# From course work to practicum: Learning to plan for teaching mathematics

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Learning to plan for teaching mathematics is the focus of an extended research project in initial teacher education. This paper discusses one early part of this project, based on a focus group interview where ten first year primary student teachers reported their planning experiences at the end of their first school practicum. Their one mathematics education course had provided a process for analysing tasks and other planning tools. Findings relate to different phases of planning during practicum, as well as how they accessed tools from course content, and the ways some used internal scripts in analysing, selecting, appropriating and adapting resources for teaching. Implications for initial teacher education are to consider how planning is decomposed within course experiences.

**Keywords** pre-service mathematics education · planning for teaching · initial teacher education · practicum · pedagogies of practice

## Introduction

Planning is a complex task for teachers, and even more challenging for pre-service teachers (PSTs). Unlike experienced teachers who draw on an extensive repertoire of teaching knowledge, PSTs are only beginning to develop this knowledge and have minimal classroom teaching experiences (Borko & Livingston, 1989; Borko & Putnam, 2000; Ensor, 2001). Making connections between initial teacher education (ITE) courses and practicum is also complex. There is a longstanding debate about which ITE effects, if any, carry into the school situation, even in the first two years of teaching (Cochran-Smith & Villegas, 2015; Grossman, 2008; Lampert, 2010). As Grossman suggests, "we need to create new tools for looking at classroom practices of our graduates" and she advocates "larger scale studies of the relationship between teacher education and classroom practices" (2008, p. 21). Questions remain about which practices from ITE are enacted during practicum, and which practices from practicum contribute to further learning within ITE courses. Because planning is an important part of teaching, it makes sense to investigate PSTs' experiences of planning during their first practicum. In an ITE programme that includes at least one practicum per year, how might PSTs go about planning to teach their mathematics lessons? We investigate this question in the context of a small group of PSTs in their first year of a three-year university ITE programme in New Zealand who have just completed their first practicum in a primary school.

In some countries, school curricula are prescribed at a national level with specific resources such a lesson plans, student textbooks, and teacher resources provided by central government and common to every school. In contrast, the New Zealand curriculum document for primary and secondary schools is oriented towards "vision", "principles", "values", "key competencies", and eight subject learning areas (Ministry of Education, 2007). This document "sets the direction for teaching and learning" but "schools have considerable flexibility when determining the detail" of their school curriculum and "can draw on a wide range of ideas, resources, and models" (Ministry of Education, 2007, p. 37). In other words, New Zealand school mathematics programmes are localised, that is, designed and resourced by teachers in each school. Consequently there is considerable variation in what, when, and how mathematics content is taught within each primary school's mathematics programme. This variation adds to the complexities of preparing PSTs to teach at any class level of the eight years of New Zealand primary schools. Within the constraints of an ITE programme, there are considerable dilemmas about what teaching practices are prioritised, and when and how these are addressed within ITE courses (Lampert, 2010).

In describing a long-term ITE curriculum design project based at the University of Michigan, Boerst, Sleep, Ball and Bass outlined four focus domains of practice for the primary mathematics methods course. These were "leading a discussion; planning mathematics lessons; assessing students' knowledge, skill, and dispositions; and representing mathematical ideas" (2011, p. 2856). "Planning mathematics lessons" is also the domain of interest for us as mathematics teacher educators. Our focus on planning for teaching mathematics involves both primary and secondary initial teacher education contexts and includes research methodologies of curriculum design, case studies of PSTs, and self-study (Wilson, 2012, 2016; Wilson & McChesney, 2013; Wilson, McChesney & Brown, 2017). One part of our larger study is connected to the first year primary mathematics education course where part of the course content is scaffolded around practices and tools for planning. In this paper, we briefly discuss relevant literature, describe the research design, and set out the practicum contexts of the participants. Next we report the analysis of the PSTs' self-reported data, organised into three chronological themes. We then discuss a further layering of analysis around three planning practices as we attempt to map back to explicit features of the mathematics education course. The final section presents conclusions and implications and sets out possible future paths of investigation.

## Background and theoretical orientation

### *Theoretical frame of pedagogies of practice*

One of the theoretical underpinnings of our study is the conceptualisation of "pedagogies of practice in professional education" involving the three elements of *representations* of practice, *approximations* and *decompositions* of practice (Grossman et al., 2009). Representations of practice are ways that practice is represented within ITE programmes and courses, and includes the practice of experienced teachers, such as direct or videoed observations or examples of teachers' artefacts, such as unit plans and assessment documentation. Approximations of practice involve bringing practice into the teacher education programme, where novices enact parts of practice in order to prepare, rehearse, practise and refine (Grossman et al., 2009). An example of a large-scale approximation is the school practicum where PSTs are placed in a teaching role without

being required to take on all of the roles and responsibilities of a classroom teacher (McChesney, 2010). In the New Zealand ITE context, examples of approximations might be "simulations or role-plays, and usually involve student teacher peers in the role of learner" (McChesney, 2010, p. 117). Smaller-scale approximations of practice might be assessing one or two examples of student work (rather than for a large class), or planning and enacting a mathematical explanation. These approximations of practice are assumed to be more accessible for PSTs because a teaching practice is simplified, scaffolded in real time with an experienced teacher educator, and rehearsed with other PSTs (Boerst et al, 2011; Moss, 2011). Away from a busy school context, and supported by both a teacher educator and their PST peers, approximations provide lower stakes than the school classroom. In these ways, approximations "can provide opportunities for students to experiment with new skills, roles, and ways of thinking with more support and feedback than actual practice in the field allows" (Grossman et al., 2009, p. 2077). For PSTs, planning is an example of an approximation, particularly at the beginning of their professional learning, because it usually involves a smaller unit, such as planning for a single lesson, planning for a group of students rather than the whole class, or planning a unit of learning rather than a whole year programme. In New Zealand ITE, and similarly in many countries, planning a lesson, writing lesson plans, and preparing unit plans are familiar and repeated PST activities (McChesney, 2010).

## *Planning for teaching*

Planning for teaching is also an example of a practice that can be decomposed or broken down into pieces, providing focus and opportunities for naming and analysing the tasks of teaching (Grossman et al., 2009). Planning for teaching mathematics encompasses different actions: gathering and selecting resources, shaping and structuring proposed learning tasks, and selecting materials or equipment for students (Clarke, Clarke & Sullivan, 2012; Sullivan, Clarke & Clarke, 2012). Planning is a complex task for teachers, and understandably even more challenging for PSTs. They are only beginning to learn about both mathematical content and curriculum for teaching (Wilson, 2016) and have limited knowledge to draw from (Bailey, 2015; Ensor, 2001), and "less scope to plan their lessons" as creatively (Mutton, Haggar, & Burn, 2011, p. 401). Planning is therefore more complicated, very time-consuming and often stressful for PSTs (Grossman & Thompson, 2008; Mutton et al., 2011). Planning, however, is also critical for PSTs' sense of readiness for teaching a mathematics lesson (Bailey, 2015; Wilson, 2016). And in ITE contexts, planning for teaching is often associated with generating a written lesson plan as a teacher product that might be assessed (John, 2006).

In the domain of planning for teaching, a focus of much early research was on the reasoning decisions made by teachers during the process of designing and preparing lessons (Shulman, 1987). In a review of literature related to planning for teaching, John (2006) proposed a model that set out a "dialogical model" of lesson planning that has a core of fixed components surrounded by satellite features attached to nodes that are "illustrative and can be changed or developed according to context" (p. 492). He identified components more likely to be significant for PSTs early on in their teaching and claims that "a more concrete plan emerges," particularly when PSTs gain more information about a teaching context and the learners. More recently, there has been renewed interest in planning for teaching during times of curriculum reforms in different countries. In Australia, a new national mathematics curriculum prompted investigations into how teachers make decisions when they determine what is to be taught and

how they will teach (Roche, Clarke, Clarke, & Sullivan, 2014; Sullivan et al., 2012). Examples of these decisions include identifying important mathematics ideas, language and terminology, selecting student tasks, and choosing pedagogical approaches. In a study of primary teachers' planning of units of mathematical learning, Roche et al. proposed a framework for teacher planning that included checking school or web documents, examining curriculum content descriptions, selecting and sequencing tasks, and adapting tasks for students (2014, p. 862). Curriculum materials were also important resources for planning in a study of third year primary PSTs in New Zealand. A metaphor of "navigating a curriculum landscape" described the process the PSTs used for long-term planning because they were engaged in "recognising, attending to, and making meaning of explicit messages and cues, and then selecting resources for particular teaching purposes including planning" (Wilson & McChesney, 2013, p. 105). We also found that these PSTs attended to their mathematics content knowledge in different ways, "sometimes collecting, selecting and moving on to other features, or stopping to explore in more depth, often checking, decoding or revisiting mathematical content" (Wilson & McChesney, 2013, p. 117). And importantly, this revisiting or re-learning of mathematical content was seen by some as contributing to their confidence and sense of preparedness before teaching.

Planning can be decomposed into constituent elements such as designing and writing lesson plans and curriculum units (Boerst et al., 2011). An important aspect of decomposition is when the constituent piece such as a lesson plan "becomes a tool that is used to influence the way they do certain things" (Mutton et al., 2011, p. 401). In addition, the written lesson plan in an ITE context

> both captures and misrepresents the practice of experienced teachers. Although experienced teachers clearly have well-developed plans for class, they would seldom plan a lesson out of the context of a larger unit of instruction, nor would they plan for hypothetical learners which we often ask novices to do (Grossman et al., 2009, p. 2075).

Student teachers may raise this question of authenticity but also recognize that being able to plan to teach lessons within a supported environment is a useful step towards their expected roles during the practicum. The writing of extended detail within a written lesson reveals the thinking of PSTs and this extended process is an opportunity for PSTs to re-edit the plan and to rehearse their future teaching (Grossman et al., 2009). While teacher educators may have opportunities to observe the PSTs' lesson plans within courses, it is more difficult to find out about how PSTs plan during practicum.

## Course context

We now explain some features of the mathematics education course in order to provide contextual detail for this study. The Year 1 mathematics education course was taught over ten consecutive weeks in the second semester, and included two assignments. There were twelve two-hour lectures for the whole cohort of approximately one hundred on-campus PSTs, and eight three-hour workshops in groups of approximately thirty-five. The first author was the course coordinator, and led the development of the course lectures, course materials and online learning platform. The cohort lectures were shared between both authors with Sue teaching one of the workshop groups and assessing these students' assignments. One aspect of the course content was analysing a student task. This involved the PSTs in solving the task, analysing the

task for mathematical content, identifying mathematical representations, and relating these to the New Zealand mathematics curriculum (Ministry of Education, 2007). This process was also an opportunity for the PSTs to re-visit their mathematical understandings, and to learn about and from curriculum materials (Grossman & Thompson, 2008). The task analysis was modelled in workshop sessions and associated with criteria for identifying a "worthwhile mathematical task" (Anthony & Walshaw, 2009). The first assignment required the PSTs to select one measurement and one geometry student task from a list of possible tasks drawn from a nationally published and easily accessible resource available to all NZ schools (Ministry of Education, 2009-2012). On a provided template, the PSTs recorded the analysis of their selected tasks including their own solution process. They identified the mathematics content for each task, matched this content with curriculum achievement objectives, and explained mathematical terms and language. The PSTs were also required to link each task to aspects of worthwhile tasks, as a professional justification of their choice (Anthony & Walshaw, 2009).

One lecture and one workshop session focussed on planning for whole lessons. In the lecture, the PSTs were presented with a template for writing the lesson plan that was similar to the format required during their upcoming practicum. The workshop session was structured around a measurement task scaffolded by the lecturer, followed by groups of four PSTs collaboratively planning a whole lesson based on this task. The second and final assignment required PSTs to independently plan and write lesson plans for two forty-minute lessons for a group of ten students: one lesson on measurement and the other on geometry, and incorporating the tasks from their first assignment. Consequently, both the course and the assignment experiences provided structured opportunities for the PSTs to draft, re-draft and rehearse planning practices prior to practicum. The development of planning practices for teaching mathematics is clearly part of the "privileged repertoire" of this first year mathematics education course as indicated by the number of lectures and workshop sessions, and as a valued practice in the focus of both assignments (Ensor, 2001). In summary, the mathematics education course began with decomposing a mathematical task, in order to orient PSTs towards important pedagogical information. This was followed by planning a mathematics lesson that was also decomposed into important elements assumed to be essential for planning in school contexts.

The PSTs completed the mathematics education course, enjoyed a two-week study break, and then began their four week practicum during the fourth and final school term of 2014. PSTs were assigned to one Associate Teacher (AT) in schools in the wider Christchurch area including full primary (Years 1 to 8, five to twelve years old), intermediate (Years 7 and 8), contributing primary (Years 1 to 6), and various other combinations (state, integrated or private schools, area schools, kura kaupapa (Māori language immersion) or Year 7 to 13 secondary schools). In addition to the AT, each PST was supported by a university teacher educator (from any discipline), who observed them teaching a lesson. Our localised context posed a limited opportunity to develop links with teachers in schools. We knew that our PSTs would be sent far and wide into a range of class levels and school situations, let alone the variation of individual school mathematics programmes. In the context of the already busy final school term, many PSTs were likely to be given a great deal of responsibility for planning and teaching, often as a means of helping out their busy AT, and therefore could be asked to teach any topic of the mathematics curriculum. The minimum mathematics-related requirement for their first practicum was to plan and teach a series of three mathematics lessons with a group of approximately 8 to 12 students. In the first week, the PSTs were expected to consult their AT and to observe them teaching a mathematics lesson. This provided PSTs with an opportunity to

notice existing classroom practices and to gather as much information as possible for their planning of future mathematics lessons.

## Research design

Our aim was to investigate how first year PSTs planned in the different contexts of their practicum and we now briefly describe the research design. Investigating PSTs' perspectives of planning involves opportunities for them to express their views in a safe environment. Interviews are therefore opportunities for PSTs to describe their activity, that is, their planning practices within the context of their practicum context. Semi-structured interviews that include prompts and probe questions initiate further elaboration, explanations and reasoning about participants' decisions and actions (Yin, 2009). In addition, interviews are a shared social experience and a focus group interview can elicit diverse responses among peers, stimulate further contributions, and consequently encompass a greater range of perspectives and experiences (Wilson, 2012; Yin, 2009). We selected a focus group interview because PSTs could self-report their planning practices and be with their peers in a more comfortable power-differentiated situation when the interviewers were their mathematics education lecturers (Wilson, 2012).

In the week following the end of the four week practicum, the PSTs returned to university to complete all course and practicum assessment requirements. Ten PSTs from Sue's course workshop class volunteered to participate in the focus group interview, and provided informed consent for their contributions to be anonymised by pseudonyms. They were invited to also contribute their planning related artefacts: the three mathematics lesson plans and associated teaching notes, plus their two assignments and their workbook from the mathematics education course. Seven PSTs volunteered their practicum lessons plans, and nine volunteered their assignment lesson plans. We collected this documentation data for three main reasons: each data source provided chronologically different data, served different purposes for the PSTs, and lastly, due to living in a post-earthquake environment, we were mindful of any extra pressure of time commitments that might be placed on our participants (McChesney & Wilson, 2016). The second assignment had been assessed and returned to the PSTs, so there was a time interval between data collection and completion of the mathematics education course requirements. This protected student academic outcomes because all course requirements were completed and enabled us as teacher educators to move more easily into the role of researcher. Initially we had organised three focus groups of about three participants, assuming this would provide more time for each PST. On their return to university after the practicum the PSTs requested that they all attend the same interview. On the agreed date for the focus group interview, one participant was unable to attend and completed an interview with Sue at a later date.

The focus group interview was audio recorded and lasted for approximately 90 minutes. The PSTs' planning documents were available during the interview, so that at times it represented a variation of a stimulated recall process whereby documents were used to prompt and support discussions (Wilson, 2012). The interviews were transcribed and provided to the PSTs for verification. For this paper, the transcript of the focus group interview provided the main source of data and the analysis of planning documentation served as corroborating and explanatory evidence. All data sources were analysed by content analysis, whereby references to planning in its widest sense, espoused or implied, were identified, and then organised into initial themes (Miles & Huberman, 1994). For each PST we identified data related to planning

actions such as references to curriculum content and resources, as well as to student learning. The second cycle of analysis involved cross referencing between the group of PSTs in order to identify common actions as well as unique responses to a particular school context. The data analysis was then checked between the two researchers, eliminating some data before finalising each theme (Cohen, Morrison, & Manion, 2011). These cycles of data analysis identified three themes. The first theme related to opportunities for the PSTs to access information from their Associate Teacher (AT) (a similar role to a Mentor Teacher) and described both how this occurred and what kind of information was accessed. The second theme follows chronologically from the first, in that for most of the PSTs, they independently sought out and selected curriculum-based resources for their planning. The final theme relates to the ways in which the PSTs used or adapted these materials for teaching, including use in written lesson planning.

## *Introducing the participants*

For the practicum, the PSTs were in a variety of primary schools within the Christchurch city region. At the time of the study and in a post-earthquake environment, there was considerable variation in how schools were organising mathematics learning. Some PSTs were placed in schools with one teacher and one class of students, while others worked with a team of teachers and multiple class levels in what is known as "collaborative learning environments." The PSTs in intermediate schools (the last two years of primary schooling, 11 and 12 year olds) were often in a teaching arrangement known as "interchange," a system of ability streaming whereby several classes of students have mathematics at the same time but students go to different teachers according to their assessed mathematics achievement. Table 1 below is an overview of the Year levels and the student ages, the class organisation and the mathematics focus and curriculum level for each PST.

| Pre-service teacher (PST) (pseudonyms) | Year level<br>Ages | Class organisation | Mathematics teaching focus<br>Curriculum level |
|---|---|---|---|
| Sarah | Year 0<br>Age 5 | Own class – new entrants | Geometry – shape<br>Level 1 |
| Helen | Year 0-1<br>Age 5 | Own class | Number - addition<br>Level 1 |
| Ella | Years 1-2<br>Age 5-6 | Own class | Number - addition<br>Level 1 and 2 |
| Jill | Year 2<br>Age 6 | Own class | Number – multiplication<br>Level 1 and 2 |
| Rose | Years 1- 4<br>Age 5 to 8 | Multi-level class | Geometry – symmetry<br>Level 1 and 2 |
| Liz | Years 3-4<br>Age 7-8 | Own class | Number - addition<br>Level 2 |
| Cathy | Years 5-6<br>Age 9-10 | Collaborative teaching | Number – doubling and halving, reading decimals, ordering fractions<br>Level 3 |
| Katie | Year 6<br>Age 10 | Own class | Measurement – time<br>Level 3 |
| Mary | Year 7<br>Age 11 | Intermediate School-Interchange system | Number- fractions, decimals and percentages<br>Level 4 |
| Ann | Years 8<br>Age 12 | Intermediate School - Interchange system | Measurement/number -converting metric measures<br>Level 4 |

Table 1. Participant PSTs and their practicum mathematics contexts

In New Zealand, children typically begin primary school on their fifth birthday, and the Curriculum Levels correspond to roughly two years of school with Levels 1 to 4 being the main focus of the 8 years of primary school. While on practicum the PSTs were expected to teach the current mathematics topic of their classroom programme, and required to plan and teach at least three mathematics lessons for a group of between 8 and 12 students.

## Results

In this section we report the analysis for each of the three themes: *Discussing with and observing Associate Teachers*, *Searching for and selecting resources*, and *Transforming resources for planning*. Only the first theme has two sub-themes or categories. In our analysis, we use the term "resources" as an inclusive term to encompass curriculum information, tasks, teacher information and student materials including equipment, and we identify specific types of

resources where relevant. One category of teacher resource in New Zealand is a set of numeracy books provided to every primary teacher (Ministry of Education, 2009-12) and the Ministry of Education *nzmaths* is an extensive online mathematics education website available to all schools.

## *Discussing with and observing Associate Teachers*

As set out by practicum expectations, one of the PSTs' first actions was to find out what they were expected to teach. For all of the PSTs, this involved having a discussion with their ATs either prior to or early in the practicum. Most PSTs described this as a collaborative process whereby they were able to "talk with," "discuss with," "question," and "work together" with their ATs to determine the focus for their three lessons. The ATs used a range of *New Zealand Curriculum* related terms to describe this focus (Ministry of Education, 2007). According to the PSTs, some ATs referred to the broader mathematics strand headings e.g. number and algebra, measurement and geometry, and statistics, some referred to specific terms such as number strategies and time, while others communicated the focus of the lessons by giving the PSTs specific curriculum "learning intentions". Examples included learning to skip count (Ella), using repeated addition to solve multiplication problems (Jill), and telling the time with hours and half hours (Katie). One PST, Ella, was directed by her AT to one of the numeracy books (Ministry of Education, 2012), and then to specific pages and activities for her lessons. In contrast, Rose was only directed to the strand heading for her teaching (Geometry), and then given "free reign" (Rose) to choose the area of mathematics within this broader area. She chose transformational geometry because it aligned with other curriculum areas such as art that she also planned to teach while on practicum.

Five of the participants described aspects of their AT's practices that they had noticed during mathematics lesson observations. Ann noticed the mathematical equations her AT wrote on the whiteboard, and noted the examples, symbols, and diagrams recorded, as well as her questions and explanations during the lesson. Ann then described how she used this information for planning, either directly copying or adapting the examples her AT used. Similarly, Katie noticed how her AT taught the students about telling the time in hours and half hours. Her AT posed word problems involving time that were connected to the students' worlds. Liz's observation lessons focussed on addition and subtraction, and like Katie she noticed how her AT posed addition and subtraction problems within word problems related to the "real life" of the students. She described this as her AT posing the tasks within a "context," as opposed to "just giving them numbers." Liz reported a specific example whereby her AT used a teaching resource to guide her teaching during the lesson, and the resource was a numeracy book (Ministry of Education, 2012). She decided to adopt this practice for her own teaching, saying "I'll use that – that's perfect!"

PSTs also noticed organisational and management practices. Within an interchange system, Mary noticed daily routines for mathematics, the classroom location for her teaching, which students she would be teaching, and the timing of lessons. Liz also noticed organisational routines. She said the observation "was really beautiful for my lesson planning – for logistical things" and especially for "finding out the things you just don't think about." She particularly noted where students sat during the lesson, how her AT used a modelling book during the lesson, the placement of the small standing whiteboard and that her AT wrote upside down on this whiteboard (from the AT perspective). Although gaining information about mathematics resources and student organisation was valuable for Mary, "from the perspective of teaching

mathematics, (the observation) wasn't useful." For her, the observed lesson did not include a range of pedagogical practices because the students completed a worksheet for the entire lesson with minimal interaction with the AT. Jill had a similar experience of minimal information from the observed lesson, stating that in hindsight "there wasn't a lot of parallel between what I'd seen modelled and what I had to do." She began her planning process with few links between the observed lesson and what she was expected to teach. In summary, the practicum aim of the lesson observation was to provide PSTs with information for their planning and future teaching. This aim was met for Ann, Katie and Liz, and, to a lesser extent, for Mary and Jill. There was not substantial evidence from the other five PSTs to establish what they had gained from observing their ATs.

## *Searching for and selecting resources*

Following the conversations with and the observations of their ATs, the PSTs needed to find and choose resources for planning their lessons. This was relatively easy for some, such as Ella and Mary who were expected to use resources provided by their ATs. Ella reported having to "plan by the book" because she was given teacher numeracy books and directed to the "book" and the "page number." Similarly, Mary was given a copy of the class textbook and directed to the section she was required to teach. Others, Liz and Jill, were also given numeracy books, but had more freedom to find and include additional resources. Liz described how she used these books as "a guide" when planning but also looked for other resources, particularly tasks presented as word problems. In addition to the numeracy books, Jill was given a series of worksheets for use in her lessons. Her AT suggested that she use these resources as a guide, saying "these are the kinds of resources that I might use – you go away and figure it out for yourself." Jill decided that she could search within these for tasks to use when planning, and still have the freedom to look for and use other resources. She then searched by "sniffing around" the classroom looking for resources she could use. Sarah also searched within her classroom, but found this challenging because the room was isolated from other classrooms. Sarah described that she had to "make do" with what was in the room and how this limited what she was able to use in her teaching. Others were able to search beyond their classrooms and Ann described how she searched within the school's resource room, and when she found multiple copies of a teacher resource, she thought these must be good and so chose the measurement resource for her planning.

In addition to looking for hard copies of resources from their school environment, most of the PSTs searched the internet by "googling" resources, usually by themselves. For example, Cathy accessed *nzmaths* because she "trusted" it as a site used extensively in the mathematics education course: "I went to *nzmaths*, found what I was looking for which was perfect because I feel like *nzmaths*, well we've talked about it so much that I can trust it, you know the resources I find on it, I feel like they are worthwhile." She was hesitant to use other sites, saying "if Sue hadn't talked about them in the course then I was a bit scared to choose them." Ann also started with *nzmaths* and then searched within sites she used for personal use such as YouTube and Pinterest. She described this as "sifting" through sites to find resources and to provide her with different options for teaching. Similarly, Rose searched the internet "looking for a bunch of stuff," because, unlike the others, she needed to find a broad range of resources to plan across two levels of the curriculum. As well as looking within *nzmaths* she found internet sites her students were already using saying "I've seen they've really loved it, and I know they are going

to be engaging." Helen was the only PST who reported searching internet resources with her AT where early in the practicum they looked through the online resources on *nzmaths* to find tasks for Helen's lessons.

The PSTs therefore devoted time to searching for and gathering up a variety of resources such as teacher and student textbooks, numeracy books, worksheets, and website links. They then searched within these to mostly select specific student tasks for their lesson planning. Ella, Jill and Rose described how it was important for their tasks to "align" with the curriculum, and viewed this matching action as an essential first step before selecting. Ella evaluated resources by asking "does this link up?" If it did, she continued on to plan her lessons, saying "yes, okay, then onwards with planning that lesson." Likewise, Jill stated that "it was important to look at all these things (referring to curriculum documents and resources), before actually starting to do any planning." She also explained how her previous experiences of completing the course assignments helped her make her selections, saying "I looked at the stuff I did in the assignment to see how to unpack it" (the task), and looked for "the nitty gritty" within it to identify features such as mathematical tools and language. Rose reported that she "chose really easy tasks going to harder ones" where all her learners could engage with the initial tasks because her class of students spanned two curriculum levels.

Tasks were also selected because of their teaching approaches and their sense of "worthwhileness", selection criteria often mentioned by PSTs. Sarah, Jill and Cathy selected tasks that were worthwhile, meaning that the tasks needed to be "interesting and exciting", "hands on and practical", and just "fun stuff" for their students. This notion of "worthwhile" may be linked to a course resource that PSTs regularly used to analyse tasks in terms of elements of effective pedagogy (Anthony & Walshaw, 2009). Liz and Katie selected tasks that positioned mathematical concepts within word problems and which had realistic contexts. Liz explained that "I wanted to use word problems to let the numbers fall out of them", and Katie described how she selected word problems with realistic contexts such as interpreting bus timetables. The PSTs reported that their selections were made by carefully analysing the content of the resources and identifying those which matched the curriculum and mathematical content they needed to teach, the teaching approaches they wanted to use, and whether or not they were "worthwhile".

## *Transforming resources for planning*

Once tasks had been selected, the PSTs transformed these in a variety of ways before writing their lesson plans. Ella, Liz and Jill carefully read the numeracy books, looking for teacher actions they could follow during their lessons. The process of reading helped Ella find more information for her planning because "if I just read the stuff prior then it does actually say what they should be doing in the lesson." Both Ella and Liz described how the content of these books served to guide their planning decisions, for example what to say, what to write, and how to use the suggested tools and equipment. Similarly, Rose read a student textbook which "gave her an idea" for creating her tasks for her lessons. Some PSTs reported that they worked through their selected tasks as part of their planning process. As well as reading the tasks, Sarah worked through each task, explaining that it was not enough to just "look through things" and decide "that would be great for class", but it was important for her to see how they "actually worked and how they could be changed." She cautioned that, while some tasks might look great on paper, they may not "work" during a lesson, so "I went home, thought about the tasks,

sort of relayed it in my head, did them and was like, oh, okay, this would work, and this wouldn't." Similarly, Ann tried out the mathematics tasks she had chosen to ensure she could both do the mathematics herself prior to teaching and to anticipate various solution processes of her students. Jill said that she had learnt about mathematics teaching by doing the tasks, as opposed to hearing about or being shown them and this influenced how she adapted tasks for her lessons. She explained that "during the course we did hands on maths, so how can I turn this worksheet into practical mathematics?" Jill posed further questions for herself such as "is there anything else I can do that is interesting and exciting, while still following these requirements?" and "how can I take these worksheets and actually make them into 'doing' activities?" Ella also mentioned questions as important aspects of her lessons and explained further:

> so what I did as opposed to searching was kind of go through the whole lesson and think about different questions and different sorts of variations of using the materials that I could try so that it wasn't so by-the-book. I thought about things like questions as opposed to activities.

Ella was clearly focusing on using questions as a means of transforming the tasks to include some teacher prompts in order to make the task experience more accessible for her students during the lesson.

## Discussion

The analysis of the chronological sequence of PSTs' self-reported actions and decisions is now organised into three "phases" of planning called *searching and gathering*, *analysing and selecting*, and *appropriating resources for teaching*. The *searching and gathering* phase began with the AT conversations and all PSTs collected information, and sometimes resources, related to the mathematical focus of their lessons. The PSTs accorded high status to information and resources from the AT which then directly focused and shaped the mathematical and resource direction of their initial searches. Next, by observing their ATs teaching a lesson, the PSTs gathered indirect information when they identified teaching practices that might shape their planning. This included several instructional practices important for planning such as how lessons were structured, how the teacher used resources and tasks, and how mathematical concepts were modelled and explained. This information also included how to manage and organise students which is a significant priority for novice teachers (Borko & Livingston, 1989). Consequently, by observing their AT, the PSTs noted information they deemed relevant for planning and teaching their future lessons.

An important finding is how the PSTs took initiative and independently searched and gathered additional resources for their planning. For a few PSTs, the search was minimal because they were provided with resources from their AT and one searched *nzmaths* alongside her AT. Most, however, independently searched for more resources in a variety of locations. This contrasts with the actions of experienced Australian teachers when planning units of learning, where Roche et al. (2014) found teachers to draw on their existing pool of resources for teaching. In our study, it was surprising to find that some PSTs searched the immediate classroom or school environment, particularly to gather material resources such as books and equipment. Outside of the school context, most PSTs accessed online sources and searched different sites. The majority of PSTs mentioned the mathematics site *nzmaths*, with two PSTs reporting that they use sites more related to social media. Their reliance on the internet, and in

particular, the professional site of *nzmaths*, was similar to the actions of third year PSTs when searching specific websites for information to support their long term planning for mathematics (Wilson & McChesney, 2013).

The second planning phase is *analysing and selecting*, a phase that it is reasonable to assume occurs to some extent during the searching and gathering phase. Although this might be more implicitly selecting important information, this included how to use teaching materials during lessons (Liz), what to say and write when communicating mathematical concepts (Ann), using word problems and realistic contexts (Liz and Helen), and organisational choices (Mary). The act of selection could also be deciding what not to choose, as illustrated by Rose when she rejected teacher actions she had observed. Her observational filter shaped what not to do, which in turn influenced what she would select for inclusion in her lessons. This included selecting a clear focus for her lesson, resources aligned with this focus, and resources and materials that were appropriate for her lessons.

Once the PSTs had gathered a variety of resources, analysing and selecting actions were more explicit when they were deciding which resources to select. An important consideration was how, and if, these resources aligned or "matched" with the curriculum focus of their lessons (Ella, Jill and Rose). PSTs used their knowledge of curriculum documents and key mathematical terms to recognise whether a resource aligned with their view of curriculum. They read resources, including student tasks, and analysed both explicit and implicit mathematics content of the resources. There was a sense among the PSTs that getting this alignment "right" was an important professional decision that they needed to make, and make independently of their AT. These processes are similar to John's (2006) claim for his dialogical model where "there is a constant iterative pattern of shuttling back and forth" between components of his model, when a "student teacher explores, frames, checks, and re-frames where appropriate" (2006, p. 492). In addition, the analysis of the mathematical content helped some of the PSTs, particularly those like Ann who were teaching more complex mathematics, to revise the content they needed to teach. She spent a considerable amount of time doing the mathematics tasks she had gathered. The processes of "reading" and "doing" tasks also helped PSTs to identify important mathematics content such as language and representations, and specific teacher actions such as how to use equipment and other materials. This highlights the multiple purposes of tasks, not only as sources of information about how to teach mathematics, but also as opportunities for PSTs to review mathematical content. Consequently, this process of reading and doing (exploring) student tasks particularly helped them to frame up possible teaching sequences, instructions and questions, and consider student organisational issues.

An important finding in the analysis and selecting phase related to matching the student tasks with the students they were teaching. Some PSTs reported that, during the exploration and analysis of student tasks, the focus of their attention shifted towards the group of children they were going to teach. This is similar to processes in later phases of teaching for PSTs (John, 2006) and might extend into the first years of teaching (Mutton et al., 2011). The PSTs considered which tasks were in their view "interesting and exciting", or which had a "fun" factor. Some PSTs described how they did think about what learners might actually do during these tasks, how learners might use suggested equipment and materials, and ways peers might work together. Several PSTs found the process of doing the tasks important for predicting possible learner responses and misconceptions. When Sarah solved the tasks for herself, she considered how her learners might respond, which in turn helped her consider possible actions she could take as the teacher. She described this process as "replaying" the lesson in her mind, visualising both what she would be doing and how the learners might respond. This is an

example of informal and independent rehearsing of a task enactment, illustrating that some PSTs were beginning to use visual rehearsals to anticipate the impact of their selected task on learners. In summary, the analysis process of reading and doing student tasks helped all of the PSTs in selecting suitable tasks and choosing those which matched the curriculum foci of their lessons, were aligned with what their ATs were using, which they recognised from trusted sources seen in previous course work, and which they predicted learners could do and would be appealing to them.

The third planning phase is named *appropriating practices and tasks for teaching* and we use the term appropriating to include adopting existing practices and tasks as well as active adaptation of these. This is similar to the part of the framework for teacher planning called "selecting and sequencing tasks including adapting them for your students" (Roche et al., 2014). In other words, *appropriating practices and tasks for teaching* relates to how PSTs transformed the tasks for teaching and the ways they thought about the lesson in more detail - what the learners would do and what they, the teacher, would do. Much of this was carried out prior to writing the lesson plans. Some followed similar organisational structures and resources to their ATs, while others designed their own plans. Some PSTs copied phrases and explanations used by their ATs as a base for their own explanations of mathematical concepts. Once selected, tasks were adapted to be more meaningful for learners. An example of this was when both Katie and Liz adapted mathematics questions by writing them as word problems situated within contexts familiar to their learners. At least two PSTs used written representations of mathematics concepts and then adapted these by changing numbers or including visual representations. Another form of adaptation was to change mathematics equations presented on worksheets into practical tasks. Jill identified previous course experiences as an influence because "during the course we did hands on maths, so how can I turn this worksheet into practical mathematics?" The final example of adapting occurred when some of the PSTs added to existing resources/tasks and prepared additional and alternative examples for learners. Ella wrote additional parallel problems for her lesson, based on those suggested in the teaching text she had to use, and she also adapted the mathematical representations so that she had several options to support her learners if needed. Rose followed a similar process by starting with tasks, then adapting these to match the differing levels of her learners. This allowed her also to have more options when planning. In summary, during this third phase of planning there is some evidence that PSTs engaged in practices of curriculum design by adapting tasks or constructing new activities for students.

## Conclusions and implications

We set out to inquire into the planning practices of first year primary PSTs during their first practicum. Although we are not alongside them in the school context, through their participation in this study we have been able to identify three planning phases which otherwise would have remained hidden from us. The planning phases are actions that we have named *searching and gathering*, *analysing and selecting*, and *appropriating and adapting*. These phases form a kind of funnelling sequence that began with an explicit and semi-public gathering of information from high status sources such as Associate Teachers. This is directly and socially connected in professional conversations with ATs, and then indirectly by observing ATs' lessons. As the phase *searching and gathering* becomes more independent, the PSTs accessed nationally published resources, and international sources which were largely internet based.

We found that the PSTs actively process information through their own filters, and this filtering involves in-the-moment *analysing and selecting* actions as PSTs decide which resources to gather and which to reject. More funnelling occurs in the *analysing and selecting* phase when PSTs make decisions from their pool of gathered resources. There was evidence that the PSTs read, analysed and decoded aspects of the gathered resources, and were attending to professional messages and meanings in curriculum materials. They tried to match resources with high status national curriculum documentation, and were looking for markers that indicated connections and alignment with both the curriculum and the mathematical foci of their lessons. Important markers were language and mathematical content such as symbols and representations. They also looked for aspects within the resources that were indicators of "worthwhileness". Although we do not know whether each PST had the same or even similar definitions of the criteria of a "worthwhile" task, it was mentioned frequently enough to suggest that this label, and aspects within it, operated as a litmus test for selecting resources for possible future teaching.

Another important part of the resource selection process was the way in which they found these markers. There is evidence that some PSTs did this by carrying out an internal dialogue with themselves whereby they asked questions that helped to interrogate the resources. Examples of these questions were "was it worthwhile?", "is the mathematics content relevant?", and "does it line up with the curriculum?" Most of the PSTs reported planning on their own, and these internal scripts were a way for them to decode the information they noticed and identified within the resources. It seemed that by creating these scripts they were replicating previous conversations from professional experiences with ITE lecturers or their ATs. An example is Cathy feeling more confident to choose only resources used in the course ("that Sue had used"). It was as if these prior experiences provided an analysis tool that comprised inquiry questions they could use to make sense of the resources in front of them. We infer these critical questions appeared to help them make decisions about what resources to select and use, and we contend that this internal dialogue is a crucial part of the planning process, providing links to a wider professional knowledge base of mathematics education.

Likewise, the process of analysing resources was mentioned often enough to suggest that PSTs consider it to be a necessary planning action. Within ITE programmes, it is therefore important for PSTs to be introduced to credible resources that are readily available, and provided with guidance about how to analyse these for teaching. An analysis process would therefore involve looking for and determining curriculum and mathematical content, pedagogical approaches, and localised contextual information. Using an internal dialogue when making decisions about which resources to use highlights the importance of PSTs being supported with prompts to guide and focus their noticing, professional reasoning, and consequent decision making when planning for mathematics teaching. These internal scripts might be composed of sequenced questions and other prompts, which serve to decompose and provide focus for resource selection and for resource analysis, providing a useful professional tool for planning. In addition, we conclude that it is important for PSTs to carry out a resource analysis process during course work where they can be supported by ITE lecturers and peers. This approximates an effective yet adaptable planning process they could carry through to any practicum situation, and refine for later use in their first years of teaching.

The *appropriating* and *adapting* phase is when the PSTs formulate and sequence their ideas, and then write the actual lesson plan. We found this also to be a phase of active decision making, made immediate and urgent when the PSTs envisage students as real actors in their lessons (Wilson, 2012). We contend that this adds a layer of complexity when PSTs decide how

to adapt resources for their students, and the consequent teaching and learning actions needed to accommodate these in their lessons. Their actions of reading and doing tasks were important for revealing new resources or prompting possible adaptations. Again their internal scripts, which included questions like "how can I change this for the students so they are more involved?", and "could the students actually do this task?", guided their decision making. Practising this part of the planning phase in an ITE course can be problematic. Course experiences can be designed to *appropriate* and *adapt* tasks for teaching as we did, in both our course and assignment work where PSTs were required to decompose tasks for teaching. It is difficult, however, for PSTs to plan for real students within these experiences. At best they hypothesise and create fictional learners when carrying out this course work, whereas on practicum they plan for real students. This highlights the importance of practicum experiences, because, while course work takes them to the threshold of planning for teaching, practicum allows them to step into and take professional responsibility for real students.

In conclusion, we acknowledge that our study was small-scale and therefore has limitations of depth and context. However, our focussed and detailed analysis of the data has revealed an active planning process initiated by the PSTs. This has provoked us to consider the implications for our work in ITE. We cannot say there is a direct connection between the planning process initiated by PSTs and the course content, however we tentatively suggest the course experiences influenced their decision making in different ways. Since collecting the data reported in this paper we have interviewed participants from a third year cohort group and plan to use this to investigate the connections between course work, their practicum planning experiences, and their planning processes in the final year of their three year programme. We conclude that planning practices should be an important component of ITE courses because through planning PSTs can build knowledge of curriculum, content and pedagogical strategies as well as move closer to the work of teachers. We continue to evaluate and revise the content of our mathematics education ITE courses, which include designing task approximations to prepare PSTs for planning and teaching mathematics during practicum. We have also designed both short and long term planning templates that include features we consider necessary for mathematics teaching, and are designed to guide and scaffold the PSTs' planning processes. These templates continue to be evaluated and reviewed based on feedback from PSTs. The findings of this study remind us that planning is a process of pedagogical reasoning (Roche et al., 2012; Shulman, 1986), and we want to shift the focus within our courses from planning as a product, as evidenced by lesson and unit plans often submitted for assessment after practicum, to planning as process. We are committed to continuing to position PSTs as agents of their own learning, and to find ways to support them to plan effectively for student learning, which we too recognise as an important practice (Boerst et al., 2011) and component of their professional knowledge base for mathematics teaching.

## References

Anthony, G., & Walshaw, M. (2009). Effective pedagogy in mathematics. In International Academy of Education (Series Ed.), *Educational Practices Series: 19.* Geneva. International Bureau of Education.

Bailey, J. (2015). The challenge of supporting a beginning teacher to plan in primary mathematics. In M. Marshman, V. Geiger, & A. Bennison (Eds.), *Mathematics education in the margins* (Proceedings of the 38th annual conference of the Mathematics Education Research Group of Australasia, pp. 69-76). Sunshine Coast: MERGA.

Boerst, T., Sleep, L., Ball, D., & Bass, H. (2011). Preparing teachers to lead mathematics discussions. *Teachers College Record, 113*(12), 2844-2877.

Borko, H., & Livingston, C. (1989). Cognition and improvisation: Differences in mathematics instruction by expert and novice teachers. *American Educational Research Journal, 26*(4), 473-498.

Borko, H., & Putnam, R. (2000). What do new views of knowledge and thinking have to say about research on teacher learning? *Educational Researcher, 29*(1), 4-15.

Clarke, D. J., Clarke, D. M., & Sullivan, P. (2012). How do mathematics teachers decide what to teach? *Australian Primary Mathematics Classroom*, *17*(3), 9-12.

Cochran-Smith, M., & Villegas, M. (2015). Framing teacher preparation research: An overview of the field, Part 1. *Journal of Teacher Education, 66*(1), 7-20.

Cohen, L., Morrison, K., & Manion, L. (2011). *Research methods in education (7th Ed)*. London: Routledge Falmer.

Ensor, P. (2001). From pre-service mathematics teacher education to beginning teacher: A study in recontextualising. *Journal for Research in Mathematics Education*, *32*(3), 296- 320.

Grossman, P. (2008). Responding to our critics: From crisis to opportunity in research on teacher education. *Journal of Teacher Education, 59*(1), 10-23.

Grossman, P., & Thompson, C. (2008). Learning from curriculum materials: Scaffolds for new teachers. *Teaching and Teacher Education, 24*, 2014-2026.

Grossman, P., Compton, C., Igra, D., Ronfeldt, M., Shahan, E., & Williamson, P. W. (2009). Teaching practice: A cross-professional perspective. *Teachers College Record, 111*(9), 2055-2100.

John, P. (2006). Lesson planning and the student teacher: Re-thinking the dominant model. *Journal of Curriculum Studies, 38*(4), 483-498.

Lampert, M. (2010). Learning teaching in, from, and for practice: What do we mean? *Journal of Teacher Education, 61*(1-2), 21-34.

McChesney, J. (2010). Decomposition and approximation: Finding a language for ITE practices in New Zealand. *Waikato Journal of Education, 15*(1), 113-119.

McChesney, J., & Wilson, S. (2016). Mathematics education in a time of earthquakes: Holding on and letting go. *For the Learning of Mathematics, 39*(2), 14-18.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: A qualitative approach*. San Francisco: Jossey Bass Publishers.

Ministry of Education. (2007). *The New Zealand Curriculum*. Wellington: Learning Media.

Ministry of Education. (various) *Figure it out* (series of booklets). Wellington, NZ: Author.

Ministry of Education. (2009-2012). *Numeracy Professional Development Project booklets.* Wellington, NZ: Learning Media.

Ministry of Education. (2012). *Book 5 Teaching addition, subtraction, and place value* (revised). Wellington, NZ: Learning Media.

Moss, P. (2011). Analyzing the teaching of professional practice. *Teachers College Record, 113*(12), 2878-2896.

Mutton, T., Hagger, H., & Burn, K. (2011). Learning to plan, planning to learn: The developing expertise of beginning teachers. *Teachers and Teaching: Theory and practice, 17*(4), 399-416.

Roche, A., Clarke, D., Clarke, D., & Sullivan, P. (2014). Primary teacher's written unit plans in mathematics and their perceptions of essential elements of these. *Mathematics Education Research Journal, 26*(4), 853-870.

Sullivan, P., Clarke, D., & Clarke, D. (2012). Teacher decisions about planning and assessment in primary mathematics. *Australian Primary Mathematics Classroom, 17*(3), 20-24.

Wilson, S. (2012). A revolving model of pre-service teacher development. In J. Dindyal, L. P. Cheng, & S. F. Ng (Eds.), *Mathematics education: Expanding horizons* (Proceedings of the 35th annual conference of the Mathematics Education Research Group of Australasia, pp. 787-792). Singapore: MERGA.

Wilson, S. (2016). Developing mathematics content knowledge for teaching: One pre-service teacher and her planning. In B. White, M. Chinnappan, & S. Trenholm (Eds.), *Opening up mathematics education research,* (Proceedings of the Mathematics Education Research Groups of Australasia, pp. 624- 631). Adelaide: MERGA.

Wilson, S., & McChesney, J. (2013). Navigating and noticing: Pre-service teachers' journeys in planning mathematics programmes. *Curriculum Matters*, *9*, 102-119.

Wilson, S., McChesney, J., & Brown, L. (2017). Cultural competencies and planning for teaching mathematics: Preservice teachers responding to expectations, opportunities, and resources. *Journal of Urban Mathematics Education, 10*(1), 95-112.

Yin, R. (2009). *Case study research: Design and methods* (4th Ed.). Los Angeles, CA: Sage Publications.

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