

“I always feel more confident when I know where things are going”: How do Pre-service Teachers Engage with Mathematics Curriculum Documentation?

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The paper reports some findings about how pre-service students engage with the mathematics and statistics section of the *New Zealand Curriculum* (2007), when writing a yearly long-term plan in this curriculum area. This authentic task for pre-service students provided opportunities to seek out information about relevant curriculum knowledge including reviewing and revising mathematical content. This paper is part of a larger study, which focuses on the needs and concerns of final year primary pre-service teachers as they anticipate teaching mathematics in their first year of teaching.

Pre-service teachers develop knowledge for teaching during their teaching practice experiences and professional education coursework. They come into contact with a range of professional materials that include official documentation such as curriculum documents, teacher guides and centralised ministry websites. We can reasonably assume that pre-service teachers engage with this documentation in different ways to experienced teachers. Where experienced teachers have the benefit of wisdom of practice (Shulman, 2004), pre-service teachers are in the process of developing their curriculum knowledge for teaching. This includes understanding curriculum content, selecting and working with related curriculum resources and making decisions about how to enact curriculum content for planning and teaching.

This paper is drawn from a study in progress that investigates experiences of final year primary pre-service teachers as they complete their initial teacher education (ITE) programme and look ahead to their first year of teaching. We discuss one aspect: how these pre-service teachers approach curricular materials and what they are seeking from these materials in the process of generating their own pedagogical document of a long-term plan of intended maths learning. In addition, this study is set in a time of transition in official curriculum documentation from a specific mathematics curriculum with information for teachers (Ministry of Education, 1992) to one that combines all learning areas in one document (Ministry of Education, 2007).

What are Some Issues for Pre-service Teachers?

Teachers gain their knowledge for teaching from a variety of sources, one of which is educational materials and structures (Shulman, 1986). For pre-service teachers, a major source is within the coursework of their professional education programmes (Grossman, 1990). The content of their professional education courses presents to pre-service teachers, either explicitly or implicitly, a set of materials and other resources that are valued and have status. This is part of the ‘privileged repertoire’ (Ensor, 2001 citing Bernstein (1996)) that is “the set of symbolic and material resources that teacher educators (and teachers) select and configure in order to shape their classroom practice” (p. 299). These resources are privileged because they have been selected as representing ‘best practice’ for teaching and included in a professional education course. In addition, pre-service teachers are set

tasks that are “approximations of practice” that bring the practice of classroom teachers into course work (Grossman, Compton, Ingra, Ronfeldt, Shahan, & Williamson, 2009). These tasks may be simplified, have more generous timelines and provide lower stakes than in the ‘real world’ of the first year of teaching.

Although these activities are not entirely authentic in terms of their audience or execution, they 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)

Approximations of practice include simulations of aspects of teaching such as teacher-student discussions, or diagnostic and other formative assessment. It can also apply to the planning and preparation of teaching documents such as lesson plans, unit plans and plans for a yearly programme. Pre-service teachers generate their own professional plans, by drawing on known information and seeking out further resources, and synthesising into a document that is valued in both the professional education course and the context of the school.

The Roles of Curriculum Materials in ITE

Both Shulman (2004) and Grossman (1990) identify curriculum knowledge as being crucial knowledge for pre-service teachers. Shulman (1986) describes curriculum as:

The full range of programmes designed for the teaching of particular subjects and topics at a given level, the variety of instructional materials available in relation to those programmes, and the set of characteristics that serve as both the indication and contraindication for the use of particular curriculum or programme materials in particular circumstances. (p.10)

Teachers need to know the content of the curriculum subject, and have knowledge and understanding of how this curriculum content is developed for teaching.

The curriculum and its associated materials are the *material medica* of pedagogy, the pharmacopeia from which the teacher draws those tools of teaching that present or exemplify particular content and remediate or evaluate the adequacy of student accomplishments.” (p.10)

At the time of this study, *The New Zealand Curriculum* (Ministry of Education, 2007) had been introduced for use in New Zealand schools. Where previously there was a separate mathematics curriculum document, mathematics and statistics is now included as one of nine Learning Areas, and the organisation and content of the mathematics achievement objectives have been changed. Barker (2008) noted that these changes highlight the debate about *what* and *how* much prescription should or could be included in a curriculum. He questions whether the revision of the content of the achievement objectives will enhance teachers’ understanding of the objectives and their interconnections that might form a broader picture of knowledge. The achievement objectives serve to set out “core knowledge considered suitable and desirable – by the designers – for all students to learn” (McGee, 2008, p. 65). Although never explained, and only for the Learning Area of mathematics and statistics, the new curriculum includes a graphical representation, a Venn Diagram, that illustrates the proportion contributed by each of the three strands, Number and Algebra, Geometry and Measurement, and Statistics. The size of each circle changes across the achievement levels to indicate changing emphasis. When certain curriculum materials are included in ITE course work, such as curriculum documents, or ministry resources such as from the NZ Numeracy Project, then these become “privileged because it places in the foreground a particular selection of pedagogical resources” (Ensor, 2001, p. 300).

A challenge for pre-service teachers is to transform their knowledge of the curriculum for classroom teaching (Fennema & Franke, 1992). Pre-service teachers present an interesting group of novice teachers because unlike experienced teachers and beginning teachers they have limited opportunities and experiences to do this:

Experienced teachers may possess rich repertoires of metaphors, experiments, activities or explanations that are particularly effective for teaching a particular topic, while beginning teachers are still in the process of developing a repertoire of instructional strategies and representations (Grossman, 1990, p. 9).

While there is some research that looks at how classroom teachers engage with mathematics curricular materials, including the use of curriculum packages and textbooks (Stein, Remillard, & Smith, 2007), this study is particularly interested in how pre-service teachers develop this knowledge. Grossman and Thompson (2008) focussed on beginning teachers and recognised they spend considerable amounts of time searching out and developing resource material for inclusion in their teaching repertoire. Beginning teachers rely on curriculum documentation and a variety of resources to provide clarification of curriculum content, mathematical content and directions for teaching. Consequently, this study focussed on how they gathered, identified, collated and synthesised curricular information for enactment in the classroom, whether on professional practice or in anticipation of their first year.

Research Design

The context for the research was an optional third year mathematics education course, taught over a five-week period, and prior to the final professional practice of the degree. The mathematics education course focussed on issues related to developing and implementing mathematics programmes in the primary classroom. The course was an optional course, meaning the course members had selected it from a number of curriculum-based courses. These pre-service teachers were yet to complete their final compulsory mathematics education course of the degree.

There were nineteen pre-service teachers in the course. During the first course session the study was described and volunteers for participation were requested. Twelve pre-service teachers indicated their willingness to participate and they were provided with detailed information about both the study and how any risks would be minimised, before giving their consent. The main ethical issue for participants was ensuring that their participation in the study did not affect their course assessments. To address this risk, assessment requirements were completed at the end of the course and after the data collection process was complete, thereby separating course assessments from research activity. Participants were also able to request that a lecturer who was external to the research process, assess their assignment work in accordance with accepted institutional practice. This also addressed another ethical tension, that of the first author having dual roles as both the course lecturer and the researcher.

Two main data collection methods were used; a written questionnaire and audio-taped focus group interviews. The questionnaire was completed midway through the course and contained three open-ended questions to elicit information about issues that participants faced as they engaged with the curriculum to design a long-term plan in mathematics. A questionnaire was selected because it was an efficient method for collecting data in a short time frame and it allowed each participant to respond privately and individually. It also enabled data to be gathered that could inform questions in future focus group interviews (Davidson & Tolich, 1998).

Two focus group interviews were completed midway through the course and two focus group interviews were carried out at the end of the course. Both sets of two interviews were audio-taped and included open-ended questions about the long-term planning process. Focus-group interviews were selected because the interactive nature of an interview allowed for the responses and views of participants to emerge in a collective setting (Cohen, Manion & Morrison, 2000). This study is concerned with identifying perspectives of pre-service teachers and interviewing as a method, placed the participants at the centre of the data gathering process. This enabled their ideas to dominate the discussion as opposed to those of the researcher. While their ‘voice’ was dominant, the interview situation also allowed the researcher to probe participants for further information when necessary.

A stimulated recall approach was adopted (Anthony, 1994), where participants referred to their completed but unmarked long-term plans during the interview. The plans acted as a prompt and support document for interview discussions. The plans were not yet assessed in order to ensure that this assessment component was separate from the research process. In addition to these methods, a researcher journal maintained a record of relevant field notes from course sessions and informal conversations throughout the time of the study. The data were analysed using a grounded theory approach, which allows for theory to emerge from data (Cohen et al., 2000). A process of thematic analysis was used to identify key data from both the questionnaire and interviews, which were then combined to generate several categories, one of which related to the participants’ use of curriculum documentation. While pre-service teachers were expected to use the curriculum to complete their plans, the nature of their responses relating to the use of the curriculum was an unexpected finding of this study.

Responses to Curriculum Documents

All pre-service teachers wanted and expected the new curriculum to provide them with sufficient detail to support the long-term planning process, but found that it did not contain the information they needed. Comments were related to the specificity of the achievement objectives in the new curriculum and most participants found the achievement objectives lacking in detail. The following comments are illustrative:

“I found the achievement objectives to be very broad” (Int. 1).

“It gives us too much freedom. I don’t like having tonnes of freedom. Within reason, I like to be told what to teach” (Int. 2).

In their position as beginning teachers, they wanted the achievement objectives in the curriculum to provide sufficient detail to inform their planning and teaching. In the absence of this detail they sought information from other resources. A common resource used to clarify the achievement objectives was the ‘old’ mathematics curriculum document (Ministry of Education, 1992), particularly the ‘old’ achievement objectives:

“I read the old achievement objectives because I found the new ones, well I didn’t really understand some of them, whereas the old ones were sort of kind of easier” (Int. 1).

“Now it’s quite brief, like I read the achievement objectives and I had to refer to the old ones because I didn’t quite understand it” (Int. 2).

The ‘old’ curriculum was used because it was familiar to the pre-service teachers, the achievement objectives were specific and it contained Suggested Learning Experiences for

each strand and level. ‘Old’ information was aligned with ‘new’ information to develop understanding for planning and teaching.

In addition to seeking clarification of *what* to teach, the pre-service teachers looked to the achievement objective for cues about *how* to teach the content. They scrutinised the words in the achievement objectives to look for messages to guide their decisions about teaching approaches that could be adopted to teach curriculum content. One participant explained his process for this, describing how he used the verbs in the achievement objectives as indicators of possible teaching approaches.

“Um to be honest, I found it pretty useful like, for example, when you are saying, you’re describing, investigating ... that’s pretty much the key idea. Then you like say, design a lesson from there” (Int. 1).

Another agreed, saying:

“I just found it useful to know exactly what I needed to teach the children” (Int. 2).

Overwhelmingly the pre-service teachers wanted direction from the curriculum to guide their teaching.

Associated with the structure of the long-term plan was the task of clarifying the scope of different units of work and then sequencing these for a whole year. The following comment was typical:

“In the new curriculum you see things written down there and all chunked into three strands – and then you actually have to take it from those three strands into twenty different units that you teach throughout the year” (Int. 2).

Identifying the different unit combinations was a time consuming process. In the first instance they looked to the Venn diagrams for guidance about how to spread the units across the year. This information was not specific which resulted in the pre-service teachers guessing the intended meanings of the diagrams. They all inferred that the diagrams placed an importance on the Number and Algebra strand and consequently they selected to prioritise this strand in their plans.

Units of work were put together by splitting and joining the achievement objectives. When making decisions about the length of each unit, they took into account the number of achievement objectives and estimated how long these would take to teach. One pre-service teacher said:

“Well, I read the AOs, and then decided how long I thought it would take a class of like, level 2 to achieve that. And that’s how long I based, like; I did it for a week or two weeks” (Int. 2).

Several participants used the units of work on the nzmaths website to guide their decisions. These units were valued and therefore viewed as exemplars for teaching because they contained clustered achievement objectives, key mathematics ideas, learning intentions and suggested lesson sequences. At the time of this study, the pre-service teachers were frustrated because the units did not align with the 2007 curriculum document. Despite this, the units were still seen as a much needed extension of the curriculum content.

Curriculum Documents as Prompts for Exploring Mathematical Content

The process of interpreting the achievement objectives prompted all of the pre-service teachers to delve into aspects of uncertainty, particularly about mathematical content. Mathematical terminology used in the achievement objectives caused concern for some pre-service teachers. In the absence of a mathematical glossary in the new curriculum, they referred to the glossary in the old document and other mathematical dictionaries to help

them define unknown mathematical terms. One pre-service teacher did this for defining the difference between polygons and polyhedrons. She also searched in teaching resources to define this content. Teaching resources were an influential source of learning and had a dual purpose i.e. to provide a selection of teaching activities and as a tutorial for developing mathematical content knowledge. One pre-service teacher explained:

“The resources helped me to see what they’ve got to do...if it’s in the book then they’ve got to learn it” (Int. 3).

Another explained that if she looked at a resource and did not understand the mathematics, or how to use the resource in the classroom, then she would not use it. If she could ‘do the maths’ then she would teach it:

“Well, if you know something you’re more likely to teach it” (Int. 3).

A consequence of not knowing content might be that this teacher would choose to omit that area of mathematics from her programme.

The content tutorials section on the nzmaths website was another useful resource for developing mathematical content knowledge. This section provided an opportunity for pre-service teachers to develop mathematical knowledge in their own time. One pre-service teacher valued the video segments:

“They showed you how to use the number equipment – it made such a difference. Actually seeing it being taught would give you a lot of confidence. Because we’re not seeing everything that is being taught, it’s so much harder to know where to start” (Int. 3).

These segments were valued because they were readily accessible and provided independent learning opportunities to extend learning from course work and professional practice experiences, and in some cases provided new learning experiences. This enabled pre-service teachers to gain mathematical content knowledge in areas they needed, prior to teaching. They expressed a sense of relief that the tutorials would be available as a support resource in their first year of teaching. The pre-service teachers acknowledged the importance of mathematical content knowledge as professional knowledge needed for teaching. This knowledge was not only needed for understanding the curriculum, but also for engaging in professional conversations about planning and teaching with other teachers. One participant said:

“It helps to understand the terminology, so that we can discuss this content with experienced teachers” (Int. 1).

She regarded mathematical content knowledge as essential knowledge for effective mathematics teaching.

Discussion and Summary

The task of constructing a long-term plan for teaching mathematics provided an opportunity for the pre-service teachers to engage with a range of curriculum documentation. They had to look beyond *The New Zealand Curriculum* (Ministry of Education, 2007) because as pre-service teachers they did not have sufficient knowledge or experience to interpret and develop the curriculum for planning over an extended period of time. To gain this knowledge they preferred and trusted resources that were written by the Ministry of Education as these were viewed as having status and value. In addition, they expected that these resources would align with the new curriculum content. They used the resources to define what to teach and to inform decisions about possible teaching approaches. In the absence of additional supplementary resources to support the

curriculum, pre-service teachers relied on external resources for planning, teaching and the development of mathematical content knowledge.

Participants recognised curriculum knowledge as essential knowledge for teaching, and there was a sense of urgency to understand the curriculum information before they completed their pre-service professional education. The long-term planning assignment provided them with an opportunity to engage with the curriculum. They were looking for cues and signals from the curriculum that they might recognise as important resources for their work as well as actively seeking any missing aspects. They saw the long-term plan as an 'authentic' task of classroom teachers, and they were therefore seeking information that was also authentic (Grossman et al, 2009). The following comment expresses this sentiment:

"It is a real task that teachers would do – the long-term plan is important because we're actually going to do it - it is actually something I would do if I was a teacher" (Int. 3).

Curriculum documentation was considered by the pre-service teachers as part of a privileged repertoire for this particular task (Ensor, 2001). When they recognised information that they could 're-resource' for their long-term plan, many participants went further in their efforts to clarify and extend their pedagogical knowledge as well as their mathematical knowledge. Where they could not find what they were looking for, they sought out further sources of information which included 'old' curriculum documentation, resource material, electronic resources, peers and lecturers.

The long-term plan itself was an important support for their developing professional knowledge because they saw that it provided planning support for their first year of teaching. By crafting this valued teaching document, they felt focussed and organised and it served as a mechanism that might keep them on a planned teaching path for the year. Completing the task before their first year, helped them feel prepared and confident to replicate the planning process:

"I always feel more confident when I know where things are going – it's just random then I sort of feel lost, and it doesn't give me direction" (Int. 2).

Pre-service teachers are in a unique position; they are on the cusp of leaving their ITE programme and beginning their first year of teaching. The pre-service teachers in this study viewed both curriculum and content knowledge as being important knowledge for teaching. The long-term plan provided a valuable experience for them to develop both areas of knowledge. In addition, engagement in an approximation of a task at this stage in their teacher education programme was valuable because it prompted the pre-service teachers to begin to transition into the role of the 'real' teacher. This study has highlighted significant findings about the development of both curriculum and content knowledge from the perspective of pre-service teachers. It also raises challenges for curriculum developers, ITE lecturers, and mentors in schools. Future research could investigate how ITE programmes assist pre-service teachers to develop knowledge of both curriculum and mathematical content, how pre-service teachers transform this knowledge from the ITE setting to the school setting, and how they develop this knowledge in their first year of teaching. Pre-service teachers are different to experienced teachers, the first year of teaching is an extension to their ITE programme, and therefore consideration also needs to be given to the content and process of professional development opportunities during their first year of teaching.

References

- Anthony, G. (1994). Learning strategies in the mathematics classroom: What can we learn from stimulated recall interviews. *New Zealand Journal of Educational Studies*, 29(2), 127-140.
- Barker, M. (2008). The New Zealand curriculum and pre-service teacher education: Public document, private perceptions. *Curriculum Matters*, 4, 7-19.
- Cohen, L., Manion, L., & Morrison, K. (2000). *Research methods in education* (5th ed). London: Routledge Falmer.
- Davidson, C., & Tolich, M. (Eds.) (1999). *Social science research in New Zealand-many paths to understanding*. Auckland: Pearson Education.
- Ensor, P. (2001). From preservice mathematics teacher education to beginning teacher: A study in recontextualising. *Journal for Research in Mathematics Education*, 32(3), 296- 320.
- Fennema, E., & Franke, M. L. (1992). Teachers' knowledge and its impact. In D. A. Grouws (Ed.), *The handbook of research on mathematics teaching and learning* (pp. 147-164). New York: Macmillan.
- Grossman, P. (1990). *The making of a teacher: Teacher knowledge and teacher education*. New York: Teachers College Press.
- 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.
- Grossman, P. & Thompson, C. (2008). Learning from curriculum materials: Scaffolds for new teachers? *Teaching and Teacher Education*, 24(4), 2014-2026.
- McGee, C. (2008). Understanding curriculum. In C. McGee & D. Fraser (Eds.), *The professional practice of teaching* (pp. 65-79). Auckland: Cengage Learning.
- Ministry of Education (1992). *Mathematics in the New Zealand Curriculum*. Wellington: Learning Media.
- Ministry of Education (2007). *The New Zealand Curriculum*. Wellington: Learning Media.
- Shulman, L. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, 15(2), 4-14.
- Stein, M. K., Remillard, J., & Smith, M. S. (2007). How curriculum influences student learning. In F. K. Lester Jr (Ed.), *Second handbook of research on mathematics teaching and learning* (pp. 319-368). Charlotte, NC: Information Age Publishing.