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How field experience shapes pre-service primary teachers' technology integration knowledge and practice

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ABSTRACT

The expectation for teachers to integrate technology within their classroom practice is growing. However, few studies examine the influences on pre-service teachers' technology integration knowledge and practice, and the role of field experience in shaping these. Narratives from semi-structured pre-COVID interviews with 35 pre-service primary school teachers in one teacher education programme in Ireland, some of whom used a digital camera, were analysed using an inductive thematic approach. Opportunities for pre-service teachers to develop their knowledge and practice were shaped by their interaction with the primary school context, the people within it and the digital resources provided, the Zone of Proximal Development (ZPD). While the initial teacher education programme provided opportunities and digital resources to support the primary teachers' learning, the Zone of Promoted Action, these were ultimately shaped by the ZPD. The results have implications for professional development programmes striving to support teachers in developing innovative practice in a post-COVID era.

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Introduction

The quality of technological and pedagogical practices in the classroom has been prominent in public discourse with calls for new and innovative ways of preparing pre-service teachers with the skills necessary for implementation (DES 2015; Van Der Vlies 2020). However, research continues to indicate that there is a lack of technological pedagogy in teacher education programmes (Hsu 2016; Rowston, Bower, and Woodcock 2020), and evidence highlights the importance of offering early teaching practicum before student teaching (Sun, Strobel, and Newby 2017). While technological advances have the potential to play a significant role in supporting teacher preparation, teacher reluctance has often been observed (Keengwe, Onchwari, and Wachira 2008), combined with low self-efficacy, and a lack of technical support (Hsu 2016; Rowston, Bower, and Woodcock 2020). While pre-service teachers might be active users of technology, and very frequent users of social media, their digital skills in other areas are lower (McGarr and McDonagh 2021). Evidence suggests pre-service teachers are positively disposed to using technology in teaching, but they lack knowledge of specific areas, for example cyber ethics and associated practices (McGarr and McDonagh 2021).

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An over-emphasis on training pre-service teachers to develop proficiency in a range of technical skills, at the expense of a focus on the pedagogical integration of technology, has also been cited (Jones 2002; McCoy et al. 2016; McCoy and Lyons 2018). Recent research suggests that many teachers have a somewhat restricted view of what 'embedding' means in this context, using digital devices for activities that would be happening in the classroom already, rather than embracing more flexible and constructivist pedagogical approaches (Feerick, Cosgrove, and Moran 2021; Feerick, Clerkin, and Cosgrove 2022). Consequently, pre-service and early career teachers have been found to integrate technology insufficiently in their educational practices (Enochsson and Rizza 2009; Tondeur et al. 2012, 2016; Farjon, Smits, and Voogt 2019) and feel inadequately prepared to do so (Drent and Meelissen 2008; Tondeur et al. 2017a; Farjon, Smits, and Voogt 2019). Digital competence is an evolving concept, and the frameworks and tools used to assess it should avoid stifling teachers' autonomy in the classroom (McGarr and McDonagh 2021). The growing focus on technostress is also relevant, with Joo, Lim, and Kim (2016) finding that technostress negatively predicts teachers' technology usage intention. Further, Jena (2015) suggests that technostress negatively predicts teachers' commitment, job satisfaction and job performance and has a significant association with their negative affectivity. In the context of the pandemic, Murphy, Marcus-Quinn, and Hourigan (2021) suggest that this may be an outcome of the pressure on novice teachers to adapt quickly to online digital teaching and may mean that ability to deliver feedback can be threatened by a lack of digital expertise.

While some suggest that technology integration may cease to be a problem when 'digital native' teachers qualify and establish themselves in the classroom (Polly et al. 2010), others indicate that it cannot be assumed that 'digital natives' will be any more comfortable with the pedagogic use of technology (Li et al. 2015). While there has been much attention placed on the enablers of ICT (information and communications technology) skills development among pre-service teachers, there has been less attention placed on the role of school placement context in shaping opportunities and experiences for pre-service teachers. Research has repeatedly shown that field experience is the most important motivator for beginning teachers to integrate technology into their own teaching (Tondeur et al. 2017a), but understanding how context influences those field experiences is crucial in supporting teacher development.

Studies have shown that pre-service teachers are not adequately prepared to teach with technology (Tiba and Condy 2021). Pre-service teachers have indicated that their use of technology while on school placement was directly linked to the school having a positive attitude towards using ICT in the classroom (Hammond et al. 2009). However, access to technology in the classroom continued to be a problem for participants who had to reserve laptops or computer rooms in advance of lessons (Hammond et al. 2009). Furthermore, if supportive conditions were not in place in schools, pre-service teachers reverted to traditional teaching methods and avoided using technology (Ell et al. 2017; Hammond 2011; Trevethan 2017). Technology such as Interactive Whiteboards (IWBs) (Nikleia 2008; Slay, Sieborger, and Hodgkinson-Williams 2008), Learning Management Systems (De Smet et al. 2012) and mobile phones (Thomas, O'Bannon, and Britt 2014) are often used in classrooms, but evidence has shown that they are often used in

traditional and restricted ways rather than as education tools to enhance learning (Nikleia 2008). This limits learners in becoming active participants or co-producers of their learning (McLoughlin and Lee 2008; Coyne and McCoy 2020).

Large-scale studies and wide-reaching meta-analyses have typically explored the impact of pre-service teachers' background (age and gender) and ICT characteristics (e.g., attitudes towards ICT) in combination with the support they receive from their teacher training institution on their ICT competencies (Tondeur et al. 2018). International research highlights common problems encountered by pre-service teachers when attempting to use technology during school placement (Hammond et al. 2009; Hammond 2011; Ell et al. 2017; Trevethan 2017). While the majority of teachers state they are enthusiastic and confident when using ICT to support teaching and learning, despite this enthusiasm newer technologies are still under-employed in classrooms (Morris 2010; Feerick, Clerkin, and Cosgrove 2022). Moreover, there is a dearth of evidence on how school structural and process characteristics shape the experiences and opportunities of the pre-service teacher in their professional development. Our research addresses this gap, specifically exploring the role of school ethos and orientation in shaping pre-service teachers' technological practice while on school placement. While evidence has increasingly pointed to a strong influence of school context on technology integration and orientation towards technology more widely (McCoy et al. 2016), understanding the link between context and technology practice during placement is less understood. Focusing on the role of school context is vital to increase the opportunities for teachers to use technology *effectively* to support student learning, as well as their own professional development. We apply a sociocultural 'zones framework' to the study of teacher learning and development, a novel feature of this article.

Drawing on a qualitative research approach, we seek to address three key research questions:

(1) What are the influences on pre-COVID pre-service primary teachers' technology integration knowledge and practice?
(2) What is the role of field experience in shaping technology integration in pre-COVID classroom practice?
(3) Does a zones framework support our understanding of technology adoption and integration among primary school teachers?

Theoretical framework: Valsiner's zone theory

The article takes a sociocultural approach to understanding how school context shapes pre-service primary school teachers' experiences in a pre-COVID classroom. Lerman's (2001) review illustrates a growing interest within the education research community in social and cultural aspects of learning. In understanding individual experience, he posits that social and cultural experiences are crucial, and he suggests that an appropriate unit of analysis might be the person-in-practice-in-person. While person-in-practice highlights the notion of learning through social participation, the second part, practice-in-person, implies that participation develops identities as the practice becomes part of the individual (Goos 2013). In line with a number of earlier studies, we propose an adaptation of Valsiner's (1997) zone theory of child development that can be used to study pre-service teacher learning and

development (Goos 2013). Valsiner pioneered the valuable 'zones framework', first developed through a detailed examination of Vygotsky's social cultural theory (Valsiner 1997; Hammond and Alotaibi 2017). The framework sees human activity as taking place within three zones: the Zone of Free Movement (ZFM), the Zone of Promoted Action (ZPA) and the Zone of Proximal Development (ZPD). The ZFM defines possibilities: 'what is available to the person acting in a particular environment at a given time' (Valsiner 1997, 317). Commentators have noted that the sense of a Zone of Free Movement is a little misleading; a ZFM is a zone of constraint as well as opportunity (Hammond and Alotaibi 2017). The second zone, the ZPA, represents practices that are being promoted, in this case by the university and school context, to support the pre-service teacher's professional development. The ZPD defines the range of possible next states in the person's developing relationship with his or her environment: which is ultimately shaped within the boundaries set up by the ZFM/ZPA system inside which the individual is allowed to act. Valsiner suggests that, while the ZPD has a personal character, it is constructed jointly with other people, through social interaction within a wider social system (Valsiner 1997). In this context, the teacher's ZPD is a set of possibilities for development of new knowledge, beliefs, goals and practices created by the teacher's interaction with the environment, the people in it and the resources it offers (Goos 2013).

As noted by Goos (2013), although Valsiner's (1997) theory is intended to explain child development, the ZFM/ZPA complex is also observable in education contexts. Classroom examples illustrated processes by which teachers can create narrow or expansive ZFM/ZPA systems, with implications for the choices allowed to students in completing set tasks. Valsiner also argued that zone theory is applicable to any human developmental phenomena where the environment is structurally organised, and so it seems reasonable to extend the theory to the study of *teacher* learning and development in structured educational environments (Goos 2013). Like Valsiner, this article takes 'development' to extend beyond the formation of cognitive functions in children or indeed teachers, referring to the potential for new domains of action and innovation and sociocultural frameworks that support the pre-service teachers' self-reflection and progress. As noted by Hammond and Alotaibi (2017), the use of the zones framework has been taken up in technology settings (e.g. Koot and Garde 2013) and is valuable as a lens on the utilisation of digital technologies among teachers and pre-service teachers (e.g. Blanton, Westbrook, and Carter 2005; Goos and Bennison 2008; Hussain, Monaghan, and Threlfall 2011; Goos 2013). Hodkinson and Hodkinson (2004) note that any separation between the person learning and the context in which they learn is artificial. It is not just that each person learns in a context; rather, each person is a reciprocal and mutually constitutive part of that context (168). Acknowledging both agency and structure, our framework helps to understand how school ethos and orientation shapes the engagement with technology of pre-service teachers in one ITE (initial teacher education) institution in Ireland. Decisions on the use of, and experiences in relation to, ICT are likely to be framed, thus approaches which focus solely on factors shaping technology adoption or on teacher agency and beliefs are disconnected from the broader field of professional learning in which the interplay of agency and structure has been analysed in more compelling ways (Billett 2001;Hodkinson and Hodkinson 2004; Hodkinson, Biesta, and James 2008; Hammond and Alotaibi 2017).

Policy

Internationally, there have been important developments in the approaches that countries have taken to embed and develop digital technologies in teacher education. In Canada, the strategy has been to establish a competency framework and to create a source of professional development for teachers (Ministry of Education and Higher Education of Québec 2018). The United Kingdom has provided online training courses (Department for Education of the United Kingdom 2019), and Spain developed a framework for competencies in digital learning for teachers combined with professional development (European Schoolnet 2018). In Ireland, since the 1980s, a technocentric focus on technology integration in schools has been the approach (Department of Education 1980). This includes the Digital Strategy for Schools (DES 2015), which recently completed its final year of implementation. It sets out a broad range of policy objectives addressing four key themes: (1) teaching, learning and assessment using ICT; (2) teacher professional development; (3) leadership, research and policy; and (4) ICT infrastructure (DES 2015). Crucially, schools are asked to take a lead role in how they embed ICT in their teaching and learning practices, reflecting their own context, which means that schools in Ireland are highly diversified in terms of the extent to which digital technologies are embedded in classroom practice. Students' and teachers' experience of technology at school varies widely, as school autonomy allows some to market themselves as 'tech driven', while others take a more blended or traditional approach (Marcus-Quinn, Hourigan, and McCoy 2019). This autonomy makes Ireland a valuable case study to examine the extent to which the ethos and technological orientation of schools provide a positive environment for pre-service teachers embedding technology in their (self-reflective) practice.

Infrastructural barriers can also be noted; while a national roll-out of high-speed broadband to all secondary schools in the country in 2013 and 2014 removed a significant barrier for these schools, namely inadequate and unreliable internet connection, other infrastructural issues became more salient (McCoy et al. 2016; Mac Domhnaill, Mohan, and McCoy 2021). Further, plans for a follow-on programme for primary schools have not yet materialised, although funding has been earmarked under the EU Recovery and Resilience programme.

Initial teacher education

Commentators increasingly suggest that teaching in the digital age requires a paradigm shift, whereby the power to change lies within teachers themselves (Bates 2015) and the role of ITE is significant in achieving this. Research has recognised that the potential of digital technologies cannot be reached if teachers do not have the right skills to deploy them (Van Der Vlies 2020). ITE programmes are considered to be the first, and perhaps the most important, stage in the development of pre-service teachers' professional identity (Putnam and Borko 1997; Wideen, Mayer-Smith, and Moon 1998), and embedding technological knowledge and skills at this stage of learning is vital. International research has explored pre-service teachers' use of technology and has reported that they do not bring their familiarity with technology into their classroom (Redmond and Albion 2002; Thinyane 2010; Albion 2011; Ottenbreit-Leftwich et al. 2012). The importance of

technology in Irish education was noted in 2011 (Teaching Council 2011)[1] but received less attention prior to this. In 2017, the Teaching Council specified that all ITE programmes should address the use of ICT in teaching and learning as well as exploring cross-curricular links and themes and how these are related to life experiences. The guidelines indicate that ITE graduates should be enabled to use technology, including multimedia resources, to aid student learning. A particular focus on literacy, numeracy, ICT and inclusion was suggested (Teaching Council 2017, 15), but the prominence of these modules varies widely across providers, depending on the hours allocated to them, and where they fit within a curriculum-focussed schedule.

The way in which pre-service teachers learn to engage with digital technologies is important. In one survey, Norwegian teachers requested support in developing their professional digital competence (OECD 2014). European research has identified that teachers are in favour of informal approaches to learning how to use digital technologies and that they prefer to participate in training activities related to authentic classroom settings (Balanskat, Blamire, and Kefala 2006; Wastiau et al. 2013). Reflecting this, our study provided pre-service teachers with an experiential, authentic use of digital technologies in the classroom, including the use of a digital camera, while on school placement. This reflects the notion that teacher learning should be an active and experiential process through which knowledge can be enacted, constructed and reviewed (Fisher, Higgins, and Loveless 2006). The digital camera provided the autonomy for pre-service teachers to engage and reflect with their teaching to enact, construct and review their own practice. In such a context, teachers are 'agents of change' as they themselves undergo change to learn to teach in ways in which they have not been taught themselves (Hargreaves et al. 2001). Crucially, our study considers how school context shapes those opportunities for pre-service teachers to develop as 'agents of change'.

Methodology

This article stems from a large-scale qualitative study exploring the experiences and reflections of pre-service teachers in using a digital camera during their school placement block in primary-level schools across Ireland. A total of 110 pre-service teachers in one higher education institution self-selected to take part in the project. A randomised control sample of pre-service teachers ($N = 50$) were assigned to a treatment group ($n = 25$) and a control group ($n = 25$). Treatment group teachers used digital video, intended to support their self-reflection, while control group teachers did not receive this technology. Full consent from all parties involved in the project (pre-service teachers, principal, class teacher, parents and students) was required prior to participation. Owing to consent not being obtained for all groups, the number of pre-service teachers participating in the project was reduced ($N = 35$). Further details can be found in McCoy and Lynam (2020).

The data presented here stem from semi-structured interviews ($N = 35$) with the treatment and control group after their five-week block of school placement. These interviews sought to examine the pre-service teachers' overall experiences of using technology throughout their five-week school placement block, to gain insights into educational practice and opportunity across different school settings. In-depth qualitative interviews were undertaken via BlackBoard Collaborate with participants in both control ($n = 20$) and treatment ($n = 15$) groups. Interviews were audio-recorded and transcribed

verbatim (with written consent of all participants) and analysed using NVivo. The interviews explored a range of key topics including their experiences of school placement, their use of digital technologies in their teaching and the role of school context in shaping their experiences. Our primary approach was on teachers' current learning and how context shaped that, rather than taking a full life-history approach. The data were analysed using Reflexive Thematic Analysis, a theoretically flexible method for developing, analysing and interpreting patterns across a qualitative dataset (Braun and Clark 2021). This approach involved six steps: familiarisation with the data, coding, generating initial themes, developing and reviewing themes, refining themes and writing up (Braun and Clarke 2013, 2021). The process generated three broad themes, connectivity and technical support; school ethos and orientation towards technology; and teacher reluctance, and sub-themes within each.

Many of the concerns around the use of digital video in classrooms relate to ethical standards and the protection of all participants. For this study, ethical approval was granted by Hibernia College Ethics Committee and the researchers followed the BERA (2018) ethical guidelines for research in education. All video recordings were saved on the tablet and uploaded to an Amazon Cloud storage server based in the EU via a secure connection. The tablet and the SD card were encrypted and secured with a pin, and the transfer of video between the tablet and cloud storage server was over a secure SSL connection. Pre-service teachers were informed that any copying or sharing of any recorded video material from the tablet to any other device, service or email account was strictly prohibited and would result in penalties under the Data Protection Act (General Data Protection Regulation 1988–2018). Pre-service teachers signed a confidentiality agreement whereby they acknowledged that they cannot share any video content nor can it be used for any other purpose. All video recordings were permanently deleted from the tablet and the cloud storage after 30 days. Participants taking part in the qualitative aspect of the research signed consent forms prior to being interviewed and were informed of their right to withdraw from the research at any time.

Limitations

Many teachers secured a placement in a school with whom they had a connection (often they had attended that school). This meant that that a broad diversity of schools, across a wide geographic spread, were included in the study. However, the research depended on school leaders agreeing to be part of the study, which may have led to some selection bias and more technologically oriented schools being slightly over-represented in the sample.

The study utilised a qualitative approach, placing a central focus on the voices of the teachers in reflecting on *their* experiences. Narratives from pre-service teachers are valuable even if they are not independent or expert observers, and we acknowledge it is possible that some teachers may have provided socially desirable responses and played down the constraints posed by the school context. A larger mixed-method study could provide a broader and perhaps more comprehensive examination of these questions, combining objective indicators of school context and ethos, with the more nuanced reflections of teachers.

Findings

Interviews with the pre-service primary teachers provide a rich understanding of how school context provides constraints on, and opportunities for, use of innovative technologies like the digital camera. Drawing on our sociocultural framework, we analyse how three key dimensions shape experience: connectivity and technical support; school ethos and orientation towards technology; and teacher reluctance. The zones framework offers a useful lens, most fundamentally positing that separating the person learning from the learning context is artificial (Hodkinson and Hodkinson 2004).

Connectivity and technical support

In line with earlier research, whether technology was available for students and teachers, and the types of technology used, varied widely across the participating schools. In some cases, the sociocultural context was shaped by the presence of reliable broadband and Wi-Fi infrastructure in the school, with a number of teachers expressing dismay at the absence of high-speed broadband in their geographic area. Responses reflected the regional variation in high-speed broadband availability in Ireland, and the challenges faced by schools in rural areas (as was particularly highlighted during COVID-19 school closures, see Mac Domhnaill, Mohan, and McCoy 2021).

> And there was some days where my internet would not work in the school. So that was a big burden I suppose on me. Especially because I was, kind of, out in a country school, there was, kind of, nothing we could do about it. If the internet was gone it was gone. (Digital Camera, 9)

Beyond broadband quality, pre-service teachers reflected on other infrastructural deficits, including hardware quality and reliability, and insufficient technical support, all of which served as tangible contextual barriers and shaped their experiences in using technology and their expectations in relation to the introduction of technologies like the digital camera.

> The technology was kind of not as up to date in the first one [placement school], so when the internet was down or the whiteboard would be off or something, the lesson, we just wouldn't use it. We'd just go with something else. (No Digital Camera, 8)

> The individual who does deal with the computers in the school that I was in was actually – he happened to be on holiday while I was there and that's why the Internet hadn't been fixed by the time I left. There was nobody else around who knew the ins and outs of what was set up in the school and had the ability to fix it. They just had to wait for him to come along. (No Digital Camera, 20)

The accounts are consistent with earlier studies showing challenges for schools in the maintenance and upkeep of equipment, creating additional burden for teaching staff who assumed responsibility for troubleshooting and technical support (Coyne et al. 2015; McCoy et al. 2016). One study noted that 'the costs and difficulties associated with managing and maintaining ICT resources in a school have largely been ignored' (Eivers 2019, 21). Further, the evidence here suggests some pre-service teachers felt that the technical supports being provided to teachers in their school were inadequate, all of which served as constraints on their professional learning and their ZPD:

> I think they are very limited really, with sort of what they're working with; and I think a lot of the teachers, they probably don't really know how to fully use the interactive whiteboard, so I think maybe they're probably not supported, in terms of they could probably do with additional training. (Digital Camera, 5)

School ethos and orientation

Overall, the placement schools illustrated a wide spectrum in terms of the prominence of digital technologies and the embedding of technology in classroom practice, which provided useful insights into the impact of different contexts on pre-service teacher experiences. For some schools, technology was pervasive and a core feature of their school ethos, which served to provide a supportive context for working with the digital camera and other technology:

> The school in general, are big into IT, and love anything kind of new, and are willing to give anything a try really. (Digital Camera, 2)

> Like, they'd all use the interactive whiteboards, all the homework is online for the pupils. So it is really, like, a technologically advanced school. And they were, like, interested in the [digital camera] and stuff like that. So, they were interested in it, yeah. (Digital Camera, 7)

This seemed to stem from more innovative leadership styles, where school leaders displayed an interest and curiosity around the potential of the new technology, for ITE and more broadly.

> The principal was really happy. She loves stuff like this. She loves projects and, you know, she was really, really happy with the idea of [a digital camera]. (Digital Camera, 8)

Such environments provided a positive context for the pre-service teacher; the ZPA was conducive to, and supportive of, the use of the digital camera and provided the context within which the teacher could develop from the use of this technology.

> the classroom teacher was very supportive, to using it [digital camera]. We had a big classroom, so it was easy to position it in an appropriate spot, and no, I mean the school were very, very supportive, from day one. (Digital Camera, 2)

> My teacher, my class teacher in particular was very, very good at technology so he was always on call for any technical issues and such. [Teachers in the school] would try to use it [technology] an awful lot . . . they were supported. (Digital Camera, 6)

In the context of a supportive and innovative school environment and ethos, the potential for digital technologies to support learning became apparent for several teachers. A number of pre-service teachers appeared to respond to this positive environment, in developing as teachers and in supporting their self-reflective practice:

> It [greater availability of technology] definitely gave me a lot more room to use different resources, do you know? With SP1 [school placement 1] I'd have to print out everything for the children to use, whereas in this one they could come up and they could write it themselves, or they could do this themselves. Yes, it definitely felt a lot more natural as well, I thought, if that makes sense. (No Digital Camera, 12)

Some teachers also reflected that a greater use of digital technologies would allow them to meet diverse student needs more effectively, and hence was seen as supportive in developing their teaching practice:

> I know the few times that I did use it [classroom technology] a lot of the children really enjoyed it, and were very engrossed. Like there would probably have been a lot of visual learners in the class, so I think if I used it a bit more I definitely would have met more of their needs. (No Digital Camera, 16)

There were numerous examples of teachers observing the potential of digital tools in supporting student engagement and participation in learning, creating a more student-centred approach.

> Yeah, definitely. I mean, the kids really, they loved it. They really were engrossed in those lessons. (No Digital Camera, 16)

Further, teachers observed real examples of the potential to make the curriculum more accessible through the use of multimedia or interactivity, which has been found in research more widely (Passey et al. 2004; Abdulrahaman et al. 2020):

> the children really perk up when they know there's something going to be on the screen as well, something different. It's a different way of getting information to them. And for me it's part and parcel of almost every lesson that I did. (No Digital Camera, 13)

> I think overall this placement really showed me the benefits of using technology in the classroom for simple things like putting up a picture, or a sentence, and getting the children to colour something colour something in, in it (the picture) including shapes, you know, spot the shape … We did a persuasive video, that encouraged students to come to our school. I was just amazed by the skills that the students had and they absolutely loved, you know … I really learnt how digital technology can really encourage children and support them in their learning. (No Digital Camera, 5)

Consistent with high levels of autonomy across Irish schools, several placement schools did not embrace a whole-school orientation towards embedding technology. While this related in some cases to the age of the school and wider infrastructural context, this was not always the case. One teacher was surprised by the absence of technology for teachers or students in her placement school, which she compared with a placement she undertook the previous year:

> The first school had loads of things, yeah. They were brilliant and they had Wi-Fi in the classroom I think which is something that's so small, so necessary, like you know. And then the second school, they didn't seem to have anything. Like she [teacher] had her own iPad and if there was Wi-Fi in the classroom it was probably her own one from home that she was using … . They had no like laptops, even though it was a new school, it was only built in 2007. (No Digital Camera, 3)

Several teachers highlighted the lack of technology available in their schools, which served to shape their approach to teaching, as well as the opportunity for them to develop as teachers. In these situations, the placement opportunity was clearly constrained by context.

> For my first placement, the school I was in is … a countryside school, and so the kind of technologies at the school would be pretty poor. Like, I mean, we had an interactive whiteboard that was broken. There's no computer room and they didn't have any access to iPads, so a lot of my placement 1, trying to incorporate technology was just a case of through, like, PowerPoints up on the screen, and that was as far as I could take it. (No Digital Camera, 4)

> I didn't really use too much technology, really being honest … because there wasn't actually that much in my class and that's something that I actually spoke to my supervisor about … which I actually was a little bit disappointed about, if you know what I mean. It didn't really give me the experience maybe that I could have had. (No Digital Camera, 12)

Structural and organisational characteristics of primary schools also framed the opportunities and experiences of the pre-service teachers, and are important in understanding the influence of the zones within which the teachers learned. Irish primary schools are classified across a range of school types, ranging from traditional denominational (often Catholic ethos) schools to more recently established multi- and non-denominational schools, including Educate Together schools (Mihut and McCoy 2020). Educate Together schools are a state-funded, independent charity that provide inclusive, learner-centred education at primary (approx. ages 4–12) and secondary (ages 12–18) level in Ireland. Many of these more recently established schools, particularly those within the Educate Together sector, are underpinned by a Blueprint which emphasises innovation and the embedding of digital technologies in teaching and learning (Mihut and McCoy 2020, 91).

> I'm in an Educate Together school, and again, I know from this particular school that they're big into technology. (No Digital Camera, 4)

> I'd say in the schools that I was in, they were Educate Together, so they had a huge amount of resources and there was an interactive whiteboard in each classroom. And the class teachers seemed to use that heavily on a daily basis. (No Digital Camera, 17)

These resources were seen to have a very tangible impact on the extent to which technology like a digital camera could become embedded in wider practice.

Above and beyond school sectoral differences and reflecting high levels of school autonomy, the types of technology available varied widely across the schools, and was noted by several pre-service teachers as framing their practice and impact:

> Just from talking to my peers who were on placement as well, two or three had visualizers in the classroom and I think that would have been really helpful. I know they're quite expensive and a lot of schools don't have them. But it would be really helpful if you had different books that maybe the children aren't using that weren't part of their booklist or that you could put that through the visualizer to vary their workload. (No Digital Camera, 9)

Teacher reluctance

Shaped by school structural and climate factors, as well as individual characteristics, there is wide variability across teachers in openness to innovation, with evidence distinguishing between early adopters, 'reluctant' teachers and innovators (McCoy et al. 2016; Kearney et al. 2018). Reflecting on observations of teachers more widely led one teacher to focus on the culture of the school, identifying an apprehension among teachers to using technologies:

> I don't think there's a huge drive, in terms of adopting new technologies or in terms of using them to the best of their capabilities. I think there's definitely an element of apprehension when it comes to using technology in the classroom from quite a number of teachers that I've observed. I'd say that from what I've observed that there isn't a great focus on adopting new technologies or of using them as best as they could. (No Digital Camera, 14)

Consistent with evidence from Polly et al. (2010) on 'digital natives', some teachers felt that the age of teachers and the profile of the teaching body influenced their orientation and extent to which the school embraced new approaches and technologies. Hence demographic characteristics were viewed as shaping the opportunities for the pre-service teacher to learn:

> I think some teachers of a certain age, wouldn't be used to using – wouldn't be used to using the interactive white board, and do you know, the technologies that are there. (Digital Camera ,4)

> there's four teachers [in the school], three of them are near retirement age. It would be a young class teacher, and he kind of took over all technology aspects of the school. If there were any issues it was him they went to, he did everything for them. (No Digital Camera, 12)

Divergence in views within schools was also noted – with principals and teachers not necessarily consistently embracing the use of the digital camera. While there was interest in the digital technology from their principal, one pre-service teacher believed that this interest was not shared by the class teacher, again framing the learning opportunities offered:

> I mean, the principal was quite supportive, and you know, was sort of like interested in it, and sort of asking me a few questions about like, why I wanted to kind of participate and things like that. And I think the class teacher maybe less so; I think she sort of maybe thought it was maybe a little bit sort of inconvenient. (Digital Camera, 2)

Even where technology was available in the classroom, the full potential of that technology was not always realised, as observed with a degree of frustration by one pre-service teacher:

> the children once a week had the use of Chromebooks . . . they had yet to kind of get the full benefit of that; like they were really just playing on kind of maths apps and stuff like that. Where, I thought there was so much more they could do with them . . . I felt like my teacher wasn't sure where to go, and they were kind of just given these Chromebooks . . . the school has invested in them, and they were just given them, and they were just sort of expected to know what to do . . . [they] could really do with someone coming in and going through the different options of what they could do with it. (Digital Camera, 1)

The possibilities for the pre-service teacher to develop new knowledge, skills and practice were shaped by the teacher's interaction with the school, people and resources.

Discussion

Teachers readily acknowledge the importance of technology as an educational tool, but research internationally continues to show a gap between technology integration goals, and actual technology practice (Tondeur et al. 2017b; Rowston, Bower, and Woodcock 2020; McGarr and McDonagh 2021). Sustained efforts to motivate teachers to integrate

digital technologies and develop effective uses of technologies in learning have not lived up to popular expectations (Niederhauser et al. 2018). Our evidence provides insights into the experiences of pre-service teachers in preparing for, using and reflecting on the digital camera and other technologies, and crucially reveals aspects of the school context which influence teachers' experiences and opportunities. The zones framework is valuable, drawing attention to the kind of environment (zones within an activity system) in which pre-service teachers act (Hammond and Alotaibi 2017). Pre-service teachers' experience of technology practice varies hugely in Ireland, as school autonomy allows some schools to market themselves as 'tech driven', while others take a blended or even traditional approach (Marcus-Quinn, Hourigan, and McCoy 2019). This makes Ireland a useful case study to explore the role of school context in shaping teachers' opportunities to develop technology practice and to understand the conditions supportive of teacher innovation. The focus on school context in shaping technology practice is particularly important given the growing interest in the mechanisms by which digital technologies may make a difference and for whom these investments may matter most.

The possibilities for the pre-service teacher to develop new knowledge, skills and practice were shaped by the teacher's interaction with the school environment, the people within it and the resources it offered, the ZPD (Hammond and Alotaibi 2017). While the education institution and ITE programme sought to create opportunities and digital resources to support the pre-service teachers' learning, the ZPA, these were ultimately shaped by the ZPD. The ZPD created diverse types of experience of technology, and participants perceived different kinds of benefits and support in using the digital video and other technology. Contextual inequalities created a need for greater 'self-scaffolding' for some and compensatory measures to embed the technology in their practice. The evidence concurs with Hammond and Alotaibi (2017):

> the undoubted strength of the zones framework is that it acknowledges teacher agency without losing sight of context. Furthermore, it sees agency as developmental, something that takes place through interaction with an environment rather than a one-off decision to use ICT or not. (149)

The evidence also highlights how technologies like the digital camera can support personalisation, allowing students and pre-service teachers alike to have more autonomy and ownership. Hammond (2011) distinguishes between the use of technology 'retrospectively' to accommodate the existing curriculum and a more forward-looking approach leading to radical changes in teaching and learning. This philosophy can equally be applied to initial teacher education and supporting a more innovative approach to teacher reflection and professional development. Pre-service teachers who gained the opportunity to use the digital camera reflected on the benefits in supporting their self-reflection and development as teachers. There was strong evidence that the digital video footage was highly supportive in pre-service teachers' weekly self-reflection and in developing their self-reflective practice. They reflected on embodied and non-embodied aspects of their teaching, in the process revising their habitus as teachers (McCoy and Lynam 2020). However, these opportunities were variously constrained by inter-related aspects of the ZPD, including school ethos, leadership, infrastructure and technical support. Indeed, those with and without the digital camera observed contextual constraints. The zones framework provides a valuable lens to support our understanding

of technology adoption and integration among teachers. The educational institution sought to provide the opportunities and resources to support professional development and digital competence, but these were ultimately shaped by the ZPD.

The narratives from pre-service teachers illustrated how technology plays different roles across different school sectors in Ireland. Digital technologies typically assume a central place in teaching and learning across schools in the Educate Together sector, for example, where students use tablet PCs in class and teachers typically use innovative technologies and create their own online content (Mihut and McCoy 2020), features which shaped the pre-service teachers' opportunities to develop technology practice. Participants also reflected on their own agency and their role in supporting student engagement and meeting diverse student needs, and the potential for technology to facilitate that. There are many educational benefits to using technology with disabled students, for example (Michaels and McDermott 2003; Schlosser and Wendt 2008). Pre-service teachers were also cognisant of these benefits, and the importance of the wider pedagogical use of technology.

In acknowledging both agency and structure, our framework helps to understand how decisions on the use of, and experiences in relation to, technology practice are likely to be framed. Approaches which focus solely on factors shaping technology adoption or on teacher agency and beliefs are insufficient, and a recognition of the interplay of agency and structure is critical.

Conclusion

Equipping teachers with the pedagogical and digital skills to support student engagement and learning across diverse contexts is of growing importance. One notable evidence gap relates to the need to better understand the impact of variations in school context within which pre-service and early career teachers develop key pedagogical and technological skills. This study addresses this gap by characterising differences in pre-service teachers' experiences of school context and ethos as they incorporate digital video and other technologies into their self-reflective practice. Funding for schools to purchase ICT resources and improve infrastructure has, until recently, been sporadic, and consequently there has been an increase in school leaders reporting that inadequacies in the provision of digital technology had directly hampered instruction in their school (Eivers 2019, 23). While schools have their own distinctive identities and culture that is shaped by their history, context and people as well as by the external context of a school (Stoll 1998), inter-school variation in the role of technology in teaching and learning is particularly pronounced in the Irish context (Marcus-Quinn, Hourigan, and McCoy 2019).

Our article sought to examine the enablers and barriers in the school context which shape pre-service teachers' opportunities to use technology to support self-reflection and their own development. Our teachers were participating in an ITE programme that seeks to inform and support pre-service teachers in creating learner-centred classrooms using the latest digital technologies. Different aspects of the school context influenced the experiences of pre-service teachers in using the digital camera to support self-reflection. In line with our sociocultural framework, innovation is clearly shaped, and constrained, by the characteristics of the school contexts within which pre-service teachers practise and ultimately teach. The success of the implementation of an innovation such as the digital camera is dependent not

on one individual factor, but on a dynamic process involving multiple individual and contextual factors. In line with other studies, where supportive conditions were not in place in schools, pre-service teachers are less likely to reap the benefits of technology, particularly for their own self-reflection (Hammond 2011; Ell et al. 2017; Trevethan 2017).

This evidence reinforces recent calls for a coordinated policy from national policymakers and teacher regulation bodies, such that responsibility for development of technology skills is not placed solely at school or teacher level (Murphy, Marcus-Quinn, and Hourigan 2021, 21). The narratives reveal the tensions in supporting innovation and change and the importance of recognising contextual influences. At an infrastructural level, it highlights the need for government to provide high-speed broadband to areas not serviced by commercial providers. Technical support also remains a barrier, with evidence repeatedly highlighting the challenges for school leaders and ICT coordinators in Ireland in relation to the maintenance and upkeep of technology (McCoy et al. 2016). Finally, school leaders have an important role to play in establishing school culture by creating a vision and setting a direction, as well as providing (pre-service) teachers with opportunities for high-quality and innovative professional development (Singh and Lokotsch 2005; Leithwood, Harris, and Hopkins 2008; Dickerson et al. 2021). National organisations, such as the Centre for School Leadership in Ireland, have an important role to play in promoting such leadership models. The potential of innovations in ITE to support the development of new knowledge and practice is clear, but this study shows that such learning takes place through an interaction with the school context, the people within it and the resources provided. ITE programmes must fundamentally be cognisant of these varying contexts within which pre- and early-service teachers develop and ensure that all teachers experience rich and supportive opportunities to develop innovative pedagogic practice.

Note

1. The Teaching Council is the professional standards body for the teaching profession, which promotes and regulates professional standards in teaching.

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