Learning the Work of Ambitious Mathematics Teaching

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Learning the Work of Ambitious Mathematics project was developed to support prospective teachers learn the work of ambitious mathematics teaching. Building on the work of U.S. researchers in the *Learning in, from, and for Teaching Practice* project, we investigate new ways to make practice studyable within the university setting. Public rehearsals of Instructional Activities are used to provide opportunities for prospective teachers to explore and be scaffolded to engage interactively with complex teaching acts. This paper overviews the rationale and design of the three year project and reports on progress after one year.

Background

Learning the Work of Ambitious Mathematics Teaching, a project involving seven researchers and mathematics education colleagues from two New Zealand universities, was developed in response to ongoing public and political discourse regarding the nature and effectiveness of initial teacher education. Shifts in education policy that have changed the focus of schooling systems from sorting students by achievement towards a model which expects that all students should be able to access and use all forms of knowledge to succeed (Alton-Lee, 2011) have led to expectations that schooling support all students to engage and achieve at higher levels of success. In mathematics education, this is particularly important for significant groups of students who have traditionally been marginalised by inequitable schooling practices (Bishop, Berryman, Cavanagh, & Teddy, 2009).

Our team, along with other mathematics educators (e.g., Kazemi, Franke, & Lampert, 2009; Sullivan, 2011) contend that productive change to mathematic education outcomes requires pedagogies that promote mathematical proficiency in its widest sense, inclusive of ways of knowing mathematics in which conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition are intertwined in mathematical practice and learning. These intellectually and socially ambitious goals which premise mathematical proficiency and which embrace equitable participation require new forms of "ambitious mathematics teaching" (Lampert, Beasley, Ghousseini, Kazemi, & Franke, 2010, p. 129)—teaching that supports learners not only to do mathematics competently, but also to make sense of it and be able to use it to solve authentic problems. Ambitious in nature, such teaching requires that teachers have specialised knowledge for teaching and teaching mathematics, alongside skills in orchestrating instructional activities and the relational work involved in creating classroom inquiry communities (Averill, 2012; Hunter & Anthony, 2011). Recognition of the complexity of ambitious mathematics teaching demands that we as teacher educators (re)think and (re)form our own pedagogical practices in initial teacher education (Anthony & Hunter, 2012). In the words of Lampert et al. (in press) "we are faced with two challenges: preparing beginning teachers to actually do teaching when they get into classroom, and preparing them to do teaching that is more socially and intellectually ambitious than the current norm".

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Research Design

Driven by the wish to reform our mathematics methods courses in ways that would better support PTs to learn the work of ambitious teaching led us to select design study methodology. Conducted in the complexity of the learning setting, design study enables us to address both at a practice-based pedagogical level and a theoretical level the exploration of the "dynamic that constitutes teaching and learning" (Ball & Forzani, 2007, p. 531).

As both teachers and learners within the research process we needed to balance multiple foci within the project including: (i) the design and enactment of Instructional Activities (IAs) that support pedagogical practices associated with ambitious mathematics teaching, (ii) PTs learning of ambitious mathematics teaching practices; and (iii) our own learning as teacher educators concerning new pedagogies of practices. Such, multiplicity of foci is appropriate within design study that seeks to both provide "systematic and warranted knowledge about learning, and to produce theories to guide instructional decision-making towards improved student learning" (Confrey, 2006, p. 136).

In view of the complexity of researching our own practice within university settings, where change is both expected yet difficult to instigate, the research project is designed in phases: Year 1 concerns the design and trial of a range of IAs to support PTs learning; year 2 includes the enactment of IAs in school settings; and year 3 is expanded to include an examination of beginning teachers' use of ambitious teaching practices in the classroom. Data collection during these phases involves video records, questionnaires, portfolios, and interviews. Consistent with the use of design research, data analysis involves an iterative and on-going collaborative analysis across the multi-cycles of enactment.

(Re)forming our Mathematics Methods Courses

Our project explores how we can, within our own teacher education sites and programmes, best support prospective teachers (PTs) to learn to *do* the complex work involved in ambitious teaching. In grappling with this challenge we are also responding to the often referred to disconnect between theory and practice where academic course work is loosely linked to school-based experiences (Ball & Forzani, 2011). In the interactive situation of the field when PTs are required to use best practices (for example, the relational aspects of ambitious mathematics teaching) they are often overwhelmed by the multiple complexities they encounter.

Our exploration of ways to support PTs to balance the 'learning about' with the 'learning to' are informed by the seminal work of U.S. researchers in the *Learning in, from, and for Teaching Practice* project. Drawing on the work of Lampert and her colleagues (e.g., Ghousseini, 2009; Kazemi et al., 2009; Lampert, 2010; Lampert et al., 2010) we aim to adopt and adapt their cycle of enactment and investigation (CEI) model—a recurring cycle that provides opportunities for PTs to observe, collectively analyse, prepare and rehearse IAs in the university setting. Continuing the cycle, the PTs then enact IAs in school settings, followed by collective analysis with their peers and teacher educator. The cyclic model is based on the premise that PTs "learn through building an iterative an interactive relationship between knowledge and principles, on one hand, and practical tools, on the other" (Lampert et al., in press).

The design and rehearsals of IAs within our course work has been an important focus of the first year, phase 1, of the project. The team trialed IAs promoted by the LTP team (e.g., choral counting, quick images, and strings) and adapted and developed new IAs (e.g., orchestrating discussions of rich tasks, kanikani) for the secondary school contexts. These

IAs were chosen or designed to be "*containers* for the practices, principles, and mathematical knowledge that novice teachers need to learn and be able to use in interaction with students" (Lampert et al., in press). Some IAs (e.g., choral counting) could be used as warm up activities adaptable across a wide range of class levels, and other IAs (e.g., orchestrating discussions of rich tasks) could form the core of a mathematics lesson.

Rehearsals involve PTs deliberately practising, in public, how to teach small and larger groups of their peers. Through the rehearsals the PTs are provided with opportunities to do what Grossman and McDonald (2008) term approximations of ambitious teaching, within a supported setting. In all sections of the process (planning for rehearsal, rehearsing with a peer group, and reflective analysis of the rehearsal) our work with the PTs has included investigation of the approximations by naming and analysing the interrelated teaching practices, the normative principles which shape teacher judgement in the use of the practices, and the mathematical knowledge. Also under analysis has been how these are used in relationships among the teacher, students (in this situation their peers) and the mathematical content to be learned.

The introduction of the IAs within the investigative phase of the CIE model required us, as teacher educators, to model the activity and then orchestrate PTs' public rehearsals of the IAs. During the rehearsal the PT is responsible for teaching the IA and their peers and teacher educator act in the role of simulated classroom students. The teacher educator, in the role of a classroom student, 'acts back' in ways that intentionally represent the intellectual and social range of actions that might be anticipated in an actual lesson (Lampert & Graziani, 2009). Additionally, the teacher educator acts as a coach—stopping the rehearsal to coach the novice as he or she deliberately practices moves that are responsive to specific and multifaceted student responses. The role of coach may also involve leading a discussion concerning the value of possible approaches. The collaborative and multi-site nature of the project has provided opportunities for us to as researcher/teacher educators to interrogate and develop new learning about pedagogies of practice as related to the role of a coach.

Another important part of the rehearsals has been the opportunities provided for the PTs to try out approximations of ambitious teaching within a supportive community of learners (Cavanagh, 2012). As the rehearsals take place scaffolding to enable the PTs to approximate complex teaching acts is strengthened by opportunities for them to hear affirming feedback from their teacher educator and peers about different aspects of their teaching.

Where to Next

After one year of the project we are unanimous in our commitment to utilising IAs within the rehearsal process. To further improve the rehearsal practice-based activity this year we are conducting detailed analysis of our coaching moves and a series of stimulated recall interviews and surveys with PTs following the rehearsal sessions. Our second year of the project includes the enactment of IAs in the school setting. This involves small groups of PTs teaching IAs to groups of students in partner schools. The activities will be videoed and analysed collectively by the respective PT groups with further opportunities for the community of PTs to reflect and rehearse the IAs.

Within our initial teacher education experience we contend that balancing opportunities for deliberate practice of routines embedded within ambitious mathematics teaching with opportunities to develop professional knowledge and judgment to be able to innovate and adapt to situations concerning learners—the hallmark of 'adaptive expertise' (Timperley,

2011)—to be central to supporting the learning continuum into the classroom workplace. In our third year of the project we will follow a small group of PTs into their first year of teaching in order further understand the challenges of enacting and learning ambitious mathematics teaching practices.

For now, we are at the first stages of an exciting learning journey. The project has created a productive educative space for both us as teacher educators and for our PTs.

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