Chapter 1
Practice-Based Initial Teacher Education: Developing Inquiring Professionals

Glenda Anthony

Abstract Practice-based initial teacher education reforms are typically organised around a set of core teaching practices, a set of normative principles to guide teachers' judgement, and the knowledge needed to teach mathematics. Developing more than understandings, practices, and visions, practice-based pedagogies also need to support prospective teachers' emergent dispositions for teaching. Based on the premise that an inquiry stance is a key attribute of adaptive expertise and teacher professionalism this paper examines the function and value of inquiry within practice-based learning. Findings from the Learning the Work of Ambitious Mathematics Teaching project are used to illustrate how opportunities to engage in critical and collaborative reflective practices can contribute to prospective teachers' development of an inquiry-oriented stance. Exemplars of prospective teachers' inquiry processes in action—both within rehearsal activities and a classroom inquiry—highlight the potential value of practice-based opportunities to learn the work of teaching.

Keywords Teacher education · Practice-based · Rehearsals · Inquiry stance Professionalism

1.1 Introduction

Initial teacher education (ITE) curricula and pedagogies reflect prevailing notions of classroom instruction at different moments in history within specific culturally ascribed educational systems. Current calls for reforms, designed to shift away from a perceived disconnect between university-based course work and practical experiences in the classroom, reflect the need to prepare teachers for the complex demands of teaching in 21st century schools. In some countries (e.g., Australia, New Zealand, United Kingdom, and United States) these reforms call for a

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reconfiguration of how teacher education is distributed between university and school sites. However, reforms are not without their critics. Researchers urge that we need to be careful that changes represent more than a pseudo-approach involving teacher candidates spending more time in clinical field placements (Zeichner 2012). Brown et al. (2015) argue that new partnerships require ITE programs to support prospective teachers in becoming more independent research-active teachers. However, in critiquing the move to school-based reforms in the UK, Meierdirk (2016) warns of the consequence concerning the "knowledge base that is needed for fruitful reflection is missing" (p. 376).

In New Zealand, the Ministry of Education has recently prioritised funding masters-level ITE programs that involve close collaboration between partner schools and universities *and* demonstrate a commitment to a teaching as inquiry stance (Aitken et al. 2013; Sinnema et al. 2017). In this paper, I draw on findings from a 3-year design-based study *Learning the Work of Ambitious Mathematics Teaching* (Anthony et al. 2015c) to argue that practice-based ITE reforms can support the development of an inquiry disposition:

> a way of knowing and being in the world of educational practice that carries across educational contexts and various points in one's professional career and that link individuals to larger groups and social movements intended to challenge the inequities perpetuated by the educational status quo. (Cochran-Smith and Lytle 2009, p. viii)

However, whilst an inquiry stance is increasingly advocated as a key attribute of professionalism associated with teacher adaptive expertise and continuous learning, little is currently known about ways to support its development within ITE settings (Parker et al. 2016). The intent of this paper is to argue for the potential of practice-based learning to afford opportunities for prospective teachers (PTs) to develop an inquiry stance. My discussion begins with an introduction to theoretical framings concerning inquiry, followed by an overview of practice-based pedagogies utilised in the Learning the Work of Ambitious Mathematics Teaching design phases. Vignettes from university in-class rehearsals, involving PTs practising core routines associated with ambitious mathematics teaching, serve to illustrate concurrent opportunities to model, practise, and engage in inquiry practices. Moving from the university to the school setting, I discuss PTs' experience of teaching instructional activities associated with rehearsals. PTs' perceptions of the challenges and their progress within the school setting serve to further illustrate how the use of inquiry practices can facilitate the development of an inquiry stance.

1.2 Inquiring Professionals

To be effective in preparing teachers for the complex demands of 21st century classrooms, PTs need opportunities to learn not only knowledge of content and students, and specific techniques and routines to manage that work, but also a vision of practice that can guide decision making, and dispositions that support student

and teacher learning (Ghousseini and Herbst 2016). As Sinnema et al. (2017) note, "to teach well, and to improve their teaching, teachers need, in our view, to demonstrate their ability to inquire into that uncertainty in ways that address the particular complexities, conditions, and challenges they face" (p. 9). Informing the recommended ITE changes incorporating an inquiry stance in New Zealand, Sinnema et al. propose the adoption of six inquiry-oriented standards for teaching: inquiry in learning, teaching strategies, enactment of teaching strategies, impact of teaching, professional learning, and education systems. Each standard emphasises "high-quality teacher inquiry closely connected to learners' experience that draws on education's body of knowledge, competencies, dispositions, ethical principles, and commitment to social justice" (p. 12). For example, their proposed *Learning Priority Inquiry Standard* requires that teachers identify learning priorities for each student and be able to defend their decisions. Mediated by beliefs and commitments to social justice, defensible decisions must necessarily draw on a complex array of knowledge resources including knowledge about the learner, the discipline, and the community.

It is evident, that these inquiry-based standards pose significant challenges of judgements for the professional teacher. Positioned as agentic, the inquiring professional must decide on the learning priorities, decide on the teaching strategies, enact these strategies, and examine their impact in tandem with assessment of the relative merits of competing alternatives. In this sense, it is clear to see that being an inquiring professional is also an attribute associated with adaptive expertise (Aitken et al. 2013; Athanases et al. 2015)—a "gold standard for becoming a professional" (Hammerness et al. 2005, p. 360). Timperley (2013) described the adaptive teacher as one who is driven by a "moral imperative to promote the engagement, learning and well-being of each of their students" and who engages in "ongoing inquiry with the aim of building the knowledge that is the core of professionalism" (p. 5). As Lampert (2010) puts it, adaptive expertise enables teachers to "innovate when necessary, rethinking key ideas, practices, and values in order to respond to non-routine inputs" (p. 24). Focused on better learning for themselves and their students, adaptive teachers pursue the knowledge of why and under which conditions certain approaches have to be used or new approaches have to be devised.

Despite advocacy for adaptive expertise, little is currently known about beginning teachers' adaptive expertise capabilities and their associated development of an inquiry stance within ITE contexts (Anthony et al. 2015b; Athanases et al. 2015; Meierdirk 2016; Soslau 2012). Research on the nature and impact of PTs' reflective practice typically concerns field-based experiences (Körkkö et al. 2016), and more recently portfolio assessments (Toom et al. 2015).

Critiquing reflective practices in ITE, Ord and Nuttall (2016) argue that reflection should be accompanied by "close attention to the *embodied sensation* of learning … as a legitimate part of the content of learning to teach" (p. 361). Likewise, Thompson and Pascal (2012) argued that reflective learning needs to involve "more sociologically informed *critically* reflective practices" (p. 322) that take greater account of collaborative and emotional dimensions. They proposed that Schön's (1983) seminal constructs of reflection-in-action and reflection-on-action

be expanded to include reflection-for-action: "the process of planning and thinking ahead about what is to come, so that we can draw on our experiences (and the professional knowledge base implicit within it) in order to make the best use of the time resources available" (p. 317). In this regard, Bronkhorst et al. (2011) argued that for meaning-orientated learning anticipatory reflection should "go beyond the planning of teaching and focus on why teaching should be done in a certain way" (p. 1128).

Despite these suggestions there remains considerable evidence that the potential of inquiry for professional learning is difficult to realise (Horn and Little 2010). Researching in New Zealand classrooms, Benade (2015) noted that the 'teaching as inquiry' model (Ministry of Education 2007) is frequently reinterpreted as an "instrumental formula for teachers to follow, with no requirement they examine their fundamental beliefs and assumptions" (p. 116). Moreover, the commonly reported practice of treating inquiry as a linear process with a fixed solution to a finite task constrains engagement in systematic and analytical examination of the tensions and problems teachers encounter. According to Lawton-Stickor and Bodamer (2016), genuine inquiry involves a "balance between constantly reflecting on and problematizing current structures and practices, and carrying out inquiry practices that seek to develop, and systematically explore questions that arise from reflection" (p. 395).

1.3 Inquiry Within Practice-Based Initial Teacher Education

In looking to support PTs learn how to *do* the complex practices of teaching as they relate to unpredictability and improvisation, teacher education researchers are increasingly exploring ways to avoid the dualism of theory and practice (Sinnema et al. 2017). In particular, ITE has witnessed a turn towards practice-based approaches that "view teaching not only as a resource for learning to teach but as a central element of learning to teach" (McDonald et al. 2014, p. 500). Grossman et al. (2009) proposed a framework for practice-based instruction that draws on three pedagogical approaches: representation of teaching (e.g., modelling, examining video or written case exemplars); decomposition of practice (e.g., focus on core/high–leverage practices); and approximation of practice (e.g., rehearsals). In combination, these approaches are used to occasion shifts in PTs' professional vision about teaching and support the development of productive dispositions, while simultaneously providing opportunities to learn the practices of ambitious teaching practices; practices that "position students' thinking and strategies as central means to drive learning forward" (Singer-Gabella et al. 2016, p. 412).

In mathematics education, research associated with the *Learning in, from, and for Teaching Practice* project (Lampert et al. 2013) provides us with what is arguably the most sustained study of practice-based ITE. This project is structured

around Cycles of Enactment and Investigation involving PTs planning and teaching purposefully designed instructional activities that serve as containers of core practices, pedagogical tools, and principles of high-quality teaching. Teaching within rehearsals involves constructing experiences "around the critical tasks and problems that permeate teachers' daily work" (Ghousseini and Herbst 2016, p. 80). Within each rehearsal "the variations of the practice as it relates to particular students and mathematical goals" (Lampert et al. 2013, p. 238) highlight the complex relational and situated nature of teaching.

The pedagogy of rehearsals, involving modelling of practice, in-the-moment coaching and shared consideration of teaching moves and aspects of the rehearsal activity, supports collaborative inquiry in multiple ways. The cycles of enactment and investigation of deliberate practice provide a space for PTs to "open up their instructional decisions to one another and their instructor" (Kazemi et al. 2016, p. 20). For example, Lampert et al. (2013) analysis of 90 rehearsals across three ITE sites categorised teacher educator interactions as either involving directive or evaluative feedback, scaffolding enactment, or facilitating a reflective discussion of instructional decisions. The researchers noted that "discussions often entailed much work on the development of novices' judgement in adapting to the uncertainties of practice" (p. 234). In particular, feedback interactions within rehearsals that prompted PTs to reconsider and/or retry specific teaching moves enabled direct links to student outcomes related to learning a mathematical concept, offering an explanation, or developing feelings of competency. Developing an inquiry stance was also fostered through individual and collective accountability within the rehearsal process. For example, using a framework of Accountable Talk (Greeno 2002), Lampert et al. (2015) argued that the process of PTs making and defending assertions and interpretations of what they are observing and what they are doing within a rehearsal, provides an opportunity for teacher educators to actively position PTs as "authors and agents in developing knowledge of teaching" (p. 353).

1.4 Developing an Inquiry Stance Within Rehearsals

In this section, vignettes—in the form of sequences of exchanges within rehearsal scenarios from our 3-year design study *Learning the Work of Ambitious Mathematics Teaching* (Anthony et al. 2015c)—are used to illustrate the way that practice-based pedagogies can support the development of PTs' inquiry stance. Building on the work of Lampert et al. (2013), the project utilised pedagogies of practice associated with cycles of investigation and enactment of instructional activities in the form of rehearsal activities in the university and group teaching in classroom settings. The purpose of these activities was to provide opportunities for PTs to learn the work of ambitious mathematics pedagogy (Lampert 2010) through enactment of high-leverage practices. Practices identified as key to the principles and vision of ambitious mathematics teaching were those that placed students'

mathematical thinking and reasoning at the centre of instruction, and supported equitable engagement of diverse learners in rich mathematical activity.

As part of the cycle of enactment and investigation, the teaching of instructional activities was rehearsed in the mathematics methods courses, and then with groups of students in school-based settings. In a rehearsal, the PT was responsible for teaching an instructional activity (e.g., Choral Count, Number String, Launching a Problem) to a group of peers acting as students, with the teacher educator acting as coach. These approximations of practice scenarios provided PTs with teaching and observational opportunities that involved controlled complexity and feedback from peers and teacher educators. Coaching, in the form of in-the-moment pauses by the teacher educator, was used to scaffold the learning of practice. This was achieved in multiple ways: stepping in and modelling aspects of practice; suggesting alternative moves to retry; prompting teacher or peer group reflection related to students' thinking, learning, and participation; asking for teacher explanation of teacher moves in order to highlight effective practice; or inputting a student response that the teacher has to address.

In the project, rehearsals conducted in the early stages of each course occasioned opportunities for PTs to attend to presentation and managerial skills (e.g., writing on the board and establishing pair-share routines). However, the focus quickly progressed to high-leverage routines associated with eliciting and responding to students' thinking. In learning to notice students' thinking, rehearsals facilitated a trajectory of practising to elicit students' thinking towards a consideration of how to elicit students' thinking in ways that enabled explanations to act as reflective tools for the learners. To illustrate, I zoom in on a rehearsal in which the eliciting process used by the teacher is extended from having peers engage with a particular response, towards using the response as a building block to further the discussion. We enter the rehearsal of a choral count, which involved counting in fives beginning from one (see Fig. 1.1), immediately after the rehearsing teacher (RT) records Robert's suggested pattern of "55 being added to each number" (pointing to diagonal numbers pairs):

RT: That's good. Does anyone have another pattern?

Coach: Pause. That's quite a complex idea and it might be one which you want to throw back to them and say does everyone agree? Like, "Let's look at what Robert said; he said that they increase by 55. Do you agree, why or why not"?

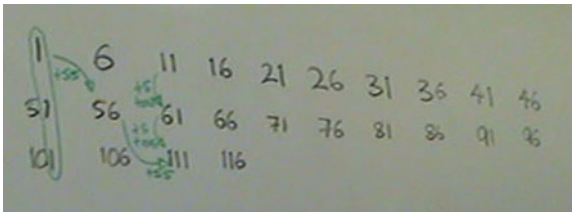

Fig. 1.1 Choral count pattern

RT: Right, I would like you all to have a think about what Robert just shared with us because that is quite a complex idea, and think about what Cath said at the start about how she adds five, and somebody else said that when we are going down we are adding five tens, so think about that, adding five [pause]. *Oh I am giving it away aren't I?* Have a chat to your neighbour about how that works.

After the rehearsing students had talked for a few minutes, the rehearsing teacher asked them to share their ideas:

Megan: If you go across it is plus 5 and then going down is five tens so 5 times 10 is 50 so the 5 plus the 50 is 55 [RT notates the explanation].
RT: So that way is the same as those two? Is that what you are saying [notating the explanation with arrows]?
Megan: Yes you can add them together.
RT: Great.
Coach: Pause. You know you said *I am kind of giving it away* but what I think RT did was you really structured it so they could work out why that pattern was. If you had just said just look at it, with Year Fours they may not have seen it. You didn't say what you need to do is…, but you said look at that idea, and look at that idea, and that gave a foundation for them to then see that and use that, so that was a good thing to do.

In this vignette we see how the coach's suggested teacher move enabled the rehearsing teacher to trial a way to support students to engage with their peers' reasoning. Notably, the coach's feedback made reference to impact in terms of the how the learner was scaffolded to engage with the structural nature of the pattern. In this way, it served to draw attention to the importance of linking the teacher move to the opportunity to learn. This explicit shift from teaching to learning enabled PTs to access essential processes in their practice and become students of their students and learners of their own practice. This shift represents an important component of inquiry. As Hadar and Broady (2016) note, "when teachers explore their students' learning they adopt a different stance, placing themselves in the role of learners" (p. 102). This change in focus from self to student is also a signifier of developing adaptive expertise (Timperley 2013).

With experience of more rehearsals, the norms associated with engagement in sharing mathematical thinking shifted. The rehearsal students, placing themselves in the role of learners, became more willing to take risks, and in doing so they offered partial solutions, conjectures, or simulated student errors involving complex or incomplete explanations. This provided an opportunity for PTs to notice and learn how to use errors as an important resource. For example, in the following String activity involving a linked set of multiplication calculations the rehearsing teacher asked the students to solve 35×5:

RT: Would anyone like to share their answer?
Dan: One hundred and fifty-five.

RT: So Dan you think it is 155?

At this point, the rehearsing teacher, noticing the student error, paused indecisively, and the coach intervened:

Coach: Pause. This is a really good moment to say agree, disagree, not sure. Don't indicate what the answer is.
RT: So does everyone agree, disagree, or are you unsure about the answer?
Coach: And now you need to say remember if you agree or disagree you have to have a mathematical reason, but Dan may first want to say whether he agrees or disagrees with a mathematical reason.

Here the coach deliberately introduced an alternative to the 'agree/disagree' talk move that had not surfaced in earlier discussion—that of allowing the contributor to disagree with their own response, to change their mind and reconstruct their reasoning. As the rehearsal proceeds, Dan takes up this option as part of his role play:

RT: So Dan do you agree or disagree?
Dan: Yes, I disagree with my answer now.
RT: Do you have a new answer or would you like more time to think about it?
Coach: Well done.
Dan: One hundred and seventy five.
RT: And how did you get that answer?
Dan: For some reason what I originally did was that I knew that 30 times 5 was 150 and I don't know why but I just added 5.
RT: Because you saw another five there?
Dan: Yeah because I saw another five there and then when everyone disagreed I was wondering why. But then it clicked, so it is 5 times 5 and that is 25. So I know that 30 times five is 150 and I know that 5 times 5 is 25 because we did that before, so I just added 150 and 25 together to make 175.

In this vignette, we again see how the participants were able to experience the effects of a teacher move that provided additional thinking space for the student. The teacher's response meant that the student's erroneous thinking became a learning tool that supported reconstruction and justification of the reasoning, using mathematics as the authority. Learning to value students' erroneous thinking offers a direct challenge to many PTs' epistemological beliefs about the nature of mathematics and mathematics learning. PTs' willingness to question personal assumptions and beliefs is another example of an inquiry stance (Le Fevre et al. 2014).

In attending to students' thinking, a teacher also needs to be able to steer the discussion towards the important mathematical idea (Leatham et al. 2015). The following episode from a Choral Count rehearsal (see Fig. 1.2) illustrates how the coach explicitly surfaced the need to connect students' mathematical thinking to a mathematics point.

We enter the rehearsal with the rehearsing teacher eliciting different patterns, supported by revoicing, and press for elaboration of the solution strategies. Responding to a request to justify the claim that the pattern increased by eight, Mai noted:

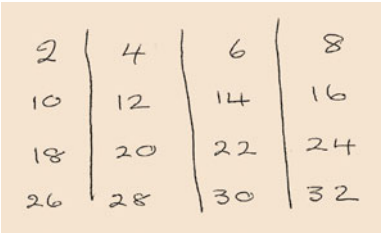

Fig. 1.2 Choral count pattern

Mai: It was ten take away two.
RT: Okay, so you say ten take away two and that's eight [recording the calculation in the first column of the choral count].
Coach: Pause. Try to think at this point about getting other students to agree or disagree. You are getting some interesting patterns here.
RT: Okay does anyone disagree with Mai's observation there? What do you think Ben?
Ben: I can see the same thing.
RT: You can see the same thing, so you agree with Mai.
RT: What do you think Tui?
Tui: Yes, and the second row seems to be the same, like 28–20 is 8.
RT: So you see it in the second row as well [recording the calculation on the choral count].
C: Pause. So thinking about your questioning here, rather than just "do you agree or disagree", try a more structured approach. For example, taking what Mai said, you could have said, "Ben can you have a look at what Mai said and see if that works in the fourth column?"

Here we see the coach prompting the PTs to reflect on what might be the bigger picture in getting students to disagree or agree. Noting that the rehearsing teacher's immediate response was to attend only to Mai's single instance, the coach pressed the PTs to consider how they could use this opportunity to link the rehearsing student's thinking to the generalisation of the pattern across the rows. In effect, the coach engaged PTs in practice and reflection on how they could use talk moves to support students to "articulate a mathematical idea that is closely related to the student mathematics of the instance" (Leatham et al. 2015, p. 92).

These previous examples relate well to specific routines associated with professional noticing of students' thinking (see Anthony et al. 2015a), but could rehearsals also involve the development of an inquiry stance around issues of social justice? In supporting PTs to learn how to establish communities of mathematical inquiry (Alton-Lee et al. 2011) we wanted PTs to experience and experiment with ways to position students as competent and valued. In the next vignette we see how the coach's prompt to explain a teacher move surfaces a discussion on ways that teachers' formative assessment practices can be used to position students as 'achieving' within a class plenary session:

RT: I saw some really good work. Susan or Troy, please could one of you come up to the board and show us your thinking for the next two lines?
Coach: (to all) So how do you think RT made a decision about who to invite up to the board?
Susan: She saw that I hadn't written any of the work. I had contributed ideas but I hadn't written anything.
Coach: I thought there might be a strategic mathematical reason?
Troy: She recognised that we knew the strategy. She doesn't want us coming up if we are going to get it all wrong.
RT: That's part of it; with my Year 9 class I would have picked the weakest overall pair who got it right—they are the ones not used to being good at maths, so that was why. You were right, I had seen you got it right, but I gave you the choice of Susan or Troy.

Importantly, the ensuing discussion positioned the PTs within the activity as having valid opinions that are worth sharing—as authors and agents in developing knowledge of teaching (Lampert et al. 2015). But also the coach's response in pressing for alternative meanings modelled the expectation that PTs engage in practices that enable reflection as both a process and an outcome (Toom et al. 2015).

Within the New Zealand context, the drive towards realising the vision of Indigenous Māori students enjoying and achieving education success as Māori, demands the development of cultural competencies (Ministry of Education 2011) be central to an inquiry stance. While the instructional activities used in the research phase of the project did not incorporate explicit contextual contexts, Averill et al. (2015) makes the case that the enactment of the rehearsal activity, in itself, modelled culturally responsive pedagogy. In particular, the use of wānanga—participating with learners and communities in robust dialogue for the benefit of [Māori] learners—was evident in the co-construction of mathematical ideas through mathematical talk within the rehearsal and in the co-construction of knowledge for teaching within the PT/coach interactions around practice. For example, in the following rehearsal episode we see how wānanga was experienced through expectations for PTs to share, respect, and attend to multiple contributions from the PTs' learning community:

Coach: Is there a way to increase the proportion of learner talk? Talk in pairs about how to adapt what Michael has done to increase the amount of learner talk.
Student1: Asking others for similar ideas.
Student2: Pairs, then giving specific maths terms and asking them to discuss again in pairs using the terms.
Student3: Other ideas, like students making up their own example for everyone to do next.

Other cultural competencies such as whanaungatanga—engaging in respectful working relationships; manaakitanga—showing integrity, sincerity and respect

towards Māori beliefs, language and culture; and ako—taking responsibility for their own learning and that of Māori learners, were embedded in the social norms associated with the rehearsal. The integration of these values within the community of learners meant that opportunities to take intellectual and social risks were readily adopted as a way of learning. As a PT noted in a post-rehearsal interview: "It was useful to see others at work, for one thing it was comforting to see others make mistakes, and to see we are all learners, even the lecturers".

1.5 Developing an Inquiry Stance in Classroom-Based Rehearsals

This section provides further exemplars of how practice-based pedagogies—this time associated with PTs' enactment and investigation cycle within a school—can support the development of an inquiry stance and associated adaptive expertise. Working in groups of four, the PTs were required to plan, teach, and review their teaching of a group of students aged 9–11 years over a six lesson sequence. Teaching a range of instructional activities afforded PTs opportunities to experience the relational demands associated with launching a problem, eliciting and responding to students' mathematical thinking, utilising a range of representations, connecting the big ideas in mathematics (Stein et al. 2008), and positioning students as competent (Boaler 2008).

Opportunities to engage in a more complex form of approximation of practice within a collaborative teaching inquiry supported the development of adaptive expertise—at least in an emergent sense (see Anthony et al. 2015b). In the process of working collaboratively to seek feedback to improve performance, PTs were afforded opportunities to develop metacognitive awareness about the value of an inquiry stance. For example, awareness of the collaborative aspect of learning through inquiry was evident in Chris' post school-lesson comment attributing learning as a function of their teamwork: "I think we have to think a lot about how we talk to children to get them to think, and that's definitely something that I need to work on—we actually did much better in the second visit."

Learning to work and learn within a group was challenging. However, many PTs expressed that, despite perceptions of intellectual and social risks, there were benefits. For example, Pip remarked early on in the teaching inquiry:

> Even though it's a group and you're teaching and you're learning, you are getting videoed. So I feel that you are on show; that you're going to be critiqued. But as I've done one or two of the lessons you just get in and you just forget about that. My thoughts are that if you make mistakes, that's good. I'm here to learn, we're here to learn. [PI#1]

Moreover, Pip noted the value of evidence-based feedback from team members:

> You don't know you do stuff, you think you are being an effective teacher, an equitable teacher but sometimes you're not. [PI#2]

Group and whole-class reviews of weekly teaching sessions helped PTs investigate thorny questions and "figure out what they do and do not yet understand about how their students are performing and what to do about it" (Hammerness et al. 2005, p. 377). These reviews surfaced many dilemmas of practice, especially in the early stages. As Chris noted, "probably the biggest thing was just the fact that a teacher is really a multi-tasker—there is just so much going on". Maximising the "public declaration of knowledge and information, and intrinsic goal setting" (Benade 2015, p. 111) supported discussions around anticipatory reflections. For example, in reviewing their video of the teaching episode Sandra noted:

> In our group we had one little girl who did it completely differently, like she was just adding on, like just counting all of them, so I think next time I would get her to repeat how one of the boys had done it, like 8 times 3, to start her thinking about other ways to do it. Like she explained her thing, but I didn't get her to repeat any other ways to get her thinking about it. [SJ#1]

To develop teacher agency and dampen the effects of enculturation into existing teaching modes, PTs were challenged to build theories of practice that bridged formal and everyday knowledge (Lampert 2010). Given repeated opportunities to experiment with teaching the instructional activities to the same group of students, PTs were pressed to evaluate what they were doing in relation to aspects of practice, the underlying principles of ambitious mathematics, and through explicit attention to student learning outcomes—a feature of developing expertise (Anthony et al. 2015b). For example, in gathering evidence of the interactions with and between students when working with groups, Troy remarked:

> Lots of kids come in with their ideas and lots of groups working well. I think they can take those ideas and use them. It's giving everyone a bit of expression; hopefully they can see themselves as more of a mathematician than they would have otherwise. [TJ#1]

However, through sharing and interpreting evidence, PTs also came to realise how their inquiry lenses were mediated by their personal histories, beliefs, and everyday practice theories (Fairbanks et al. 2010). For example, Pip, a PT who had struggled as a mathematics learner, was keenly focused on the impact of her teaching for diverse learners in terms of participatory practices. In attempting to resolve tensions between the research-based literature and her everyday knowledge of ability grouping structures, Pip was able to incorporate new evidence from her teaching inquiry:

> I can see that thinking about your groupings, not just letting the students randomly choose is a big part. I can see it being another way to change the perception that maths is only for those people with a maths brain … and making this fun for everyone, it's not just for the bright and clever, it's for everybody. [PI#2]

Overall, there was a sense that these practice-based learning opportunities enabled PTs to appreciate that learning to manage uncertainty and develop confidence in one's improvisational capability is something that develops over time—not just with repeated practice, but with sustained professional inquiry into that practice. However, like others (e.g., Campbell and Elliot 2015; Kazemi and Wæge

2015), PTs in our study exhibited differing levels of commitment to, and confidence with, inquiry based practices. For some, willingness to take an agentic position towards improving practice appeared to be moderated somewhat by the authority of the status quo. For example, Chris near the end of his ITE, when asked whether he would like to continue to use rich group tasks responded:

> I think coming out as a new teacher it would be something that I would implement slowly … now that I have experienced this, I don't know if I would be confident to go into the classroom on the first day and go right so this is how we are doing maths. Maybe when I am comfortable in the teacher role it would definitely be something I would look at implementing one day a week to start with, then maybe two days a week. So just giving those problems out, and doing much like we done in the inquiry, creating that environment where the children are willing to discuss their thoughts and ideas. [I#2]

Rayna, in contrast, draws on her practice-based teaching experiences to argue that ambitious teaching is "doable":

> …it's not just something that people have researched and decided it works. It works, and it has benefits for everybody, like it's not just picking the mainstream and teaching to them or trying to extend them or help them, it actually works for everybody and I've seen the benefits myself so I can stand there on my own two feet and say "I've done it and it works". I think that is the biggest thing for me is that I can stand in a staffroom and say "well I've done it and it works".

1.6 Supporting Teaching Inquiry-Orientated Standards

It seems that these practice-based opportunities, designed to learn the complex work of teaching, can also be structured to develop PTs' disposition to inquire into their practice. In reviewing the preceding exemplars, it is evident that the practice-based opportunities within rehearsal cycles involving enactment of investigation can usefully contribute to the six teaching inquiry-orientated standards proposed by Sinnema et al. (2017): Learning priorities; Teaching strategies; Enactment of teaching strategies; Impact inquiry; Professional learning inquiry; and Education system.

Rehearsals were designed using instructional activities that afforded opportunities to inquire into the effects of particular instructional moves, that is, to "get deep enough into authentic interactions with specific learners to practice inventing educative responses" (Lampert et al. 2010, p. 135). I have provided examples of how, as part of this experimentation process, PTs were required to make defensible decisions on *learning priorities* for each of their learners and for those teaching strategies most likely to be successful for prioritised learning.

In *selecting and enacting teaching strategies*, PTs were expected to draw on education's body of knowledge, both theoretical and informal. The process of collaborative planning and public explication of theories of practice within reflection sessions also supported PTs to develop skills at anticipating the reactions and

questions that students bring to a given topic, as well as how particular instructional strategies are likely to work. Moreover, opportunities to repeat rehearsal activities with different peer groups and different problems, including practice in how to adjust instructional activities for student learning needs, supported PTs' developing awareness of the situated nature of practice.

Central to the classroom inquiry was a focus on what happened and whether this made enough of a difference for learners. In examining the *impact of teaching* on each of their students, PTs were, in the first instance, able to draw on their experience as learners in the university-based rehearsal process. In particular, these early experiences of being a learner challenged PTs' expectations for providing explanations, sharing their thinking, and listening and learning from others. Moreover, discussion of these experiences surfaced issues of social justice related to socio-political positioning and participatory practices that framed explorations of impact for each of the students in the school-based settings.

Sinnema et al. (2017) describe the *Professional learning* inquiry as one that requires teachers to be metacognitive and self-regulated learners, as evidenced by "teachers increasingly becoming their own teachers and demonstrating the skills to learn from practice and also to learn for practice" (p. 10). Engagement in the classroom inquiry required that PTs identify their own learning needs as teachers in relation to impact. For example, Troy's journal entry noted the importance of team planning for individual student outcomes and anticipated next steps in their enactment of teaching strategies as follows:

> E [a student] is a very reluctant participant. We aim to encourage her participation by devising simpler problems and highlighting how her strategies/solutions relate to other more complex problems. C's [another student] change, in contrast, will be providing clear, accessible explanation of his strategies to his peers. [TJ#2]

Moreover, participatory norms that affirmed the entitlement and obligation for PTs to challenge information presented by the teacher educators fostered an attitude of open-mindedness. Being "open to alternative possibilities", being "willing to acknowledge that one's beliefs could be incomplete or misinformed" and engaging in "critical examination of evidence" (Le Fevre et al. 2014, p. 2) are key inquiry processes.

Sinnema et al. (2017) final inquiry standard—*Education system* inquiry—references the broader context of school, teaching, and learning. The standard emphasises the need for teachers to "participate in moving education-related debates forward and to contribute to system-wide improvements" (p. 10). As noted above, teacher educator efforts to model culturally inclusive pedagogies, combined with practice-based opportunities involving mathematical inquiry communities, went some way to challenge the hegemonic participatory practices associated with ability-based groupings in our schools (Anthony and Hunter 2017). Moreover, learning experienced as social and dialogical inquiry within communities of practice acknowledged that learning is integrally connected to worldly experiences and emotions. As Pip explained towards the end of her course:

> I wasn't good at maths and knowing about the research about how teachers who are confident and have good attitudes about maths pass that on to their students, but doing maths how we've done it this way I feel more confident that I can go into the classroom. It's changed my attitude about how I feel about myself. Being able to facilitate discussion and bringing children's thinking out has been a really important part for my learning. [PI#2]

In grappling with the inherently situated, relational, and practical nature of teaching, it appeared as if PTs' practice-based experiences of teaching—of coming to know about teaching—existed "in relation to themselves, others, and contexts of time, space, and resources" (Ord and Nuttall 2016, p. 359). Potentially, these experiences of learning to construct and analyse practice with peers could lay the foundation for participation in collegial teacher inquiry as an ongoing part of professional and career development.

1.7 Challenges and Implications Going Forward

Designing and enacting practice-based activities are based on the belief that learning the work of teaching cannot be separated from its enactment; that is, teachers do not learn new things and then learn how to implement them. Exploring the function and value of inquiry in practice-based teaching, I argue that inquiry must be regarded both as a process and product. That is, in supporting PTs' development *of an* inquiry stance, it is imperative that PTs *engage* in critical and collaborative reflective practices, including reflections on, in, and for practice.

Exemplars from the *Learning the Work of Ambitious Teaching* project have shown how practice-based activities can occasion PTs learning of attributes of professionalism associated with inquiry, collective responsibility, and knowledge co-construction—attributes that signify adaptive expertise. Going forward, such expertise is crucial for mathematics teachers to "do teaching that is more socially and intellectually ambitious than the current norm" (Lampert et al. 2013 p. 241). However, in shaping this proficiency, I argue that it is imperative that teacher educators explicitly attend to the development of inquiry stance. For, without explicit attention to the development of an inquiry stance we run the risk of PTs learning a toolbox of core practices that are 'nice to know' but difficult to implement in the 'real' classroom setting. Moreover, in claiming that teacher inquiry in practice-based settings supports continuous learning and improvement, we need to be wary of pseudo-practice-based reforms that do little more than increase the amount of time spent in schools. In particular, we need to ensure that PTs have access to the full resource set of: education's body of knowledge; cultural, technical and relational competencies; dispositions; ethical principles; and commitment to social justice (Sinnema et al. 2017). Without appropriate access to this resource set the enactment of reflective practice would surely be in a technical sense rather than a critical sense (Meierdirk 2016).

These conjectures are based on my own and colleagues' emergent experiences of practice-based ITE. The challenge of how successfully we have supported PTs to

examine in a critical way their fundamental beliefs and assumptions and develop an inquiry stance remains real. To develop courageous teachers who are willing to share their reflective thoughts with colleagues, invite feedback, question their own practice, and commit to change, requires that we all commit to the collaborative community of practice. Without such commitment, the preparation of teachers who can survive outside of the previously privatised practice that 21st century learning is focused on eradicating is less certain. This work will undoubtedly require ongoing theorisation of the concept of inquiry, and its relationship to adaptive expertise, particularly as it applies within practice-based teacher education.

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