Chapter 11
Thinking About the Future for Learning: ILE Realities and Possibilities

Liz Reinsfield

Abstract The emergence of Innovative Learning Environments (ILEs) has led to research interest in secondary teachers' evolving professional identities and practice, when they are motivated to design learning to accommodate their students' learning needs. Learner-centred and responsive teaching approaches can accommodate students' academic interests and learning needs within social contexts marked by rapid change, as precipitated by evolutions in digital technologies. These have led to trends affecting teachers' patterns of work. The project reported here shows how changes to learning spaces can affect both teachers' thinking and the ways in which they might design learning. The interpretive, qualitative research project enabled exploration into teachers' perceptions and lived experiences through interviews, observations and teacher-generated resources. The project's findings extrapolate ways in which teacher thinking can support the learning of those who will face the realities of uncertain and rapidly technologised futures. The findings imply challenges for pre-service and secondary teachers' practices and professional development if they are to reshape and use affordances providing access to the technologies of flexible and well-provisioned physical spaces and digital resources. This chapter ends with suggestions for supporting current and future teachers to prepare for schooling within this century.

Keywords Technology education · ILE · Pedagogy

Introduction

The emergence of Innovative Learning Environments (ILEs) has led to a focus on the ways in which teachers develop their pedagogical responses to accommodate students' learning needs. School structures are also changing to accommodate new ideas about teaching and learning (Leggat, 2015; Wright, Chap. 2). There is a correlation between high-quality ILE models and improved student outcomes, particularly

L. Reinsfield (✉)
School of Education, University of Waikato, Hamilton, New Zealand
e-mail: elizabeth.reinsfield@waikato.ac.nz

© The Author(s), under exclusive license to Springer Nature Singapore Pte Ltd. 2021

N. Wright and E. Khoo (eds.), *Pedagogy and Partnerships in Innovative Learning Environments*, https://doi.org/10.1007/978-981-16-5711-5_11

when there are interdisciplinary, collaborative approaches to teaching, coupled with sustained professional learning and supportive school structures (Blackmore et al., 2011; Darling-Hammond et al., 2002; Osborne, 2016; Reinsfield, 2019a, b; Wright, 2018). This chapter considers existing Initial Teacher Education (ITE) programmes and their role in preparing student teachers for the types of practices they are likely to experience in the future. This is currently pertinent given the paucity of research in this area and it is difficult for student teachers to be placed in ILEs to see such practices first-hand because they are still relatively uncommon.

There are various factors fundamental to the successful implementation and enactment of innovative and responsive educational practice. Educational change is a complex process. The move to flexible, large, and well-provisioned spaces means that teachers will need to reshape their thinking and pedagogical practices, navigating a range of potentially unfamiliar challenges. In such contexts, teachers might feel forced or rushed in their need to change (Handal & Herrington, 2003). Some teachers can be suspicious of reform and understandably concerned that their changing practices can negatively affect their students' learning outcomes. In such situations, teachers may rely more heavily on their own beliefs, on what they perceive to be their teacher identity, defaulting to routine practices rather than potentially riskier, unfamiliar and/or student-centred pedagogical approaches (Reinsfield, 2018a). For example, innovation in teaching can be represented through an increased engagement in differing pedagogical practices, which include real-world learning opportunities for students, resulting from engaging in personalised learning programmes (Organisation for Economic Co-operation and Development (OECD), 2014).

Learner-Centred and Responsive Pedagogies

There has been growing international attention focusing on learner-centred approaches to pedagogy because such approaches better recognise students' academic interests and needs (McCombs & Whisler, 1997; Onchwari et al., 2009; Tabulawa, 2003; Windschitl, 2002). A learner-centred perspective allows a teacher to acknowledge students' worldviews, as represented by their knowledge, skills and cultural context, which is valued in Aotearoa New Zealand (McCombs & Whisler, 1997; Reinsfield, 2019a). Within a frame of learner-centred pedagogy, the expectation is that it encourages students to reflect and assess their learning, positioning teachers to provide opportunities for students to engage in self-directed, critical and authentic learning. Self-regulated learners have been described as confident, diligent, proactive and resourceful, knowing what they can and need to do to achieve academically.

Self-regulation can be supported by teachers exploiting students' interests, by offering scope to pursue creativity and innovation, or through research and experimentation. They also seek support and advice as they require it (Zimmerman, 1990). Zimmerman argued that self-regulated learners can solve problem, take responsibility for their learning, plan, set goals, reflect and be adaptive. With appropriate

support, self-regulated learners are likely to experience confidence and self-belief as learners. However, this state of well-being can depend, amongst other factors, such as the professional skill of teachers to design an environment that fosters such a climate for learning. The design of an environment is impacted on what a teacher values for learning, their teacher identity, and subsequent use of pedagogical practices.

Secondary Teachers' Professional Identity and Pedagogical Practice

Teachers' identities and how they describe their practices can be viewed via Hoyle's (2008) observation "that one of the defining characteristics of members of a profession is the ability to function effectively in uncertain and indeterminate situations" (p. 285). The professional identity of teachers appears to have a direct correlation with their emerging professional practices (Biggs, 2006; Dakers, 2006; de Vries, 2005; Fox-Turnbull & O'Sullivan, 2013). These practices evolve within specific school contexts in tandem with their own sense of professional belonging (Guskey, 1988; MacGregor, 2017; Roche & Marsh, 2000; Shavelson et al., 1976). Teachers' identities inevitably influence their engagement and use of a range of pedagogies and tools. This is particularly applicable to teachers' uptake and use of digital technologies in their practices, or when teachers find themselves in schools where they must collaborate and teach in teams, applying different kinds of curriculum provision than they may have previously experienced.

The term "effective pedagogy" is presented in the *New Zealand Curriculum* (NZC) (Ministry of Education, 2007, p. 34). The NZC outlines that "there is no formula that will guarantee learning for every student in every context" (MoE, 2007, p. 34), and also communicates that students learn best when they feel supported and safe in their school or classroom. With such advice, teachers are encouraged to consider their own contexts and work out how to provide optimum conditions for learning. This might include reflecting on their own actions, designing the learning focus to meet identified needs, facilitating and supporting students' collaborative practices and recognising students' prior experiences as valuable classroom assets. Put together, these actions offer substantive learning opportunities. Such opportunities for enacting a range of pedagogical approaches are likely to be mediated by the school's context, what it values and privileges through resourcing and curriculum design (Reinsfield, 2018a) (see Chap. 2). Parents can thus make decisions for their children based on, perhaps, the ethos and values they think the best match their children's needs, and/or their social expectations. Community expectations can therefore have the potential to enable, moderate or limit teachers' innovative classroom practices (OECD, 2012; Reinsfield, 2018a).

Education has traditionally focused on the development of students' competencies, in particular their understanding of content knowledge and practical skills. There has been a growing expectation however, that education develops students'

capabilities to adapt to rapid social and technological change and contributes to the generation of new knowledge (Fraser, 2000; Reinsfield, 2018a). To foster a climate of innovation for learning in which these expectations can be met, teachers are likely to need to encourage students' creative, critical and reflective thinking, about issues such as the influence and role of digital technologies in our lives.

Digital Technologies in ILEs

Policy documents, like the Aotearoa New Zealand School Property Strategy (Ministry of Education, 2011) assert that ILE's are a means to develop "a world-leading education system [able to provide] all Aotearoa New Zealanders with the knowledge, skills and values to be successful citizens in the 21st Century" (p. 2). Twenty-first century skills are recently associated with future-focused conceptions of learning, which harness the use of digital pedagogies, are learner-centred in nature, and designed to emphasise critical and creative thinking in a variety of ways (Leggat, 2015; MoE, 2016a; Organisation for Economic Co-operation Development (OECD), 2013; Reinsfield, 2018a). The use of digital technologies can transform learning to enable students' participation in a developing global and digital community (Dakers, 2016; de Vries, 2009; Feenberg, 2006; Wallace & Hasse, 2014), but the reported research was also focused on engagement with and enactment of the technology curriculum. This was particularly pertinent because the technology curriculum had just been revised, to emphasise the place of digital technologies. Teachers need to be supported to develop a learning context to know the distinction between the use of digital pedagogies, and the role of digital technology in the curriculum. This need is observed in schools but also has ongoing implications for ITE teachers' understandings of such practices (see Chap. 3).

One of the roles of ITE programmes is to expose student teachers to changes in educational thinking and practice. There are existing tensions however, between espoused and research-informed best practice, and the types of teaching that student teachers might observe when they enter schools for their professional experience (Reinsfield, 2018b). The emergence of ILEs signals another tension for ITE programmes, especially as many student teachers will not be placed in schools of this nature during their time at University. The next section describes the research project, which explored technology teachers' practice in secondary schools in Aotearoa New Zealand.

The Project

This chapter, reporting findings from an interpretive, qualitative research project in which I (Reinsfield, 2018a) applied multiple case study methods to contextualise and communicate the nature of six teachers' practice, four of whom worked in a

junior secondary ILE. Observational, self-report, and visual data collection methods helped me understand the influences on secondary teachers' perceptions and practice at individual, interpersonal, and organisational levels. I had direct contact with participants in their school consider how social arrangements and rules affected teachers' practices in their professional context (Patton, 2001). I used Nvivo 11 for coding and assuring trustworthiness, while Activity Theory acted as my interpretive analysis framework. It helped me conceptualise the school's internal operations, its department settings, and established teachers' shared understandings within their own community of practice (Wenger, 1998).

Activity Theory

Socio-cultural theorists have used Vygotsky's (1978) first generation of activity theory, centring on the concept of mediation and represented in triangular form. Vygotsky's mediated triangle can be used to situate teachers as participants of an activity. In the context of my research (Reinsfield, 2018a), teachers' engagement with differing pedagogical practices presented opportunities to develop new understandings about the potential to transform teachers' thinking. They recognised that meaningful activity is seldom accomplished in isolation, and that "the mind does not work alone" (Pea, 1993, p. 47). From this perspective, individuals' knowledge and meaning-making were perceived to result from collaboration with others in their professional community, as represented by joint actions (such as teaching or professional learning discussions), shared artefacts or the use of common language.

Cultural artefacts and the tools and knowledge required for their sustained use are passed through the generations (Barab et al., 2004). For example, how teachers engage with and use digital technologies to enable their practice, can be represented in different ways. Individuals' understandings of the use of digital technologies are likely to limit, moderate or enable their engagement in an activity. Cultural boundaries (or discourse) in a school can also affect ways that teachers foster students' developing, new, or significant knowledge, and subsequently share that knowledge with others—such as student teachers. A secondary teacher's practice is socially embedded and likely to be reflective of explicitly stated rules, and the valued practices within a school community. The way that teachers' practices are therefore reflective of their sociocultural context—in this case an ILE. In newly conceived learning environments such as ILEs, teachers' engagement in new praxis is likely to be influenced by their prior knowledge and motivation to develop further understanding. However, there can also be conflicting individual or collective actions, and motives can counter shared goals within the community.

According to Engeström's (2001) model, elements of an activity system are goal-directed and consist of instruments, subjects, objects, rules, community, division of labour, and outcomes. These elements and their interactions are represented in Fig. 11.1.

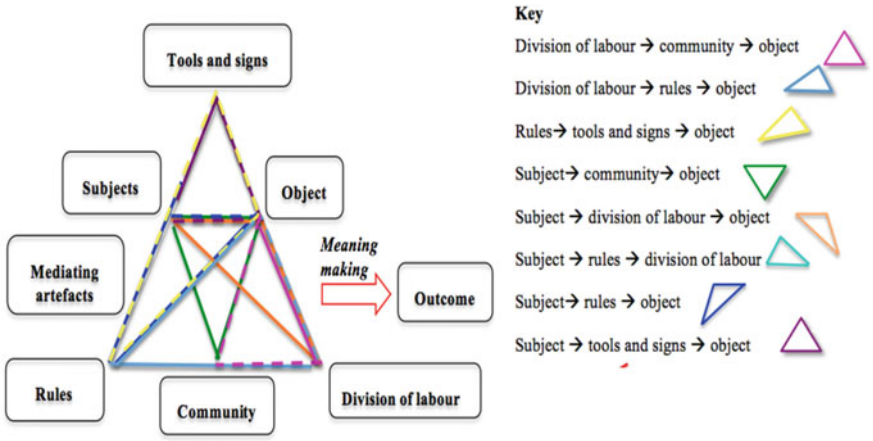

Fig. 11.1 A sub-activity system

The elements and their application in Reinsfield's (2018a, b) research are outlined in Table 11.1, as the mediators for an activity system, which can be used to understand human activity from a holistic perspective (Kuutii, 1991).

An activity system highlights multiple perspectives, customs, and motivators (Engeström, 2001). The element of division of labour, for example, acknowledges that participants will have experiences that mediate their professional responses.

Activity systems can aid the acknowledgement of rules and conventions, as determined by the discourse in a school. The notion of "contradictions" is a key principle in activity theory and can identify tensions in a phenomenon, and as a means to develop understanding, facilitate change, or to motivate new learning (Kuutii, 1991). Contradictions can occur as the result of socio-historical circumstances within or across activity systems and at different stages of an activity (Engeström & Sannino,

Table 11.1 Activity theory as an interpretive framework

Activity system element	Explanation
Tools and signs	The theoretical ideas and resources available for teachers' developing understanding of new praxis
Mediating artefacts	The conceptual and physical resources that represent teachers' learning processes
Subjects	Secondary school teachers in an ILE
Objects	Teachers' perceptions and engagement with the curriculum
Rules	The discourse determining the sociocultural environment
Community	Secondary school teachers, school community and the influence of political agenda
Division of labour	Teachers' roles in the department, use of pedagogies
Outcomes	Representations of teachers' pedagogical understandings

2011, Kuutii, 1991), or in Technology Education as a consequence of socio-economic constructs that attribute value-like tensions in students' conceptual or practical skill development within a curriculum (Engeström, 1987; Reinsfield, 2018a). Identifying contradictions can recognise existing challenges to practice and support conceptual change (Roth, 2013; Singer & Voica, 2008). According to Vygotsky (1978), human learning is an "outside-in" process described as internalisation and externalisation, where knowledge can be transformed from a social context to an inner psychological conception. Key here is an interest in "how interpersonal activity, including tools/and or language, became transformed into intrapersonal, mediated thought", or how teachers' thinking impacts their practice. The next section considers the factors influencing teachers' meaning-making practices when engaging with the official curriculum.

Findings

Reinsfield's (2018a) findings indicated that there are persistent tensions that continue to influence secondary teachers' pedagogical practice. How these tensions are navigated can depend on the nature of the school that they teach in. Of particular interest was a newly established ILE school where staff had already been involved in professional learning that focused explicitly on teaching in larger, more open classroom spaces than they would have been used to. I observed a range of professional discussions, which reviewed past professional experiences and what staff needed to think about and plan for in the new learning spaces. All teachers were expected to use digital technologies to enable students' learning. The factors highlighted as enabling or limiting teachers' practice included community expectations for learning, wider organisational issues, and the nature of the integrated curriculum.

In this school, teachers were regarded as both generalists and curriculum specialists and worked as part of a team to deliver an integrated curriculum to students in Years 7 to 10. Research observations equated to learning where two curriculum areas (e.g., Technology Education and Mathematics) were combined into modules connected via a common topic or project. Participant teachers indicated that when working with other teachers, much of their planning time was spent establishing the role of their learning area in delivering the integrated curriculum. Teachers supported colleagues' understandings of the curriculum practices needed to support teaching as it is conceptualised in the *New Zealand Curriculum* (Ministry of Education (MoE), 2007, 2017). This finding has implications for ITE programmes, where secondary teachers' learning about the curriculum has traditionally been siloed into specialist areas.

Participant technology teachers' use of digital technologies highlighted both their perceptions and ways that they designed learning. For example, there was a school-wide expectation that all students used their devices (in the place of books), and used equipment like 3D printers when students were learning about the technological area of designing and developing material outcomes. One participant signalled some

professional tension that resulted from teaching in a school where computer-aided design and manufacturing equipment (CAD/CAM) was readily available and could produce an outcome overnight, and without human intervention. She explained that it was still important for students to be encouraged to develop manual skills and rationalised her concerns, stating that the senior high school was

> … Getting some quite technical equipment, he's getting a big laser cutter and CNC machine... so we'll go down there as well and it'll be great for big projects. You might spend two terms designing something on a CAD package and then he'll press a button, go home and it'll be made in the morning and that's an okay thing but it's good to have some hand skills. (Final Interview E, Line 421)

This teacher positioned technology education as a subject underpinned by innovation and/or sustainable practices and described a tension between a future-focused conception of a subject that could make a difference to society, versus a traditional perspective, which valued an emphasis on quality outcomes to be sent home to parents.

Two of the participants felt that they were required to moderate the pedagogical risks that they were taking because of their community's expectations about the learning that *should* occur when students were studying technology education. One asserted there were continuing tensions for teachers because

> The unsustainability of the secondary model perpetuates the content cramming philosophy. The process-orientated [approach] is really good and technology teachers are really good at teaching procedural knowledge. There have been a couple of readings lately that suggest that procedural knowledge doesn't actually help the students… It's actually the social knowledge and the conceptual knowledge that changes the way that they think about the world. So that's our challenge really. (Baseline Interview E, Line 147)

All of the participant teachers acknowledged the need for them to continue to learn professionally. For example, one teacher described the range of strategies he used to remain current in his practice, stating

> I talk to others, Technology Online is my friend, I read papers, I just draw upon all of the stuff that I've learnt in the past too and always reflect and think about my practice and how I can do better. I learn from students, if things are working or not working. I don't ever do the same unit or the same project again. (Baseline Interview F, Line 187)

All teachers suggested a need to empower learners and be responsive to their needs, thereby changing the power dynamics between themselves and their students. One teacher stated that

> Our focus [is] on sustainability, enterprise and empowerment… We've [also] got the other [focus] which is innovate, design and make but really we've got to explore how those two fit together… We really want to empower our students and make them understand that they have a voice in the technological process and that technology is not done *to* them or doesn't need to be done *to* them [Emphasis added]
>
> ...We want our students to be able to solve problems and make stuff to solve those problems that makes a difference to them, to the community, to the world, and present that to an authentic audience. (Baseline Interview E, Line 187)

This teacher's classroom environment consisted of a large open space, shared with two other teachers who were working with their own groups of students. It was at times difficult for the students to hear over the noise from the other groups. The learning context was entitled a "Formula One" project and focused on the collaborative production of a car. This lesson began with teacher-led discussion about the planning processes required for the production of their Formula One car. The students then transitioned to an activity where they were required to conduct online research about electric motors. The lesson is represented as the activity system in Fig. 11.2.

This teacher's lesson was strongly influenced by the subject-rule and subject-community objectives. She emphasised her rules and described her classroom expectations by emphasising the need for students to get out their equipment (e.g., laptops). The lesson content focused on the making of a predetermined practical outcome—namely a car that would be collaboratively produced by the students. In the final phase of the observed lesson, the teacher changed the nature of the learning by directing students to do some independent research. She limited them to research about electric motors and provided the hyperlink to a website, stating

> Okay, you've got ten minutes and I'm going to get you to report back, and find out what you can about electric motors… Types of electric motors, fastest electric motors are good, any electric motors, okay? It could be the electric motor that's in your computer... (Lesson Observation E, line 65)

During her final interview however, the teacher reflected upon this lesson and indicated that she had cancelled that project. She explained

> I thought, it's not working and this school is about being flexible, we don't have to struggle to the end of the year, so I sat down and had a bit of a counselling session with the students and I asked "What's going well, what's not going well, how many of you guys want to continue?" They didn't really care and I said, "Oh well, next semester, you choose something else".

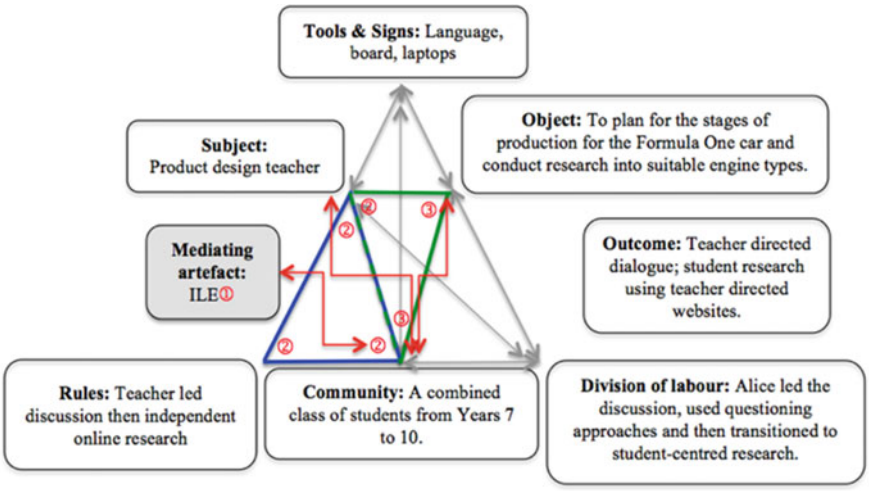

Fig. 11.2 Activity system representing the lesson observation

> …[Next term] I just did a making class and we just did some more basic stuff, it was a different group of kids and we did some 3D printing and we did some laser cutting and we did some basic wood materials and it was pretty much saying this is what we'll make and this is how we'll make it and there was flexibility, I mean after, they made something on the 3D printer they could make whatever they like.
>
> It's a culture thing and it's [about] building capability. We've had some students make some good little projects but it's the exception rather than the rule. (Final Interview E, Line 5)

The same teacher also described a project that she felt had been more successful. She indicated

> I did a Maths [and] Technology module and we did a whole load of small things. We did a puzzle that's got pins on and three circles and you've got to get them to the other side. It was a great project and we got the kids to work out the minimum number of moves and how many moves would be required if you had one more disc and then they worked out the formula for it, so it was fantastic. (Final interview E, Line 389)

She reflected upon the lesson observation, stating

> I just had so much on my mind at that point, trying to set up the workshop and having kids here and it just shows you that you can't multitask like that and you're not doing the best job that you can and you've got to really focus on the kids in front of you. (Final Interview E, Line 94)

She also reflected that if ideas for learning are

> Student generated, then they work and maybe that was the problem, I was saying, "We're making this car"… (Final Interview E, Line 227)

Whilst this teacher had established a reputation in the technology community for her work in the subject, her transition to a newly established school context had caused some professional tension. Her espoused perceptions advocated for learning that was flexible, and learner-centred but the reality of managing this approach alongside her other professional responsibilities was affecting her practice. Such contradictions highlighted opposing views and actions, which identified tensions in practice and provided insight about the potential for future change.

Interestingly, there were consistent tensions between the teachers' perceptions of the nature of technology and the need for them to interpret and adhere to a curriculum (MoE, 2007) that was not well understood. The objects used to support teachers during school-based professional learning focused on best practice, made assumptions about teachers' understandings, or did not directly connect to the enactment of the curriculum—in a deliberate manner. The rules imposed, such as the curriculum structures and community expectations, directly affected teachers' practice.

The influence of the subject-community-objective elements was evident during the department meetings. Specifically, these relationships were noticeable when teachers discussed the challenges they experienced when ensuring that the "essence" of technology education was maintained within an integrated curriculum in the newly established environment. The tensions, which support recommendations for change (Engeström, 1987) included the:

– propensity for teachers to make decisions about the nature of learning, without consulting students
– the differing levels of teacher engagement and interpretation of the curriculum (MoE, 2007), and
– the need for teachers to navigate disparity (as a tension or contradiction) between curriculum theory and practice.

There was evidence of a disparity between teachers' espoused perceptions and practice, and there were differing ways of thinking and attitudes towards their own practice, as the result of teachers' previous professional experiences. Teachers' capacity to make meaning of the curriculum (MoE, 2007) determined whether they felt empowered to take pedagogical risks, replicate, or retreat to previously established practice. It was apparent that curriculum structures were impacting on students' experiences of technology education.

Discussion

Government policy encourages teachers in Aotearoa New Zealand to be legitimate curriculum decision-makers (MoE, 2007). The tensions that exist between policy (in this case the curriculum) and practice (teaching and learning in schools) are socially organised and mediated by teachers' perceptions of the curriculum and their understanding of professional praxis. Participants' understanding of the curriculum was closely aligned to their past experiences as specialist teachers of technology. This finding is pertinent in light of the recent changes to the technology curriculum, where the role of digital technologies has been emphasised as a means to enhance learning. While developing students' digital capabilities is to occur primarily through the technology learning area, it is also expected to be embedded across the curriculum to (MoE, 2017). Such curriculum modelling was observed in Wright's research (2018), and addresses ideas Kiernan (2018) summarised. Kiernan predicted that the way that digital technologies are developing, 85% of the jobs that will exist by 2030, have yet to be invented. It is crucial that schools take heed of such trends to facilitate learning that positions students to cope in the future workplace.

Uncertainty about the future is likely to lead to opposing forces in meaning and meaning-making about what and how teachers should teach. Subsequent decision-making might unite or destabilise teachers' evolving understandings, which in turn can lead to a consolidation of thought or alternatively, a resistance to the dominant discourse in their school context (Mortimer & Scott, 2003). The need to foster staff culture and develop a shared vision was a pervasive idea within this research.

Staff Culture and Community Involvement

My research identified the importance of teachers working collaboratively, enacting an integrated curriculum, and being adaptive practitioners. Teachers in the new ILE were required to assess students' conceptual and real-world understandings in new ways and provide learning opportunities that facilitated deeper learning (Allen et al., 2016). In such contexts, teachers needed sound pedagogical knowledge and a commitment to constructivist approaches (Goodwin & Webb, 2014; Saxton et al., 2014). The kinds of things the ILE intended to foster were constructivist approaches to learning that valued collaboration, individual autonomy, active engagement, personal relevance and pluralism. The school leaders understood that such approaches acknowledge students' interests, allows them to make sense of their learning, and gives them spaces to actively create their own knowledge (Archambault, 1974; Cook-Sather, 2002; Duckworth, 1996; Lebow, 1993). Learning may take the form of problem-based learning (PBL), inquiry learning, and experiential learning and lead to an environment where there is less intrusive teacher guidance (Barrows & Tamblyn, 1980; Berwald, 1987; Boud et al., 2013; Kirschner et al., 2006; Kolb & Fry, 1975; Lombardi, 2007; Papert, 1980; Peacock, 1997; Snape & Fox-Turnbull, 2013). Ways to foster such an environment are discussed in the next section.

Establishing an Innovative Environment for Learning

Participant teachers in the ILE had the unique opportunity to foster a learning environment that could be construed as constructivist, innovative and future-focused in nature. Such approaches can translate to learning spaces where students' points of view are sought and valued, assumptions can be challenged, and personal meaning developed by working in ways that focus on a bigger picture for learning (Brooks & Brooks, 1993). Reinsfield's (2018a) research identified that whilst teachers' rhetoric might align with policy intent (such as the *New Zealand Curriculum* or learner-centred pedagogies), there can be organisational factors impeding curriculum implementation. This was surprising, as it was anticipated that in a newly established ILE, the school structures would be more responsive to the types of adaptive practice than a more traditional school might not be able to accommodate.

The recent review of the technology learning area in the *New Zealand Curriculum* provides an opportunity to conceive pedagogy differently and re-position students' learning so that it can be inclusive of creative, innovative, and critical thinking approaches, in a more purposeful and self-regulating manner. It is time for secondary schooling to be viewed not only as a means of preparing students for the *known* future workforce, but also for the *unknown* roles that might require different ways of thinking (Reinsfield & Williams, 2018). According to Reinsfield and Williams (2018) a technological way of thinking emphasises problem-based and critical thinking and can encourage students to focus on new or emerging societal issues that have personal meaning. The continued emergence of and engagement with new technologies means

that teachers have a unique position in which to explore unique teaching approaches, should they choose to think in a technological rather than technical way. A *technical* way of thinking when using digital tools might solely value a pre-determined and sequential approach to a task, focused on skills in its use, as determined by the teacher. A *technological* way of thinking implies criticality and creativity, and manifests iterative or responsive approaches to learning, which are meaningful, and determined by the learner (Reinsfield, 2018a).

From 2020, Aotearoa New Zealand schools are required to provide opportunities for students to engage with a range of digital technologies, to enable learning and develop capability for the future. To enable such a focus however, teachers and student teachers need to be exposed to, embracing of, and become habitual users of digital technologies, as modelled in their pedagogical practice. There was evidence to suggest that establishing a new environment requires wider understanding of how teachers' practice might be limited, moderated, or enabled by their previous professional experiences (MacGregor, 2017; Reinsfield, 2018a), to foster a climate that can exploit students' potential for learning—identifying the need for organisational structures to ensure that teachers can be supported as adaptive professionals who take risks and reflect upon their practice in meaningful ways.

The purpose of identifying contradictions and commonalities is to determine some of the historically accumulated tensions in (technology) education, with a view to propose strategies that can assist teachers to navigate these tensions and transform their practice (Engeström, 2001). By comparing networks of interacting activity systems, tensions were identified to represent the differing interpretations of the teachers' understandings for practice (Gee & Green, 1998). The factors in each school represented common themes despite the fact that the ILE was newly established and staff had experienced professional learning to develop their understanding of future-focused pedagogies. These commonalities included teachers' identities and the challenges they faced when making meaning of the curriculum concepts for their own specialist area. The school's community expectations were used to rationalise a technical approach to their subject, and there was some hesitation to engage with some of the aspects of the curriculum that were perceived to be more challenging (MoE, 2007). This suggests that these views communicate legitimate concerns about how the curriculum continues to be interpreted and enacted (Meyer & Land, 2003).

The Future for Learning

Future-focused approaches have the potential to engage students in authentic learning, which can make a difference to their school and local community and foster understanding about the way that technology interacts with the wider society. Such approaches can develop students' understanding of societal or global issues. However, the reported findings suggest that for the participants involved, there were enduring and outdated understandings about their learning area—in their school community. In turn, such views influenced their practice. There were particular

implications for motivated teachers because collegial, parental and students' understandings had to be navigated with a view to designing learning in their subject to address how it is conceptualised in the curriculum (MoE, 2007).

It could be assumed that when teachers are appointed for their expertise and philosophical attitudes towards contemporary pedagogies, that they would feel confident to interpret and enact the curriculum. There is a continuing need to consolidate teachers' understanding of the technology curriculum, and its association with the use of digital technologies within an integrated curriculum. There is however, a risk that teachers' practices might further entrench or continue to perpetuate outdated understandings about the nature of teaching in a secondary context. The next section provides some recommendations regarding the influence of such issues on Initial Teacher Education.

Recommendations for ITE Programme Design

In Aotearoa New Zealand, the Teaching Council, the regulatory body for education, has recently released new regulations for Initial Teacher Education programmes (Teaching Council New Zealand, 2019) requiring providers to prepare students to be future-focused and adaptive practitioners. There are challenges however, when student teachers need to be prepared for practice which is not well understood (Reinsfield, 2019b). Initial Teacher Education providers can, like some schooling contexts, be constrained by customary practice or practitioners' differing levels of engagement with new praxis. The findings from this research suggest an urgent need for ITE programmes to review and deliberately plan to:

- embed generic pedagogical approaches, such as e-learning, to model and extrapolate the pertinence of such practices in contextually specific ways (e.g., for Primary teachers)
- support ITE lecturers to think in technical, technological, and deliberate ways to enable connections between theory and practice
- support student teachers towards becoming adaptive professionals, who critique their own and others' practice, and advocate for constructivist and learner-centred pedagogies
- expose and provide opportunities for student teachers to collaboratively plan across curriculum areas to develop their understanding of the evolving nature of professional practice in both ILE and traditional schooling sectors, and to exploit the potential that a future-focused approach to learning can provide.

Conclusions

The ever-evolving nature of education means that there is an ongoing need for practitioners to reflect on, and critique their own and others' pedagogical practice.

The emergence of ILEs has accelerated this process in Aotearoa New Zealand and imply necessary changes to existing and student teachers' professional practice. The research upon which this chapter is based indicates an urgent need for student teachers to be exposed to research-informed and future-focused practices, so that they are well-positioned to make deliberate choices about the types of learning that will support students in a technologically mediated future. To facilitate such change, however, ITE educators will be required to engage with and develop both their technical and technological ways of thinking, to ensure their student teachers' success in the profession.

References

Allen, M., Webb, A., & Matthews, C. E. (2016). Adaptive teaching in STEM: Characteristics for effectiveness. *Theory into Practice, 55*(3), 217–224. https://doi.org/10.1080/00405841.2016.1173994

Archambault, R. D. (1974). *John Dewey on education: Selected writings.* The University of Chicago Press.

Barab, S. A., Evans, M. A., & Baek, E. O. (2004). Activity theory as a lens for characterizing the participatory unit. *Handbook of Research on Educational Communications and Technology, 2*, 199–213.

Barrows, H. S., & Tamblyn R. M. (1980). *Problem-based learning: An approach to medical education.* Springer.

Berwald, J. (1987). Teaching foreign languages with realia and other authentic materials: ERIC Q & A. *ERIC Clearinghouse on Languages*, 1–6. ERIC.

Biggs, C. (2006). Technology—A fair go for girls: The need to make the classroom inclusive for girls. *ACE papers: Contemporary Issues in Technology Education in New Zealand, 18*(3), 1–12. http://hdl.handle.net/2292/25167

Blackmore, J., Bateman, D., Loughlin, J., O'Mara, J., & Aranda, G. (2011). *Research into the connection between built learning spaces and student outcomes.* Department of Education and Early Childhood Development. http://dro.deakin.edu.au/eserv/DU:30036968/blackmore-researchinto-2011.pdf

Boud, D., Keogh, R., & Walker, D. (2013). *Reflection: Turning experience into learning* (2nd ed.). Routledge.

Brooks, J. G., & Brooks, M. G. (1993). *In search of understanding: The case for constructivist classrooms.* Association for Supervision and Curriculum Development.

Cook-Sather, A. (2002). Authorizing students' perspectives: Toward trust, dialogue, and change in education. *Educational Researcher, 31*(4), 3–14. https://doi.org/10.3102/0013189X031004003

Dakers, J. (2006). *Defining technological literacy: Towards an epistemological framework*. Palgrave MacMillan.

Dakers, J. (Ed.). (2016). *New frontiers in technological literacy: Breaking with the past*. Palgrave MacMillan.

Darling-Hammond, L., Chung, R., & Frelow, F. (2002). Variation in teacher preparation: How well do different pathways prepare teachers to teach? *Journal of Teacher Education, 53*(4), 286–302. https://doi.org/10.1177/0022487102053004002

de Vries, M. (2005). *Teaching about technology: An introduction to the philosophy of technology for non-philosophers.* Springer.

de Vries, M. (2009). The developing field of technology education: An introduction. In A. Jones & M. de Vries (Eds.), *International handbook of research and development in technology education* (pp. 1–9). Sense.

Duckworth, E. (1996). *The having of wonderful ideas and other essays on teaching and learning*. Teachers College Press.

Engeström, Y. (1987). *Learning by expanding: An activity-theoretical approach to developmental research*. Orienta-Konsultit. http://lchc.ucsd.edu/mca/Paper/Engestrom/Learning-by-Expanding.pdf

Engeström, Y. (2001). Expansive learning at work: Toward an activity theoretical reconceptualization. *Journal of Education and Work, 14*(1), 133–156. https://doi.org/10.1080/13639080020028747

Engeström, Y., & Sannino, A. (2011). Discursive manifestations of contradictions in organizational change efforts: A methodological framework. *Journal of Organizational Change Management, 24*(3), 368–387. https://doi.org/10.1108/09534811111132758

Feenberg, A. (2006). What is philosophy of technology? In J. R. Dakers (Ed.), *Defining technological literacy* (pp. 5–16). Palgrave MacMillan.

Fox-Turnbull, W., & O'Sullivan, G. (2013). Supporting conceptual understandings of and pedagogical practice in technology through a website in New Zealand. *International Journal of Technology and Design Education, 23*(2), 391–408. https://doi.org/10.1007/s10798-011-9185-1

Fraser, D. (2000). Curriculum integration: What it is and is not. *SET: Research Information for Teachers, 3*, 34–37.

Gee, J. P., & Green, J. L. (1998). Chapter 4: Discourse analysis, learning, and social practice: A methodological study. *Review of research in education*, *23*(1), 119–169.

Goodwin, D., & Webb, M. A. (2014). Comparing teachers' paradigms with the teaching and learning paradigm of their state's teacher evaluation system. *Research in Higher Education Journal, 25*, 1–11.

Guskey, T. R. (1988). Teacher efficacy, self-concept, and attitudes toward the implementation of instructional innovation. *Teaching and Teacher Education, 4*(1), 63–69. https://doi.org/10.1016/0742-051X(88)90025-X

Handal, B., & Herrington, A. (2003). Mathematics teachers' beliefs and curriculum reform. *Mathematics Education Research Journal, 15*(1), 59–69. https://doi.org/10.1007/BF03217369

Hoyle, E. (2008). Changing conceptions of teaching as a profession: Personal reflections. In *Teaching: Professionalization, development and leadership* (pp. 285–304). Springer.

Kiernan, G. (2018, 27 June). From education to employment: Megatrends affecting NZ's working environment. *Infometrics*. http://www.infometrics.co.nz/infometrics_megatrends/

Kirschner, P. A., Sweller, J., & Clark, R. E. (2006). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educational Psychologist, 41*(2), 75–86. https://doi.org/10.1207/s15326985ep4102_1

Kolb, D. A., & Fry, R. (1975). *Towards an applied theory of experiential learning: Theories of Group Processes.* Wiley.

Kuutii, K. (1991). Activity theory and its applications to information systems research and development. In H. E. Nissen, H. K. Klein, & R. Hirschheim (Eds.), *Information systems research: Contemporary approaches and emergent traditions* (pp. 529–549). Elsevier Science.

Lebow, D. (1993). Constructivist values for instructional systems design: Five principles toward a new mindset. *Educational Technology Research and Development, 41*(3), 4–16. https://doi.org/10.1007/BF02297354

Leggat, P. (2015). *Modern learning environments, 21st Century learning and curriculum and future-focused learning* (Sabbatical report). https://www.google.co.nz/search?q=Leggat+modern+learning+environments&oq=Leggat+modern+learning+environments&aqs=chrome..69i57j69i60.13727j0j8&sourceid=chrome&ie=UTF-8

Lombardi, M. M. (2007). Authentic learning for the 21st century: An overview. *Educause Learning Initiative, 1*, 1–12.

MacGregor, D. (2017). Exploring the role of professional learning communities in supporting the identity transition of beginning design and technology teachers. In J. Williams & D. Barlex (Eds.), *Contemporary research in technology education* (pp. 143–159). Springer.

McCombs, B. L., & Whisler, J. S. (1997). *The learner-centered classroom and school: Strategies for increasing student motivation and achievement*. Jossey-Bass Publishers.
Meyer, J. H. F., & Land, R. (2003). Threshold concepts and troublesome knowledge: Linkages to ways of thinking and practicing. In C. Rust (Ed.), *Improving student learning: Theory and practice ten years on* (pp. 412–424). Oxford Centre for Staff and Learning Development.
Ministry of Education. (2007). *The New Zealand curriculum.* Ministry of Education. https://nzcurriculum.tki.org.nz/The-New-Zealand-Curriculum
Ministry of Education. (2011). The New Zealand school property strategy, 2011–2021. Learning media. Organisation for economic cooperation and development. (2013). Innovative learning environments. OECD Publishing. http://dx.doi.org/10.1787/9789264203488-en
Ministry of Education. (2016a). Digital technology to become part of the New Zealand Curriculum and Te Marautanga o Aotearoa. https://education.govt.nz/news/digital-technology-to-become-part-of-the-new-zealand-curriculum-and-te-marautanga-o-aotearoa/
Ministry of Education. (2017). *Digital technologies: Hangarau Matihiki.* https://education.govt.nz/assets/Documents/Ministry/consultations/DT-consultation/DTCP1701-Digital-Technologies-Hangarau-Matihiko-ENG.pdf
Mortimer, E., & Scott, P. (2003). *Meaning making in secondary science classrooms.* McGraw-Hill Education.
Organisation for Economic Co-operation Development. (2012). *Equity and quality in education: Supporting disadvantaged students and schools.* OECD Publishing. https://www.oecd.org/education/school/50293148.pdf
Organisation for Economic Co-operation and Development. (2014). *Education at a glance 2014: OECD Indicators.* OECD Publishing. https://doi.org/10.1787/eag-2014-en
Onchwari, G., Onchwari, J., & Keengwe, J. (2009). Technology and student learning: Toward a learner centered teaching model. *Association for the Advancement of Computing in Education Journal, 17*(1), 11–22.
Osborne, M. (2016). *Innovative learning environments.* CORE Education White paper. http://blog.core-ed.org/files/2017/01/Innovative-Learning-Environments-FINAL-web.pdf
Papert, S. (1980). *Mindstorms: Children, computers, and powerful ideas.* Basic Books.
Patton, M. Q. (2002). Qualitative evaluation and research methods. Sage.
Pea, R. D. (1993). Practices of distributed intelligence and designs for education. *Distributed cognitions: Psychological and Educational Considerations, 11*, 47–87.
Peacock, M. (1997). The effect of authentic materials on the motivation of EFL learners. *ELT Journal, 51*(2), 144–156. https://doi.org/10.1093/elt/51.2.144
Reinsfield, E. (2018a). *The potential for a future-focused curriculum in New Zealand: The perceptions and practice of six secondary school technology teachers* (Doctoral thesis). https://hdl.handle.net/10289/11939
Reinsfield, E. (2018b, October). A future-focused technology education curriculum in New Zealand: The implications for Initial Teacher Education Programmes. In *AATE conference.*
Reinsfield, E. (2019a). A future-focused conception of the New Zealand curriculum: Culturally responsive approaches to technology education. *International Journal for Technology and Design Education.* https://doi.org/10.1007/s10798-019-09510-y6
Reinsfield, E. (2019b). Technology teacher education: Best Practice. In *Encyclopedia for teacher education.* https://link.springer.com/content/pdf/10.1007%2F978-981-13-1179-6_161-1.pdf
Reinsfield, E., & Williams, P. J. (2018). New Zealand secondary teachers' perceptions "Technological" or "Technical" thinking. *International Journal for Technology and Design Education.* https://doi.org/10.1007/s10798-017-9418-z
Roche, L. A., & Marsh, H. W. (2000). Multiple dimensions of university teacher self-concept. *Instructional Science, 28*(5), 439–468. https://doi.org/10.1023/A:1026576404113
Roth, W. M. (2013). Contradictions and uncertainty in scientists' mathematical modeling and interpretation of data. *The Journal of Mathematical Behavior, 32*(3), 593–612. https://doi.org/10.1016/j.jmathb.2013.07.001

Saxton, E., Burns, R., Holveck, S., Kelley, S., Prince, D., Rigelman, N., & Skinner, E. A. (2014). A common measurement system for K-12 STEM education: Adopting an educational evaluation methodology that elevates theoretical foundations and systems thinking. *Studies in Educational Evaluation, 40*, 18–35. https://doi.org/10.1016/j.stueduc.2013.11.005

Shavelson, R. J., Hubner, J. J., & Stanton, G. C. (1976). Self-concept: Validation of construct interpretations. *Review of Educational Research, 46*(3), 407–441. https://doi.org/10.3102/00346543046003407

Singer, F. M., & Voica, C. (2008). Between perception and intuition: Learning about infinity. *The Journal of Mathematical Behavior, 27*(3), 188–205.

Snape, P., & Fox-Turnbull, W. (2013). Perspectives of authenticity: Implementation in technology education. *International Journal of Technology and Design Education, 23*(1), 51–68. https://doi.org/10.1007/s10798-011-9168-2

Tabulawa, R. (2003). International aid agencies, learner-centred pedagogy and political democratisation: A critique. *Comparative Education, 39*(1), 7–26. https://doi.org/10.1080/03050060302559

Teaching Council New Zealand. (2019). *ITE programme approval, monitoring and review requirements*. https://teachingcouncil.nz/sites/default/files/ITE_statement_Dec%202018.pdf

Vygotsky, L. S., & Cole, M. (1978). Mind in society: The development of higher psychological processes. Harvard University Press.

Wallace, J., & Hasse, C. (2014). Situating technological literacy in the workplace. In J. Dakers (Ed.), *New frontiers in technological literacy* (pp. 134–164). Palgrave Macmillan.

Wenger, E. (1998). Communities of practice: Learning as a social system. *Systems Thinker, 9*(5), 2–3.

Windschitl, M. (2002). Framing constructivism in practice as the negotiation of dilemmas: An analysis of the conceptual, pedagogical, cultural, and political challenges facing teachers. *Review of Educational Research, 72*(2), 131–175. https://doi.org/10.3102/00346543072002131

Wright, N. (2018). *Becoming an innovative learning environment: The making of a New Zealand secondary school*. Springer. https://doi.org/10.1007/978-981-13-0764-5

Zimmerman, B. J. (1990). Self-regulated learning and academic achievement: An overview. *Educational Psychologist, 25*(1), 3–17. https://doi.org/10.1207/s15326985ep2501_2