Occasioning teacher-educators' learning through practice-based teacher education[1]

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In looking for further understanding of how teacher-educators enhance their professional knowledge and expertise, this paper explores how involvement in a design-based study focused on implementing pedagogies of practice occasioned learning. Driven by our desire to prepare beginning teachers to do the work of ambitious mathematics teaching, we explore the affordances and constraints when learning to implement cycles of enactment and investigation of public rehearsals within methods and school-based settings. The opening of practice-based spaces, involving rehearsals of practice-based mathematical activities, supported learning from, and with, our colleagues and prospective teachers. Collectively, collaboration and inquiry within practice-based settings occasioned new possibilities of being a teacher-educator; possibilities that are more inclusive and responsive to the diversity of our prospective teachers' learning and to that of the students they will teach.

Keywords teacher education · teacher educator learning · diverse learners · ambitious teaching · rehearsals of practice.

Introduction

Be(com)ing a mathematics teacher-educator is complex and challenging. However, despite intensified performance accountability measures for initial teacher education (O'Neill & Snook, 2015), little is known about the preparation, practices, and ongoing professional learning for teacher-educators (Knight et al., 2014). Put more directly by Even (2014): "We need to know how preparation and continuous development programs for didacticians might be organized, what might be useful learning experiences, and for what purposes, as well as what kinds of support are helpful" (p. 332). In this paper, we respond to the calls (Anthony, Cooke, & Muir, 2016) to strengthen our understanding of how teacher-educators can acquire the expertise that is needed to prepare teachers for ambitious mathematics teaching. We do so, in the context of our teacher-

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educator/researcher experiences in a practice-based intervention—*Learning the Work of Ambitious Mathematics Teaching* (LAMT) (Anthony et al., 2015). Situated within two initial teacher education programmes in New Zealand, these experiences involved implementation of practice-based pedagogies centred on the modelling and enactment of public rehearsals of a range of mathematical Instructional Activities (IAs).

Within the emerging field of research on practice-based teacher education, there is a growing collection of studies that explore pedagogies of practice across a diverse range of curriculum areas (e.g., science (Windschitl, Thompson, & Braaten, 2011); English language learners (Peercy, 2014) and mathematics)). In mathematics education, the focus of this paper, studies include the design of instructional activities (Lampert & Graziani, 2009), the nature of roles in rehearsals (Averill, Drake, Anderson, & Anthony, 2016), prospective teachers' (PTs) opportunities to learn the work of teaching within rehearsals (Lampert et al., 2013), and the development of an inquiry stance through rehearsal activities (Anthony, 2018), to name a few. However, to date, few studies have attended to the nature of, and challenges involved for teacher-educators' learning (Kazemi, Ghousseini, Cunard, & Turrou, 2016). In this paper, our aim is to contribute to the knowledge base on teacher-educator learning by drawing on our experiences as researcher/teacher-educators within the LAMT project. By analysing data from our collaborative meetings, our individual reflections on our learning journey, videos of rehearsals, and student surveys, we discuss the affordances and constraints associated with mathematics teacher-educator learning, in particular, learning associated with modelling and coaching rehearsals. As a prelude to presenting our analysis, we overview developments in practice-based pedagogies, specifically, the pedagogies that were the focus of our LAMT project, and provide a theoretical framing of teacher-educator learning.

Practice-based Pedagogies in Initial Teacher Education

In looking to support PTs to learn how to *do* the complex practices of teaching as they relate to unpredictability and improvisation, initial teacher education 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). The various adaptations of practice-based reforms in initial teacher education have been informed by Grossman, Hammerness, and McDonald's (2009) framework for practice-based instruction that encompasses three pedagogical approaches: representation of teaching (modelling, examining video or written case exemplars); decomposition of practice (e.g., focusing 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 inquiry-based 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, Stengel, Shahan, & Kim, 2016, p. 412).

In mathematics education, the *Learning in, from, and for Teaching Practice* (LTP) project (Lampert et al., 2013) provides us with what is arguably the most sustained study of practice-based initial teacher education. Their project incorporates cycles of learning experiences that begin with PTs observing teacher-educators modelling instruction, followed by PTs planning and teaching purposefully designed IAs that serve as containers of core practices, pedagogical tools, and principles of ambitious teaching. PTs enact an instructional activity, in the form of a public rehearsal, with their peers playing the role of students, and later enactment within 'live' classrooms with students affords opportunities for in-the-moment feedback on specific teaching

practices. Supporting collaborative inquiry in multiple ways, these deliberate approximations of practice provide spaces for PTs to "open up their instructional decisions to one another and their instructor" (Kazemi et al. 2016, p. 20). Moreover, 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 ambitious teaching.

For the PT, teaching within rehearsals involves constructing experiences "around the critical tasks and problems that permeate teachers' daily work" (Ghousseini & Herbst 2016, p. 80). Whereas, for the teacher-educator, the pedagogy of rehearsals involves modelling of practice, and in-the-moment coaching that occasions shared consideration and professional noticing of teaching moves and aspects of the rehearsal activity (Averill et al., 2016; Averill, Anderson, & Drake, 2015). Within the LTP study, Lampert et al.'s (2013) analysis of 90 rehearsals across three ITE sites categorised teacher-educator interactions with PTs as either involving directive or evaluative feedback, scaffolding enactment, or facilitating a reflective discussion of instructional decisions. Specifically, discussions often entailed "work on the development of novices' judgement in adapting to the uncertainties of practice" (p. 234) including feedback interactions that prompted PTs to reconsider and/or retry specific teaching moves related to learning a mathematical concept, offering an explanation, or developing feelings of competency.

In being explicit that responsive mathematics teaching is more than supporting students to obtain correct mathematical answers, at speed, rehearsals—as cycles of enactment and investigation—provide a good theoretical "fit" for ambitious teaching. That is, the pedagogies of rehearsal require that the teacher educator as coach "assess how her students [PTs] are currently thinking and to be responsive in some way to their needs, experience, questions, and ideas" (Windschitl & Stroupe, 2017, p. 257). Moreover, the fit extends to opportunities for PTs to experience and develop an inquiry stance associated with adaptive expertise (Anthony, Hunter, & Hunter, 2015a). Fostered through individual and collective accountability within the rehearsal process, Lampert, Ghousseini, and Beasley (2015) argue 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).

Teacher-educator Learning

What and how do teacher-educators learn to be effective at guiding cohorts of PTs through these cycles of enactment and investigation? Windschitl and Stroupe (2017), in the context of science reforms, note that "students, teachers, and teacher-educators have responsibilities to learn and to take up new roles in the educational system that are fundamentally different from the status quo" (p. 251). Based on their 'three-story challenge' model, they claim that this challenge is greatest for teacher-educators. In enacting practice-based teacher education, they argue that teacher-educators' integration of knowledge across three contexts involves:

- Level A: Understanding the nature and development of disciplinary content and practice.
- Level B: Using knowledge of the principles and pedagogic practices that enhance students' opportunities to learn (e.g., orchestrating student talk, incorporating students' ideas, and managing collective reasoning).
- Level C: Providing opportunities for PTs to learn to take up practices that are linked to student learning and support equity in much the same way that teachers provide opportunities for their students.

It is at Level C that reformers of initial teacher education claim that practice-based pedagogies of enactment come into their own. Rehearsals, the focus of teacher-educator learning in this paper,

provide an opportunity for PTs to learn the complex and relational work that characterises ambitious mathematics teaching.

Teacher-educator learning, like any professional learning, is a social process located within a complex system that involves "recursive interactions between systems and elements that coalesce in ways that are unpredictable but also highly patterned" (Opfer & Pedder, 2011, p. 379). This complexity is mirrored in the multiple professional roles of teacher-educators, namely teacher of teachers, researcher, facilitator, curriculum developer, gatekeeper, and bridge-builder (Meijer, Kuijpers, Boei, Vrieling, & Geijsel, 2017).

Arguing that teacher-educators as a professional group have "more autonomy and control over their work than teachers per se" (p. 271), Loughran (2014) offers a view of professional development of teacher-educators as "professional growth". His proposed framework posits that the development of teacher-educators' knowledge and practices of teaching and learning about teaching "is intimately tied to: understandings of identity; the challenges and expectations of the teacher education enterprise; and the place of scholarship as an important maker of knowledge, skill, and ability in the academy" (p. 272). However, in these challenging times of reforms in initial teacher education, the notion of professional growth needs to embrace more than an incidental trajectory occasioned by learning on the job. Professional growth needs to be purposefully conceptualised and informed by research into one's practice, inclusive of PTs' learning, and a desire for programmatic responses to one's learning in a way that leads to meaningful change to the learning of the students the PTs will teach.

Within the emergent studies on professional development of teacher-educators, Meijer, et al.'s (2017) educational design research explored interventions that enhance teacher-educators' transformative learning towards stimulating PTs' inquiry-based attitudes. They noted that teacher-educator learning and the development of a shared vision was enhanced by opportunities to: learn with and from peers; study one's own beliefs and behaviour in practice; and receive learning support. They claimed that "personal confrontation and elaborating on inconsistencies and discrepancies between intended and actual behavior in particular, contributes to transformative learning" (p. 836). Confronting dilemmas of practice aligns with the work of Engeström's Cultural Historical Activity Theory (2001) where tensions within and between activity systems are regarded as sources of change and innovation. Indeed, Engeström proposed that deep professional growth, termed expansive learning, is signified by "qualitative shifts in the functioning of the activity system as participants react to growing of contradictions within it, which in turn may lead to a deliberate collective change effort" (p. 137).

To focus on changes in pedagogies that would better support PTs to learn socially and intellectually ambitious teaching practices, the LAMT project utilised educational design research (McKenney & Reeves, 2014). Prompted by the need to resolve the long-standing tensions of the practice-theory divide, this methodology supported the trial and development of innovation in teaching practice, whilst simultaneously contributing to a purposeful trajectory of professional learning. In the initial stages, where the object is in a state of emergence, learners would be expected to "open the problem superficially" (Roth & Radford, 2011, p. 107). As the project advances, the possibility of new learning is occasioned through one's increased abilities to interpret situations "with the object becoming available to the learner's consciousness in its entirety" (p. 107).

Drawing on models of teacher professional learning, LAMT also embraced suggestions that teacher-educators could benefit from engagement within communities of practice (Parker, Patton, & O'Sullivan, 2016). While not intending to undermine the more frequently reported teacher-educator self-study, communities of practice, involving groups of people who share a concern and passion for what they do and learning to do it better, "seek to break down walls of solo practice" (Byrk, 2015, p. 469). Following compositional elements of community of practice

suggested by Wenger and Wenger-Traynor (2015)—notably domain, community, and practice—participation in the LAMT project (both within and across our respective institutions) aimed to support new ideas and innovations to emerge between rather than within people.

In addition to collaborative professional reflection with colleagues both within and across our two institutions, we envisioned that our community of practice would be inclusive of our students—the PTs. Tobin and Roth (2005) contend that participation in cogenerative dialogues supports teachers to "learn to collaborate with students to establish and maintain effective learning environments—rather than endeavouring to establish control over them" (p. 315). In attending to student voice, we questioned, "Is it possible that prospective teachers will teach us how to teach them?" (Mueller & Skamp, 2003, p. 428).

Our Study Context

This paper draws on a subset of data from a design-based project—*Learning the work of Ambitious Mathematics Teaching* (LAMT) (Anthony et al., 2015). Conducted over three years, the project aimed to trial and evaluate new practice-based instructional strategies and tools that would support PTs learning the work of ambitious mathematics teaching. We took as our starting point those practices identified as key to the principles and vision of ambitious mathematics teaching. Most notably, these included pedagogical practices that place students' mathematical thinking and reasoning at the centre of instruction and support equitable engagement of diverse learners in rich mathematical activity: teaching towards a big mathematical idea, implementing tasks that promote reasoning and problem solving; as well as eliciting and responding to students' ideas, supporting productive struggle, and positioning students as competent.

Taking our lead from the LTP practice-based teacher education project (see Kazemi, Franke, & Lampert, 2009; Lampert et al., 2013) we introduced a series of rehearsal activities within our methods courses. Prior to the subsequent rehearsal phase, PTs work on a 'representation' and 'decomposition' of practice (Grossman et al., 2009) through having the opportunity to observe and analyse their mathematics teacher-educator teaching an Instructional Activity within the method course, and consider suitable planning protocols. Next, for each rehearsal, selected PTs were responsible for planning (in collaboration with a group of peers), then teaching an Instructional Activity (e.g., quick images, choral counts, strings: for a fuller description see, for example, Kazemi & Waege, 2015; and Kazemi et al., 2016) to a group of peers acting as students, with the teacher-educator acting as an independent coach.

The in-class rehearsals enabled PTs to teach mathematics to peers (acting as student learners) under conditions of controlled complexity and engage in timely dialogical discussions with peers and the teacher-educator(s). Interactions were instigated by the PT leading the rehearsal (the lead PT), or more frequently, by in-the-moment coaching pauses called by the teacher-educator. Designed to scaffold the learning process, coaching pauses took multiple forms: stepping in and modelling aspects of practice; exploring the in-the-moment decision-making of the lead PT; prompting consideration of or suggesting alternative moves to try/retry; prompting teacher or peer group reflection related to PTs' or students' thinking, learning, and participation; and asking for PT or teacher-educator explanation of teacher moves in order to highlight effective practice (see Averill et al., 2016).

More than just repeated opportunities for doing teaching, we hoped that these Cycles of Enactment and Investigation would afford opportunities for PTs to engage in progressively more sophisticated enactments of ambitious mathematics teaching. Specifically, our role as coaches was to press the rehearsing PT and their peers to think more deeply in an evidence-based way about specific teaching (re)actions in relation to opportunities for each student's participation and

potential and actual learning. Through the purposeful sequencing of IAs and incorporation of inquiry and integrated feedback, our aim was that PTs would develop skills in both the routine elements of classroom interaction, and be able to respond to the non-routine aspects inherent in students' engagement with learning mathematics in an ambitious classroom.

Designing and teaching with and within rehearsals, inclusive of the role of coaching, was for all involved in the project a new experience. In looking to understand how this experience, embedded in the wider project, occasioned our learning as teacher-educators, we ask (i) what was it that we needed to learn, (ii) what was it that was learnt and that we are still learning, and (iii) how did that come about?

Data collection and analysis

The nine researcher/teacher-educators in the project comprised new and long-term teacher-educators whose main previous teaching included primary (six) or secondary level (three) experience. Across the LAMT project, data collection involved a sample of 15 video records of in-class rehearsals from four different courses across both university sites collected across a sample of rehearsals during the three years of the project. In the university of the first author eight PTs participated in stimulated recall interviews in the first year of the study. Additionally, in the first year of the study, PTs in both universities also completed surveys towards the end of their respective methods papers seeking feedback on their perceptions of participation within the rehearsals. As part of the design research process, field notes were also kept on the key discussion points and follow up email-correspondence of research team meetings (whole team meeting conducted 3 times each year) and several participants, including the authors of this paper kept individual journals/jottings of reflections in progress. In particular, Drake (2016) purposely used a journal as part of his learning process.

Our Learning Journey

The initial learning focus involved familiarisation with a range of IAs used in the modelling and rehearsal process. This was achieved in multiple ways. Firstly, research team meetings included opportunities to practise teaching IAs to each other alongside collegial feedback and reflection. The full team discussions were informed by development of the project practices, reflections on these, and discussion amongst team members within each institution. Secondly, to further understand and familiarise oneself with IAs, several teacher-educators also sought opportunities to practise teaching IAs in a partner school. The increased utilisation of these IAs within mathematics classes has meant that a third option of considering classroom enactment is now available through numerous websites (e.g., https://tedd.org/).

The public teaching of IAs (and later coaching practice) within team meetings surfaced interesting dynamics re the giving and receiving of critique. Working from a position of perceived expert with our PTs, the opening up of our teaching to peers as part of the learning process exposed our propensity to risk taking and our adaptive awareness (Bohle Carbonell, Stalmeijer, Könings, Segers & van Merriënboer, 2014). While acknowledging that learning for individuals was mediated by personal practice theories (Wetzel, De Arment, & Reed (2015), to move learning forward we found it helpful to develop and elucidate a collective vision of ambitious teaching. Acknowledged as a work in progress, in the first year of the project we defined the principles associated with the ambitious teaching as follows:

1. Students are sense makers.

2. Teachers and students learn together; relationships become a resource for developing mathematical proficiency and identity.
3. Ambitious instruction requires clear mathematical learning goals.
4. Teachers plan equitable and responsive learning experiences that enable each student to engage in rigorous academic mathematics work.
5. Teachers plan mathematics learning experiences that enable students to build on their existing proficiencies, interests, and experiences.

Our next learning involved pedagogies of rehearsals. In introducing rehearsal activities to our PTs, we deliberately and explicitly established norms for the rehearsal activity that included building respectful relationships that foster inquiry and risk taking. We noted that teacher-educator modelling of the IAs was one way to build familiarity and trust. Modelling included opportunities for PTs to probe teaching moves and in some instances, an additional teacher-educator acting as coach supported this interrogation. Coaching pauses included questions to the PTs acting as students, questions to PTs in general, and questions to the teacher-educator modelling. For example:

- Why do you think Michael asked you to think for yourself about this? (to PTs acting as students)
- What do you notice about how Roger is recording students' responses on the board? (to PTs in general)
- Why did you chose to use pairs at this point? (to teacher-educator modelling) (Averill et al., 2015)

Aimed to facilitate PTs' professional noticing of teaching moves and consequent student outcomes, these discussions also facilitated our understanding of PTs—in terms of their knowledge and beliefs about learning and teaching mathematics, and their understanding of mathematics. In the early rehearsals, PTs acting as students provided insights into their own mathematical understandings (e.g., representation of 3×4 as groups of 4 or groups of 3) and PTs initial discomfort in providing mathematical explanations).

Developing our expertise in coaching paralleled our vision of PTs' learning in that these new ways of knowing and being within the rehearsals involved integrating our professional knowledge and practical experiences in an adaptive manner. Given our concern to ensure our pedagogies provided opportunities for each PT to learn the work of ambitious teaching, we needed to be able to "flexibly adapt core practices to the exigencies of [our] particular contexts" (Beltramo, 2017, p. 325). In reflecting on our in-the-moment coaching, we had to think about how often we should pause the rehearsal, at what points of the lesson, and what should be the nature of the exchanges during these pauses. Answers to these questions needed to attend to PTs' multiple learning outcomes associated with ambitious teaching such as developing routine skills, adaptive expertise, dispositions to inquiry, and visions of teaching and learning. In addition to accessing literature on pedagogies of rehearsals (e.g., Kazemi et al., 2009), we generated evidence to inform and reshape our teaching towards improved learning (both ours and our students) from multiple sources: our professional noticing in the moment, personal or collegial reflections on rehearsals enactment; analysis of rehearsal videos; stimulated recall interviews with PTs; and PT surveys.

A significant dilemma that prompted learning in the early stages of rehearsal enactment arose through the sharing of videoed rehearsals at team meetings. While the public sharing of our first attempts at leading rehearsals was a novel, and sometimes uncomfortable process, it was a tangible reminder of the role of the emotive dimensions and embodied experiences (Ord &

Nuttall, 2016) in becoming a teacher/teacher-educator. To facilitate productive critique it was important that we co-constructed norms that fostered trust and respect for individual and institutional differences. Our community operated under informal principles recognising that our collective goal was to develop our practice but that deep learning can be personally challenging. We accepted shared responsibility for learning and maintaining a safe environment knowing that we were all developing our coaching skills. We valued the process of iterative inquiry and focused on inquiry-based interactions rather than critique (e.g., asking questions such as "Why did you decide to do it that way?" "I am interested in…", "Did you think about…"). Both the teacher educator modelling and the coach took responsibility for managing the progress of the activity (e.g., making interjections such as "I think this pause is getting off track - can we carry on?" "I am not comfortable with what is happening at the moment. Can we step back and come at this from another angle?")

Observations across a range of rehearsals surfaced differences in the most frequently used interactions—be they directive or evaluative versus questioning prompts. Wondering which (and when) different types of interactions were most appropriate, Averill et al.'s (2016) inquiry across 27 rehearsals in one initial teacher education setting argued that questions used in coaching of rehearsals were important from an equity perspective in that they "inform and empower novice teachers" (p. 490). From their experience, they claimed that although questions could potentially lengthen rehearsals they provided the benefit of "enhancing participation and enabling co-construction of meaning" (p. 490). For example, in the following episode selected by Averill et al. (2016) the coach uses a question to surface why having a student report an incorrect solution might be a productive teaching move:

> Coach: You obviously did some thinking about why you chose this specific response. Can you share that?
>
> Presenter: I'm really trying to get students to think and share in pairs and to realise that they don't always have to have the right answer, but that their thinking is work in progress. I wanted to give them the opportunity, I thought maybe when they were explaining it, they might have thought, "Oh, I know what it is now, it is meant to be such and such."

Regardless of individual coaching differences, our experiences in the initial round of rehearsals within methods classes were all characterised by a shift in focus of our coaching pauses/interactions. Attending to more pragmatic, routine aspects of teaching such as where to stand, writing on the board, projection of voice, and organisation of pair-share activities, meant that initial coaching pauses were more likely to be made early in the teaching sequence. These prompts were also more likely to be directive in nature, directed to practise in real-time specified teaching moves—either as a next move, or in the form of 'rewind and retry'. PT feedback from seven stimulated interviews affirmed that PTs valued the opportunity to "get started" on the learning journey of being a teacher, of 'doing' teaching rather than just reading and hearing about how to teach. Despite several PTs noting that first efforts were "quite nerve wracking", there was a sense of appreciation that rehearsal experiences "of standing up in front to people and teaching" helped make "sure I'm using those key techniques", provided a bridge to the school-based rehearsals, and ultimately to the practicum experiences. These emotions paralleled teacher-educators' initial experiences of working in a more improvised relational space—both in the team-based rehearsal activities and coaching rehearsals.

While we had previously accessed PTs' teaching in our methods courses, in the form of micro-type teaching activities, what differed in LAMT was that the repeated opportunities to engage in rehearsals of IAs supported a shared and deepening understanding of the principles and practices of ambitious teaching. Early rehearsals in our methods classes, which for some courses

was combined with enactments in school-based settings, enhanced our understanding of our PTs' learning, learning preferences, and learning needs. In team meetings, we noted being initially surprised at the diversity of the extent and nature of teaching skills, and becoming more aware of the distance between our expectations of our PTs around noticing and responding to students' thinking and the extent to which they enacted these and attended to mathematical thinking.

As the courses progressed, and rehearsals became an embedded way of working as a community, our aim was that coaching pauses would afford opportunities for PTs to engage in theory building and the development of a shared conceptual framework aligned to ambitious teaching. In particular, attending to the complex work of professional noticing within the rehearsal process (Anthony, Hunter, & Hunter, 2015b) involved two aspects of learning. Firstly, to respond more flexibly to our students' learning we took time to know our PTs (including observing and working with them in school-based enactments of IAs). As part of active listening, we learnt to read their body language (such as signals for help, gestures, and worried looks). Moreover, we sought to understand how the rehearsal process could both model and support PTs' development of cultural competencies (Averill et al., 2015). Learning to both trust and use our community as a resource for learning reflected the cultural competency—wānanga—described as "participating with learners and communities in robust dialogue for the benefit of Māori learners' achievement" (Ministry of Education, 2011, p. 4). Discussions around practice by talking with PTs about their learning, listening to their ideas, and caring for and discussing their learning progress exemplified this cultural competency in action. For example, in the following rehearsal episode, featured in Averill et al. (2015), wānanga was evident in the sense that PTs were confident and comfortable to share their ideas, and realise that more than one answer is suitable and relevant:

> 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.
>
> *Student 1: Asking others for similar ideas.*
>
> *Student 2: Pairs then giving specific maths terms and asking them to discuss again in pairs using the terms*
>
> *Student 3: Other ideas - students making up their own example for everyone to do next.*

Second, within both the rehearsal enactment and investigation phases we needed to learn how to support PTs to engage in dialogic conversations that respected each other's reasoning and supported risk-taking, in ways that developed PTs' agency and inquiry stance (Anthony, 2018). Drawing on the cultural competency of ako—defined as teachers "taking responsibility for their own learning and that of Māori learners" (Ministry of Education, 2011, p. 4), we wanted rehearsals to embody reciprocity of teaching and learning in which PTs (and the students engaged in the IA) shared responsibility for their own and others' learning. This involved us developing a deeper understanding of and adapting our coaching moves to PTs' learning trajectory. For example, once we were aware of the PTs' capacity to notice students' thinking, we needed to be able to adapt our coaching pauses to press the lead PT to engage with student thinking in a way that used that thinking as a resource for learning. Such press for thinking is shown in the following excerpt from a String rehearsal involving a linked set of multiplication calculations the rehearsing teacher asked the students to solve 35×5:

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

In addition to prompting for a mathematical justification, the deliberate introduction of an alternative to the 'agree/disagree' talk move allowed the contributor to disagree with their own response. This provided all PTs with a strategy that could orient students positively towards their own errors by encouraging them to reconstruct their reasoning and change their mind if desired. Furthermore, rather than the teacher being the arbiter of what is right or wrong, this move indicated the value put on student thinking in the class and provided a space for all students to engage in thinking and mathematical reasoning.

However, within our methods courses, challenges in responding to students' thinking continued. We learnt from post-rehearsal interviews that PTs' participation as a student within the rehearsal provided a useful learning experience. For example, Brian discussed how his evaluation of his experience as a learner influenced his thoughts on effective teaching as follows:

> I switched off after the first person started. So I was thinking about how I was doing it, I wasn't really listening to what they were saying and then when the person next to me got put on the spot I switched back on. I thought, "Oh I better keep my mind on what's happening here", and I thought about that strategy. I thought I'm not going to be predictable and say after the first person gave their response of how they got their answer and say, "Kate can you tell me how Annie got that answer." That's exactly what happened in the rehearsal, so I'm going to use it on the second person, maybe lull them into a false sense of security, to keep them on their toes.

Through the rehearsals, we became aware that despite attending to the 'big ideas' in their planning, PTs struggled to connect students' thinking to the mathematical point of the lesson. We needed again to look for opportunities to surface ways to 'make a connect'. The following extract from a Choral Count rehearsal illustrates how the coach facilitated PTs' reflection on the 'connect' in action. We join the rehearsal mid stage at which point the rehearsing teacher has asked the students to discuss the similarities between two solution strategies ($4 \times 5 = 20$ and $4 + 4 + 4 + 4 + 4 = 20$). Receiving the response that they were the same except one involved multiplication and the other involved addition, the coach, noticing that the rehearsing teacher accepted these responses and moved on in the lesson, instigated a pause as follows:

> Coach: When you were using that, what did you want them to draw out?
>
> Rehearsing Teacher: That this was the same as that [indicates the solution strategies on the board].
>
> Coach: So just think about the kinds of questions that you could ask because you've kind of got halfway there but I don't think that it is explicit that doing this and doing this is the same. So let's just have a think, what could [Rehearsing Teacher] ask to push that a little further?

In this instance, the coaching pause successfully pressed the PTs to consider how to link the students' thinking to a big mathematical idea. One of the rehearsing students responded as follows:

> Rehearsing Student: Well she could ask, "How many times did you need to add four in order to get the answer?"

> Coach: Pause. So trying to find that connection there. Another thing that you might want to do, so if you pull that out what [Rehearsing Student] said—that you have got 4 times 5 and then you have got (points to each 4 in the repeated addition)—would that work if you had other numbers? So then you are pressing them to generalise.

In this instance, inviting the PTs to consider alternative teaching moves and providing the rehearsing teacher with space to consider her next move exemplified ako in action at two levels. At the first level, high expectations of student learning alongside the need to attend and build on students' responses were apparent, and at the second level the seeking of suggestions from the wider group of PTs affirmed expectations of an inquiry stance that related theory to practice within the pedagogical discussions. Across both levels, learners could be expected to believe that their teacher/coach was invested in their learning, knew how to help them learn, provided feedback on learning, and enjoyed learning with them—all aspects of ako.

Survey responses affirmed that taking the role of the school student also encouraged PTs to think more deeply about affective issues associated with diversity:

> … reflects how our future students will feel when we teach;
>
> … helped me to see what the other teachers were doing well and not so well; and
>
> … helped me to see the importance of the type of language used and where to use it.

Survey responses, across all courses, likewise affirmed PTs valuing the rehearsal process in terms of the ability to learn immediately from trial and error approaches. While in school settings, adaptations were reported within and across successive lessons, the PTs liked the opportunity to "try out the discussed suggestions straight away and see and experience the effect". As one PT noted: "I learn best when allowed to make mistakes and learn from them". Making mistakes was also mentioned in terms of community, with many PTs noting that it was reassuring to see others make mistakes and develop an understanding of how mistakes can be tools for learning:

> 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. (Survey response)

However, for a minority of PTs, survey responses noted rehearsals prompted worries about their ability to do the rehearsal "correctly" and concerns about being used as "lab rats". Given that this approach to PT learning requires PTs to engage deeply and publicly with mathematics and its teaching, PTs who are not ready to express their personal orientation to mathematics can feel exposed and vulnerable. These student comments provided timely feedback that we as teacher-educators needed to continue to work on our community norms to ensure that each PT was comfortable with the rehearsal process. Grouping PTs for school-based enactment and investigation of IAs (involving groups of 4 PTs collaboratively planning then one of the PTs teaching a group of students with the others observing) and group assessment activities (shared reflections) provided further opportunities to negotiate professional collaboration norms.

School-based enactments, in particular, provided another opportunity for teacher-educators to learn more about our PTs' learning. We took the opportunity to attend all of the enactments in our partner schools, observing PTs working with small groups. Working with 'real' students provided evidence of PTs' ability, or not, for some PTs, to adapt lessons to 'fit' the students, with many initial lesson activities being either too easy or too hard for the students in terms of links with prior knowledge. School-based enactments were followed by post-lesson reflections (based on group observations and reviewing videos) and whole cohort discussions within the methods course programme. As teacher-educators, it was evident that these experiences of repeated school visits provided opportunities for PTs to reflect, but more importantly to forward plan inquiry

into teaching. For example, in a post-school interview one PT reflected on a school-based enactment as follows:

> I probably got more from watching the other teachers. I found I could watch the children a lot more. Seeing what PT-Matt had done and how they responded… The first time we had a young girl who wasn't grasping the idea. So when I taught her I made sure when she was thinking a lot about something - she wasn't necessarily getting it right, but got a little bit here, or a step there - I made sure that I used her thinking in the discussion—that was a development for me as a teacher.

This PT summed up this experience as:

> It also showed me how much you have to be—you are not just thinking about telling the information or getting the information or getting the answer from them—there is so much more going on. You have to be onto it all the time and noticing everything and thinking two steps ahead of you and what might come out. And that planning, and when you look in your planning for expected answers, sometimes they are not as easy as you think.

Factors supporting teacher-educator learning

Throughout the curriculum reform process within the LAMT project, our learning was for the most part stimulated by active listening to student voice within rehearsals and the reflective sessions following school-based enactments of IAs, reflective discussions with one another, and analysis of the research data. The development of pedagogies of rehearsal required professional noticing of our learners: actively listening and responding to PTs' thinking, and teaching actions to facilitate wider discussions that explicitly linked theory and practice-in-action to outcomes of student learning. Active listening was supported in the first instance by our increased awareness of the principles of ambitious teaching prompted by collegial discussions and purposeful reading (see Drake, 2016). Developing a growing understanding of high-leverage practices was supported by learning from their use in the rehearsals in action.

Participation in, and attending to our community of practice, was a second feature that supported teacher-educator learning. Adapting Windschitl and Stroupe's (2017) three-level challenge model, we propose that the community of practice within the LAMT project provided a Level D space—where meta-knowledge about the levels A, B, and C could develop. Within this space, we were able to experiment, to reflect, and adapt our pedagogies of rehearsals based on a range of research data. The cross-institutional nature of the project was key for its success as the regular team meetings helped maintain the coherence of the project as we sought to respond to situational differences. These meetings ensured continual reflection on the professional learning that was taking place at both the institutional and individual level, and provided a forum to discuss the discoveries of our individual inquiries. Being cross-institutional also meant that our collaborative community varied – at times encompassing our entire research team, while at others, the researchers at our own institution, or our class-based communities. In each situation, there was a clear role for the individual within the collective.

Driven by our research objectives to implement pedagogies of practice, the student voice data directly informed cycles of implementation of curricula reforms across courses. Adaptations included changes in: the nature and the frequency of rehearsals and pauses within them (Averill et al., 2016; Anthony et al., 2015b); course assessment practices to include reflections on IA activities within practicum experiences; and inclusion of extended classroom inquiry options (see Anthony et al., 2015a).

A second layer of community of practice involved our PTs and their teacher-educator(s), and in some methods courses, students in partner schools. In this community, we as teacher-educators were able to take risks and learn to co-construct rehearsal activities that supported PTs' learning the work of ambitious teaching. Moreover, it was in this community that we were able to reflect

in and on practice, that we learnt more about our students and about ourselves as teacher-educators. In particular, attending to PT voice about rehearsal experiences and observations of PTs in school-based settings supported these reflections. In taking a 'reflection-for-action' stance (Thompson & Pascal, 2012), our anticipatory reflection enabled us to "go beyond the planning of teaching and focus on why teaching should be done in a certain way" (Bronkhorst, Meijer, Koster, & Vermunt, 2011, p. 1128).

A third layer of community of practice involves dissemination of our experience and findings in the wider teacher-educator professional research community. Our numerous presentations at national and international teacher-educator fora and writing for academic journals, with retrospective and continuing analysis, has occasioned further learning and adaptation of our practice. In one institution, the use of rehearsal had been trialled across other curriculum areas. Moreover, the within-the-moment coaching used in the rehearsals has morphed into a "dynamic mentoring" model (Hunter, Hunter, Bills, & Thompson, 2016) utilised for in-class mentoring in the large-scale *Developing Mathematical Inquiry Communities* professional learning program.

Conclusion

For us, there is no doubt that the introduction of pedagogies of rehearsals, within practice-based reforms of our curricula, have had a significant impact on our learning—in terms of the multiple levels of teacher-educator knowledge proposed by Windschitl and Stroup (2017). However, more than adding new knowledge, placing the teacher-educator in contexts where they can learn from and with their PTs has occasioned new possibilities of being a teacher-educator; possibilities that are more inclusive and responsive to the diversity of our PTs' learning and to that of the students they will teach.

Implementing reforms with our mathematics methods courses has not come without its challenges. Sustaining these reforms requires planning in terms of ensuring adequate time is available within the courses for this work as well as time outside the course teaching for reflective discussions with peers. There are also issues of staff succession, school partnerships, and across program developments (e.g., assessment and scheduling of school-based practicum). Specifically, our findings offer a challenge to calls for PTs to spend considerably more time in the field. In looking for a third space (Zeichner, 2012), the approximation of practice afforded by the pedagogies of rehearsal and enactment in university and school settings offers an alternative and viable way to support PTs to learn the work of ambitious teaching.

We are, however, cognisant that there is much more to learn about how a cycle of enactments and investigation of IAs allow PTs to take up ambitious teaching practice in their practicum experiences and beyond. Grossman and McDonald's (2008) call for "studies of teacher education that can track the impact of programmes over time while respecting the complexity of linking initial preparation to eventual outcomes" (p. 199) remains highly pertinent to the challenging space of initial teacher education. In addition to investigating how preparation supports PTs "to navigate the complex task of teaching increasingly diverse populations in the face of strong accountability pressures" (Cochran-Smith, Villegas, Abrams, Chavez-Moreno, Mills, & Stern, 2015, p. 117), we must not lose sight of the need to explore how teacher-educators learn the work of ambitious teaching in the context of teacher education. We concur with recent calls by Kelchtermans, Smith, and Vanderlinde (2017) for the need to develop more systematic understandings of the connections between professional learning that occurs as a by-product of teacher-educators' work and that which is associated with formal programs of research.

While some may argue that creating practice-based teacher education reforms are too complex and/or costly to implement and sustain (Meiderdirk, 2016), we claim that there is much

to learn about the value of practice-based teacher education. Our collective engagement in LAMT has helped us re-vision our mathematics teacher education programs. We believe this revisioning has helped not only to develop courageous teacher-educators, but courageous teachers who are willing to share their reflective thoughts with colleagues, invite feedback, question their own practice, and commit to change, with much of this change being driven by our commitment to a collaborative community of practice. We suggest the creation of a collaborative community is an important but under-emphasised driver of teacher-educator learning and change in initial teacher education practice that warrants further investigation.

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