Over the Research Period



Note: The following values were given to each level of implementation: I'm unsure of the task = 0; never = 1; less than once a term = 2; about once a term = 3; about once a month = 4; about once a week = 5; almost daily = 6.

Participant 2's rankings of factors they felt supported their implementation are shown in Figure 5.

Figure 5:
Factors Supporting Participant 2's DT Implementation Over the Research Period



Note: Values from 10 (most support) through to 1 (least support) were given to the participant's ranking of each factor.

Participant 2 showed an increase in their Raranga Matihiko Kaiako framework ranking immediately after the PLD (pre- = developing understandings; mid-/post- = integrating) and showed an increase in four of the five key skills over the research period. A challenge to Participant 2 as their implementation increased was access to quality digital devices and the internet:

> Our laptops are dated and often need attention before use; iPads won't update or accept updated apps and have limited battery life. [There are] not enough iPads to go around, and the Wi-Fi is unreliable when we have multiple users. (P2Q2)

Participant 2 rated access to lesson ideas and resources as a factor that highly supported their implementation of the DT curriculum. At the midpoint, they stated that they had trialled some of the activities they were provided with in the PLD and, at the post-point, were able to access additional resources to support their DT implementation:

> I am more confident finding resources to support teaching. (P2Q3)

The initial decline and then subsequent improvement in access to more PLD and greater understanding of the curriculum factors raise questions about the short-term nature of this PLD and the lack of follow-up support for participants. At the six-month post-PLD mark, Participant 2 described several challenges to their DT implementation. Their school had two other PLD priorities and was preparing for a big school event. They found supporting students to use devices took up a lot of classroom time, and, as a part-time teacher, they were trying to work more efficiently alongside their teaching partner in managing DT lessons that carried over multiple days.

Participant 3: Online Facilitated PLD

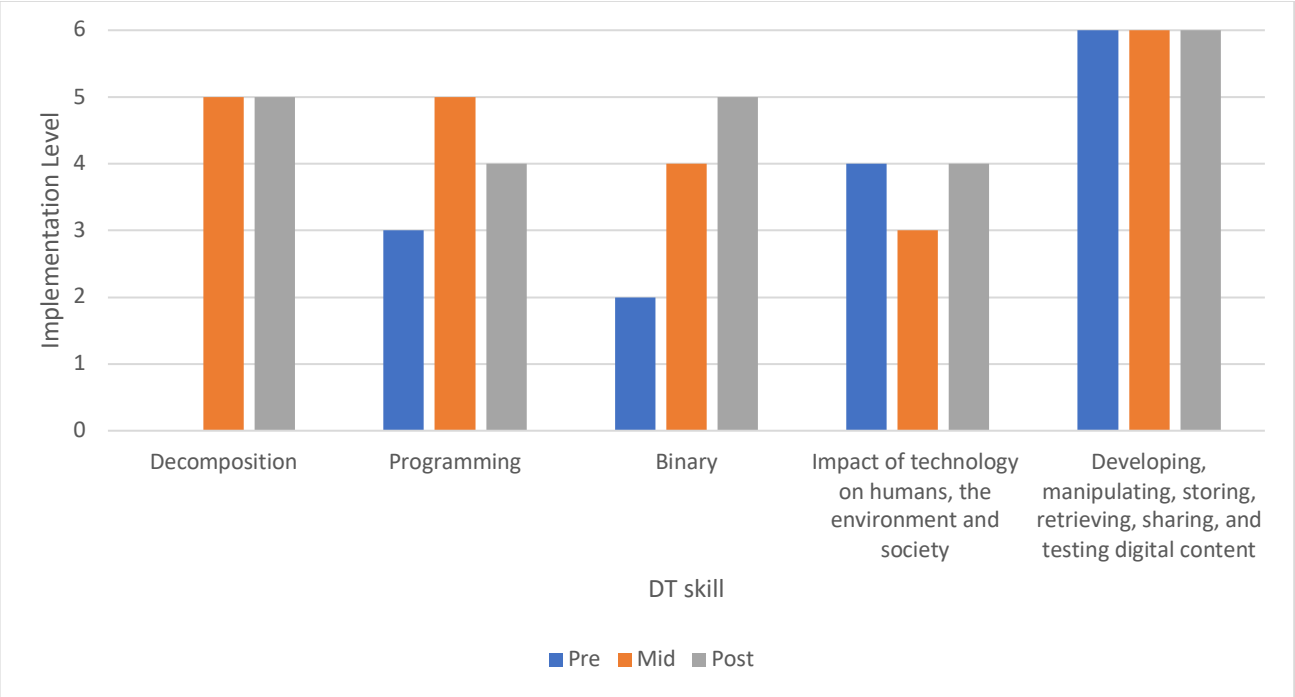
The basic background information of Participant 3 is shown in Table 3.

Table 3:
Participant 3's Background Information

Age	20–29 years
Gender	Female
Age of students (years)	2022/2023: 11–13
Highest education qualification	Master's degree
CS qualification	No
Previous DT PLD	No
Research PLD completed	1–4 hours DT PLD
Intended to complete further DT PLD – mid-mark	Yes
Intended to complete further DT PLD – post-mark	Yes

Participant 3's level of DT implementation is graphed in Figure 6.

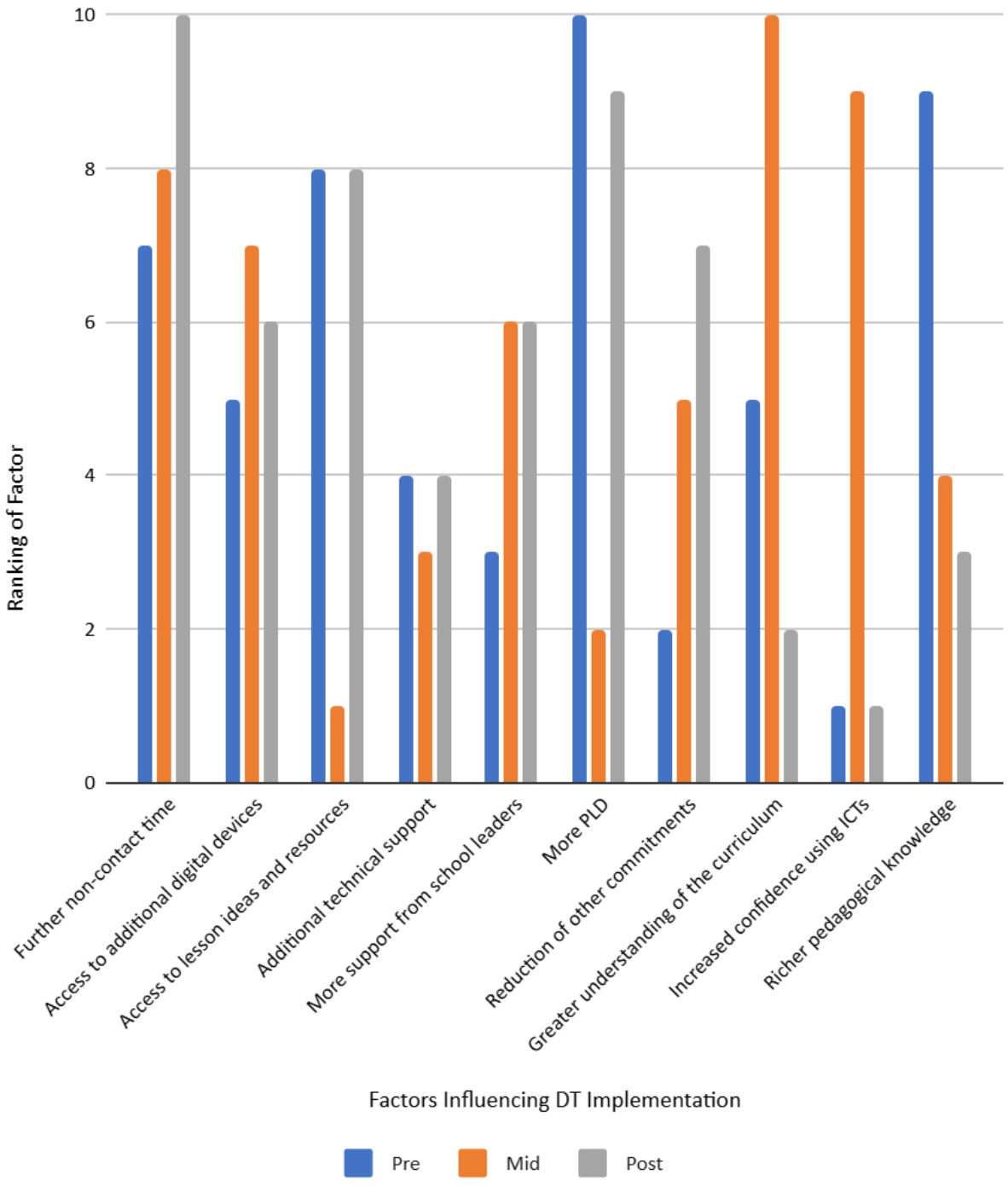
Figure 6:
Participant 3's Implementation Over the Research Period



Note: The following values were given to each level of implementation: I'm unsure of the task = 0; never = 1; less than once a term = 2; about once a term = 3; about once a month = 4; about once a week = 5; almost daily = 6.

Participant 3's rankings of factors they felt supported their implementation are shown in Figure 7.

Figure 7:
Factors Supporting Participant 3's DT Implementation Over the Research Period



Note: Values from 10 (most support) through to 1 (least support) were given to the participant's ranking of each factor.

With steady increases in their Raranga Matihiko Kaiako framework ranking at each period (pre- = developing understandings; mid- = integrating; post- = embedded), it seems Participant 3 achieved their initial goal of integrating DT in an engaging way throughout their daily programme.

> I believe the experience I have developed looking more deeply into DT curriculum has helped me organise and present the learning in a more fun and interactive way for the kids. (P3Q3)

Continual increases in their implementation of binary skills were seen, although some of this may be attributed to the two-day CS workshop that Participant 3 undertook between the mid- and post-data collection points. Over the research period, access to additional non-contact time and a reduction in other commitments became more of a concern for them. Immediately after the PLD, a drop in access to lesson ideas was seen, but, at the post-mark, this had risen to its initial value, with Participant 3 claiming that they aspired to develop more inclusive DT lessons:

> I feel less confident in developing DT activities for students with diverse needs. (P3Q3)

In the post- period, Participant 3 saw the importance of school leadership support to their implementation as more important than before, commenting that they did not feel their school leadership team listened to the teachers regarding the implementation of DT.

Participant 4: Online Facilitated PLD

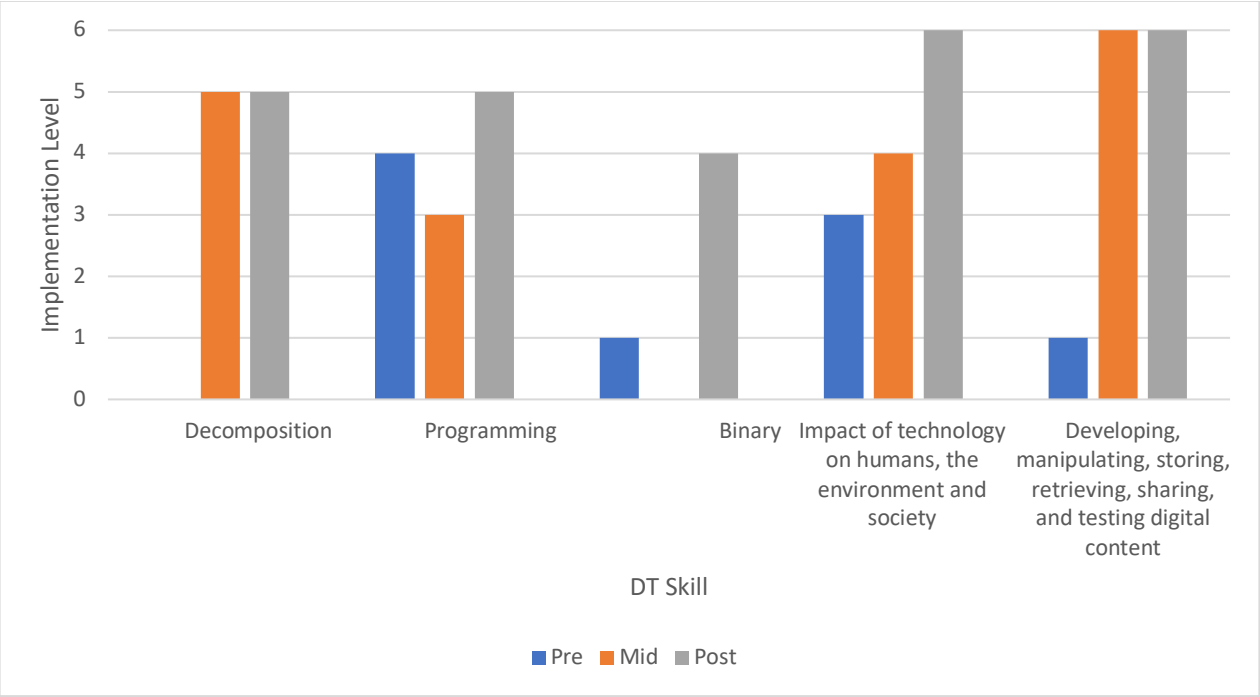
The basic background information of Participant 4 is shown in Table 4.

Table 4:
Participant 4's Background Information

Age	40–49 years
Gender	Female
Age of students (years)	2022/2023: 9–11
Highest education qualification	Degree
CS qualification	No
Previous DT PLD	Yes
Research PLD completed	1–4 hours DT PLD
Intended to complete further DT PLD – mid-mark	Yes
Intended to complete further DT PLD – post-mark	Yes

Participant 4's level of DT implementation is graphed in Figure 8.

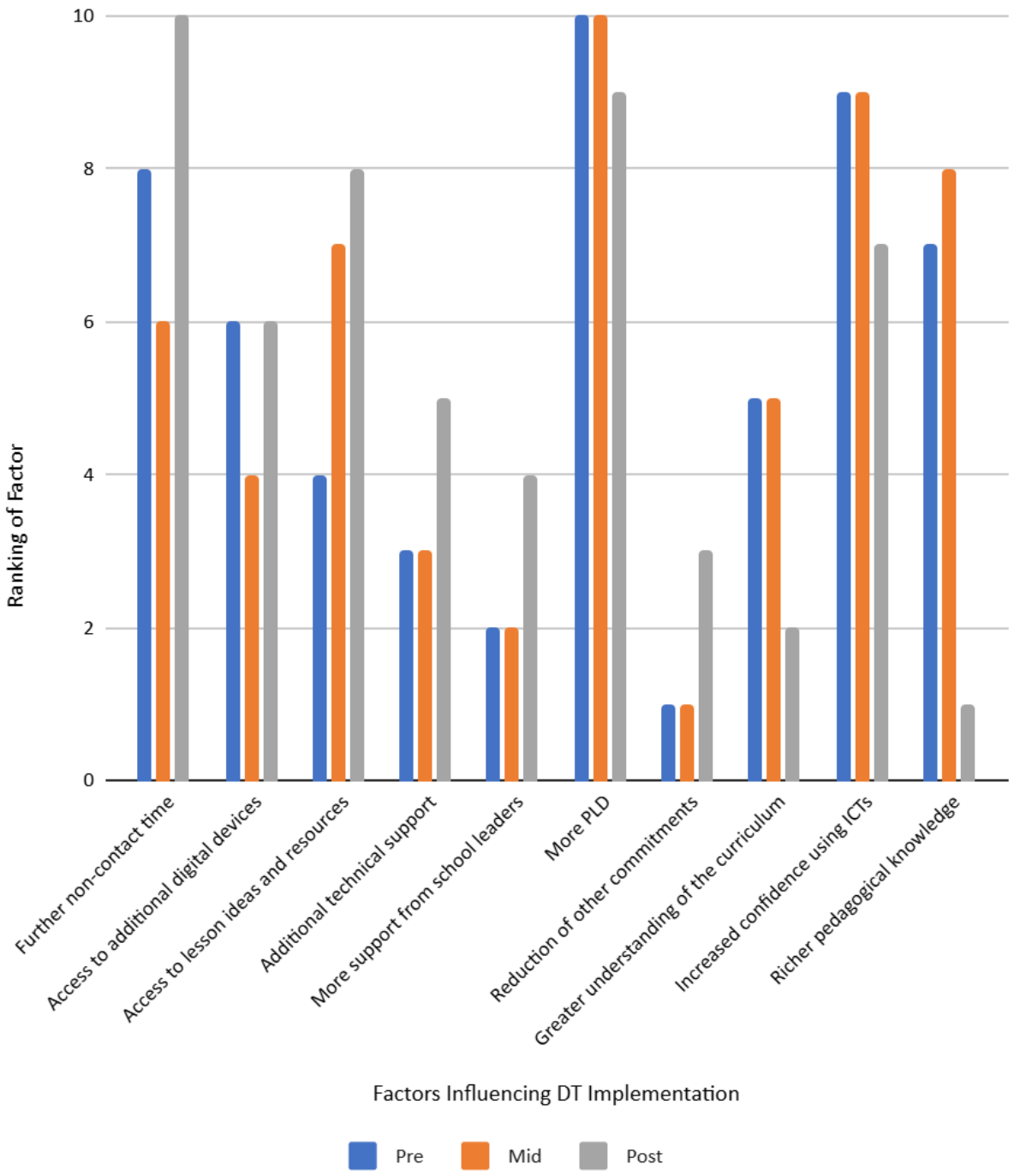
Figure 8:
Participant 4's DT Implementation Over the Research Period



Note: The following values were given to each level of implementation: I'm unsure of the task = 0; never = 1; less than once a term = 2; about once a term = 3; about once a month = 4; about once a week = 5; almost daily = 6.

Participant 4's rankings of factors they felt supported their implementation are shown in Figure 9.

Figure 9:
Factors Supporting Participant 4's DT Implementation Over the Research Period



Note: Values from 10 (most support) through to 1 (least support) were given to the participant's ranking of each factor.

Participant 4 showed steady increases in their Raranga Matihiko Kaiako framework ranking throughout the research period (pre- = developing understandings; mid- = integrating; post- = embedded), with their qualitative comments illustrating the development in both their understanding of the DT curriculum content and how to implement this.

> I have a better understanding of the curriculum [content] now. The facilitator was great at simplifying some of the terms and their meanings. (P4Q2)
>
> My confidence in the content I deliver has grown, and I am able to integrate it through more curriculum areas. (P4Q3)

They showed a large increase in their implementation of decomposition skills immediately after the PLD and commented that they had previously been implementing parts of the DT curriculum content without realising it. Non-contact time and further PLD were the highest challenges to Participant 4's implementation, yet access to lesson ideas and resources was an increasingly important factor in enabling them to keep students engaged and continue their own learning.

> My challenge is to continue to find fresh resources. For example, I have been using Scratch Jr for a couple of years, and I do it really well, but I need to find other Apps or sites so that my students are not getting bored, and they/we are continuing to grow their/our capabilities. (P4Q2)

A lack of classroom time to implement DT was raised, with Participant 4 claiming, at the final data collection point, that they lacked adequate time to effectively implement DT, even when they were embedding the learning within other curriculum areas.

Participant 5: Online Self-Led PLD

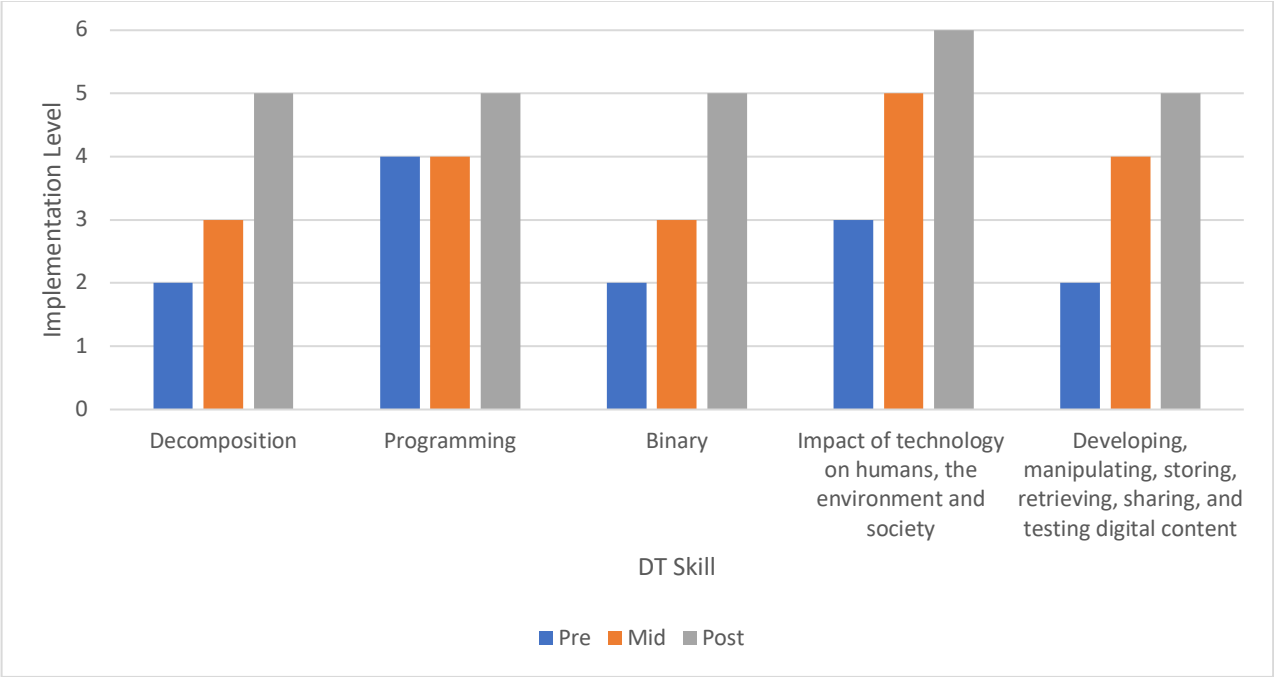
The basic background information of Participant 5 is shown in Table 5.

Table 5:
Participant 5's Background Information

Age	40–49 years
Gender	Female
Age of students (years)	2022: 5–7; 2023: 6–8
Highest education qualification	Degree
CS qualification	No
Previous DT PLD	No
Research PLD completed	4–8 hours DT PLD
Intended to complete further DT PLD – mid-mark	Yes
Intended to complete further DT PLD – ppost-mark	No

Participant 5's level of DT implementation is graphed in Figure 10.

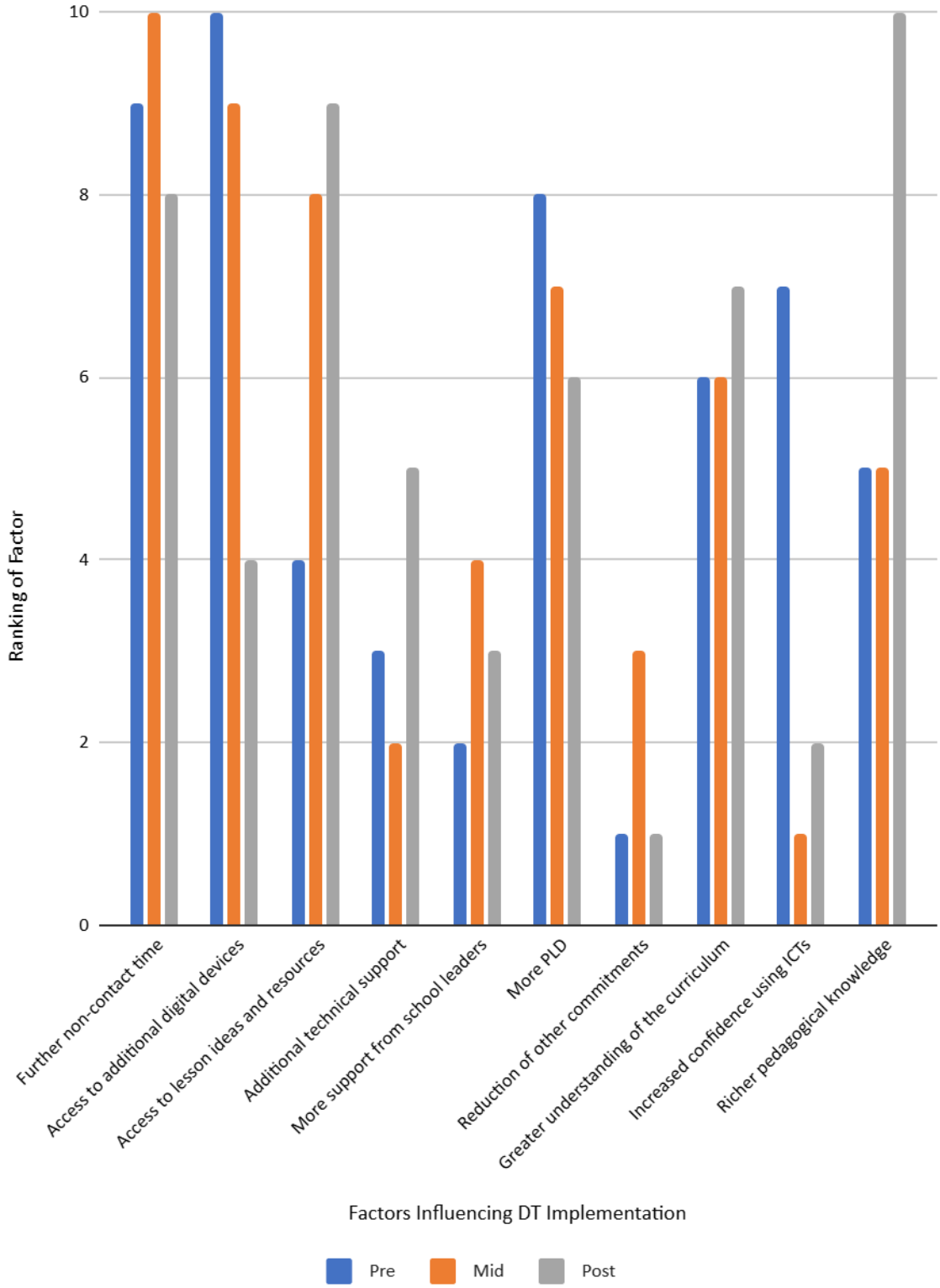
Figure Ten:
Participant 5's DT Implementation Over the Research Period



Note: The following values were given to each level of implementation: I'm unsure of the task = 0; never = 1; less than once a term = 2; about once a term = 3; about once a month = 4; about once a week = 5; almost daily = 6.

Participant 5's rankings of factors they felt supported their implementation are shown in Figure 11.

Figure 11:
Factors Supporting Participant 5's DT Implementation Over the Research Period



Note: Values from 10 (most support) through to 1 (least support) were given to the participant's ranking of each factor.

Participant 5 showed an increase in their Raranga Matihiko Kaiako framework ranking at the mid-mark (pre- = developing understandings; mid-/post- = integrating), which could partly be explained by the additional DT they received throughout the research period from external facilitators as part of a school-wide initiative. At the six-month mark, Participant 5 stated that they implemented each of the key DT skills at least weekly and claimed their school had new PLD priorities. Implementing skills they were unfamiliar with, while supporting the varied needs of particular students, was an ongoing challenge for Participant 5, alongside ensuring the lessons were designed to include all students regardless of their knowledge and abilities.

> We have many students with high and complex and varied needs – this can be an issue when teaching ANY curriculum – but especially one I am not completely 100% confident in/knowledgeable about. (P5Q2)

A large drop in the importance of access to additional digital devices was seen during the final data collection period, with Participant 5 stating they had been focusing on unplugged DT learning that does not require digital devices.

Participant 6: Online Self-led PLD

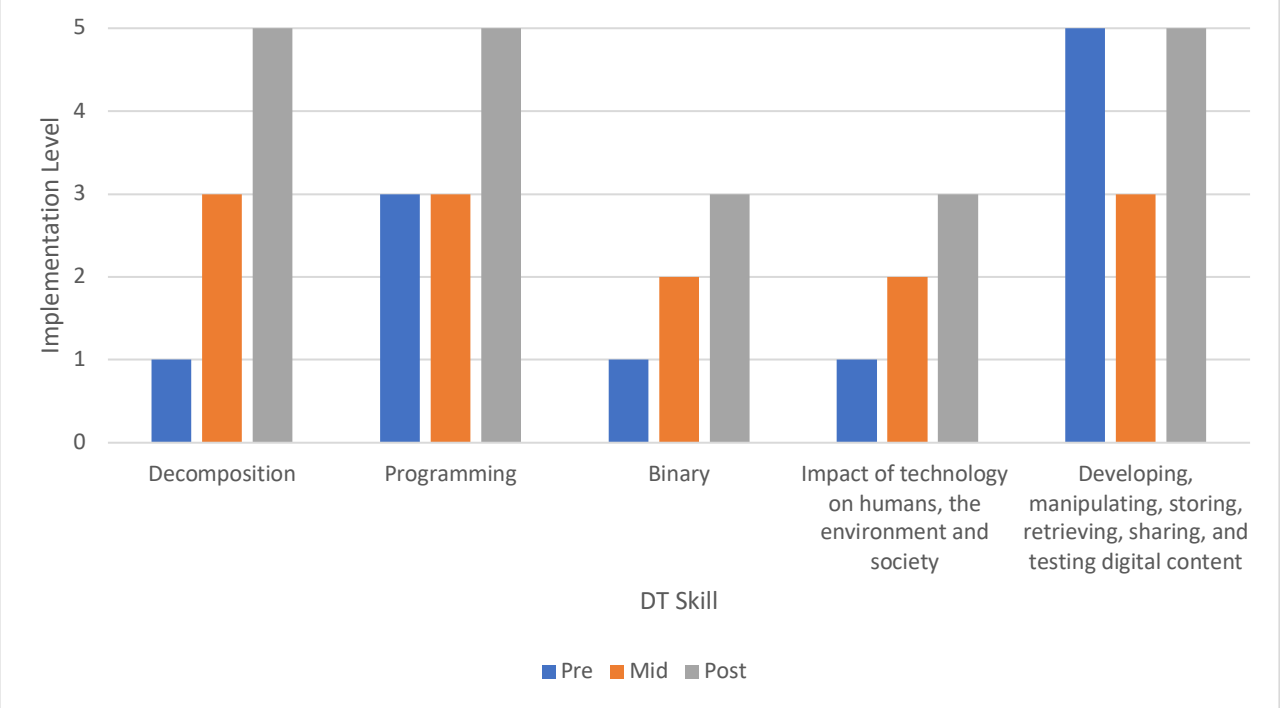
The basic background information of Participant 6 is shown in Table 6.

Table 6:
Participant 6's Background Information

Age	50–59 years
Gender	Female
Age of students (years)	2022: 9–11: 2023: 8–10
Highest education qualification	Degree
CS qualification	No
Previous DT PLD	No
Research PLD completed	8–12 hours DT PLD
Intended to complete further DT PLD – mid-mark	Yes
Intended to complete further DT PLD – post-mark	Yes

Participant 6's level of DT implementation is graphed in Figure 12.

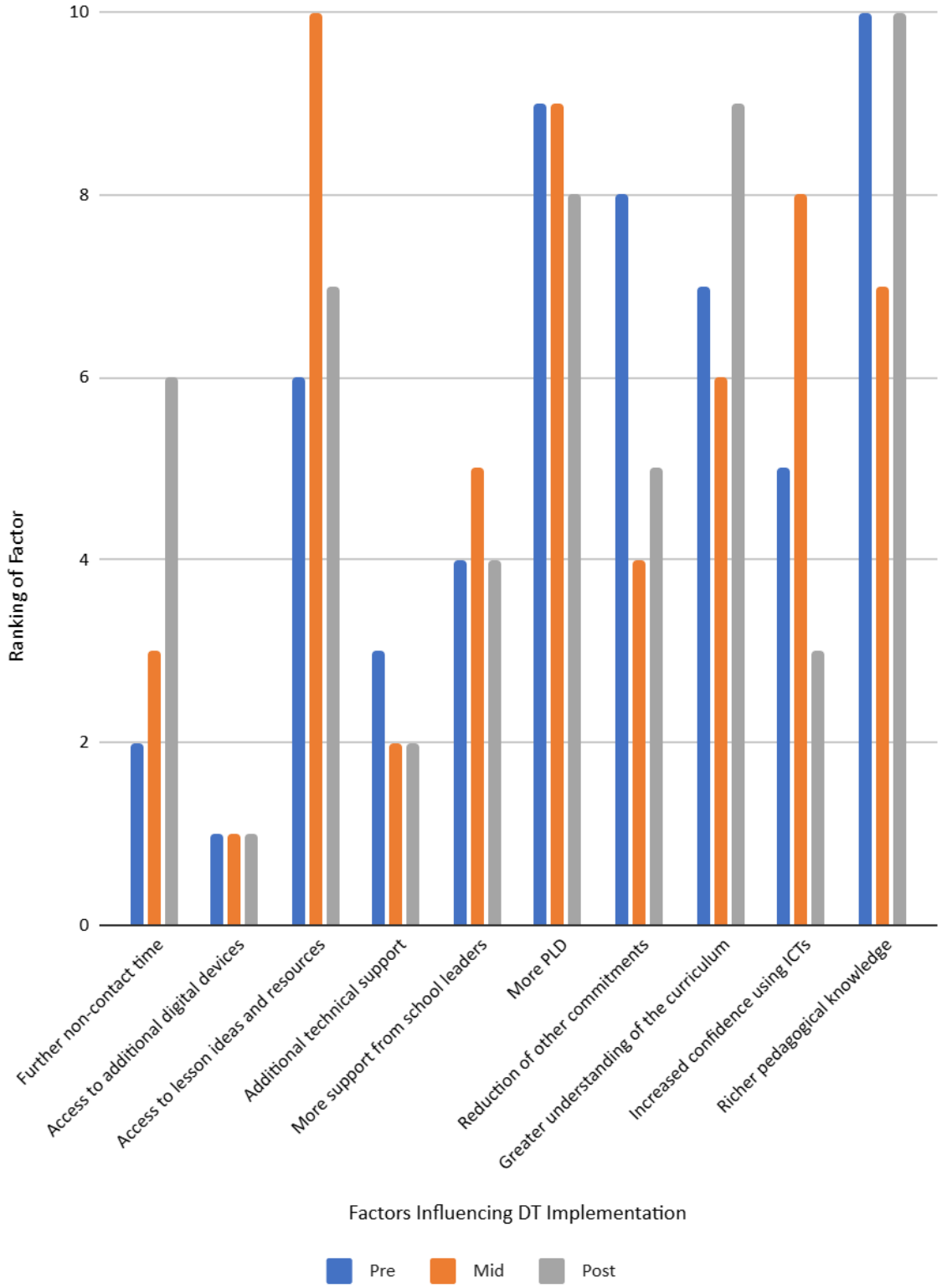
Figure 12:
Participant 6's DT Implementation Over the Research Period



Note: The following values were given to each level of implementation: I'm unsure of the task = 0; never = 1; less than once a term = 2; about once a term = 3; about once a month = 4; about once a week = 5; almost daily = 6.

Participant 6's rankings of factors they felt supported their implementation are shown in Figure 13.

Figure 13:
Factors Supporting Participant 6's DT Implementation Over the Research Period



Note: Values from 10 (most support) through to 1 (least support) were given to the participant's ranking of each factor.

Immediately after the PLD, Participant 6 claimed their understanding of and confidence to teach DT was greater, yet the real change in both was seen at the six-month post-mark, with their qualitative comments supporting a jump in their Raranga Matihiko Kaiako framework stage (pre-/mid- = developing understandings; post- = integrating).

> I am more aware of the Digital Technologies curriculum [content] and am constantly thinking about how I can integrate it into what we are doing all the time. (P6Q3)

These comments connect with the continual increases in the implementation of three of the five DT skills. Of note is the drop and subsequent rise in the importance Participant 6 placed on a greater understanding of the curriculum content and richer pedagogical knowledge. The qualitative data suggests that, immediately after the PLD, they had an increase in their confidence to teach DT, and, by the six-month point, they wanted to develop their knowledge further because they had set a goal to integrate DT into everything they were doing in class. At each of the three data collection points, Participant 6 mentioned a lack of time as a challenge to their DT implementation, both in introducing something new to their classroom and in working collaboratively with colleagues.

> I think the biggest challenge at the moment is finding the time to share our successes and failures and supporting each other. (P6Q3)

This final statement shows that Participant 6 understands the importance of connecting with other teachers to further their DT knowledge and support others yet struggles to find the time amongst other commitments to undertake this collaboration.

Discussion

Finding 1: Implementation of key DT skills was more intentional after the PLD

Like the participants in Rich et al.'s (2017) research, participants felt they had initially underestimated the amount of each skill they were already teaching within other learning areas after they were introduced to key CS skills and showed how these are taught within other learning areas in their first PLD session. This finding is supported by constructivist learning theory, which suggests that participants were able to connect new learning from the PLD to their current teaching practice, resulting in an instant confidence boost and planning and delivery of more explicit DT lessons.

Contrary to Whitworth and Chiu's (2015) concerns around the ineffectiveness of 'one-shot' workshops, each of the three short PLD models had a positive and lasting impact on the quality and quantity of DT implementation. Reinforcing Stupurienė et al.'s (2023) recommendation, there is a need for further investment in high-quality PLD to enhance teachers' DT knowledge and boost their confidence to implement DT.

Finding 2: Participants wanted additional DT PLD but lacked the time to undertake this

For many participants, their sense of the importance of completing additional DT PLD increased at each data collection point, yet their intentions to complete the PLD decreased. This difference between aspirations and actions is repeated in the findings of Korhonen et al. (2023) and Israel et al. (2022), with participants describing barriers to implementation such as limited time, other school priorities and a lack of support. Adding further concern to this finding is that a lack of time to upskill in new curriculum content has been found to cause some teachers' anxiety (Korhonen et al., 2023).

While this finding emphasises that teachers require support in the form of either additional classroom release time or a reduction in other commitments in order to be able to commit to additional DT PLD, there are other factors to consider. Following a school-wide approach may help to support knowledge development across teachers (DeLyser et al., 2020) and ensuring teachers engage only in high-quality targeted PLD is crucial to make the most of teachers' limited time (Korhonen et al., 2023).

Finding 3: The provision of familiar lesson resources gave participants the confidence to trial DT implementation

In keeping with the findings of Love et al. (2022), participants found the hands-on lesson ideas and resources provided as part of the PLD supported their implementation and willingness to trial implementing DT. While Crow et al. (2019) found a wealth of DT resources available online, the provision of lesson ideas that provided teachers were provided guidance was seen to give teachers the confidence to trial implementing the DT lessons immediately after the PLD, while their knowledge and enthusiasm were elevated. This relationship between the provision of resources and teachers' implementation is so strong that Stupurienė et al. (2023) suggest many teachers are unlikely to begin DT implementation without guidance around lesson resources.

While the provision of resources through the PLD initially boosted teachers' DT implementation, at the six-month post-PLD mark, accessing resources became a challenge to the implementation for most participants. Additionally, participants felt an inability to create their own resources to meet the learning and behavioural needs of their group of students.

This finding raises questions about the need for PLD that provides participants with resources to boost their confidence to implement DT (Stupurienė et al., 2023), yet also supports teachers to plan DT lessons targeted to the needs of their students (Love et al., 2022).

Limitations

This article describes the experiences of only six participants within a much larger research project. No male teachers were included, nor teachers implementing the Hangarau Matihiko curriculum. Only questionnaire data was collected, and participants were recruited solely through electronic means (email and social media). Participants engaged with three different PLD models, each with slightly different content and features. While these research features are not uncommon in education research, acknowledging them helps to contextualise and validate the research findings.

Conclusions and Future Work

While change is nothing new in education, the introduction of the New Zealand DT curriculum content in 2018 has faced many unprecedented challenges. The COVID-19 lockdowns had a direct impact on how schools operated throughout 2020 and 2021, and there has been a lack of MOE funding and support to boost teachers' DT implementation post-2021. The Aotearoa/New Zealand Histories curriculum was mandated from 2023, and many schools are now investing in PLD in areas of Te Mātaiaho, the refreshed curriculum being mandated in stages from 2025. Amidst these challenges and conflicting priorities, it is crucial that we remember our somewhat forgotten Hangarau Matihiko and DT curriculum content and the importance of teaching these skills to future-proof our students.

The research found that each short-term DT PLD model had a positive impact on teachers' DT confidence and implementation, with improvements seen in the quality and quantity of DT lessons that participants were implementing. Of particular importance to the New Zealand context, a positive development was observed in participants' ability to authentically embed the DT curriculum throughout other learning areas.

While participants understood the value of additional DT PLD to support their DT implementation, they simply lacked the time to engage in it. Although some students can struggle with basic digital literacy, others possess or develop a high level of digital literacy, and all students are likely to be expected to achieve a high level of digital literacy. Teachers need to keep growing their DT knowledge and implementing DT to develop students' digital literacy.

Pairing PLD with a bank of lesson ideas and resources gave teachers the confidence to test new ideas in their classrooms and initially boosted their DT implementation, yet participants required further support to develop their own targeted DT resources. While many OECD countries are now calling for the development of standardised learning resources (van der Vlies, 2020), further research is needed in this area to determine the

impact this has on teachers' efficacy beliefs, the authenticity of their implementation and the ability to meet all students' learning and behavioural needs.

Given the increasing importance of ensuring students are provided with the skills for their futures as outlined within CS curricula, it is crucial that countries invest in high-quality DT PLD that aims to raise teachers' DT knowledge, confidence and ability to plan for DT implementation. The numerous barriers teachers face when implementing CS curricula mean that the slow global implementation of the curricula is unsurprising. Through investigating the experiences of these teachers, we have a better understanding of the changes that we can advocate for to better support current and future teachers' DT implementation.

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