

Foundation Content Knowledge: Pre-service Teachers as Half-empty or Becoming Fluent?

Megan Anakin

University of Otago College of Education
<megan.anakin@otago.ac.nz>

Chris Linsell

University of Otago College of Education
<chris.linsell@otago.ac.nz>

The concept of a growth-oriented disposition framed the analysis of theoretical and practical dimensions of pre-service teachers' mathematics content knowledge. We identify historical hangovers, tacit habits, and pedagogical strangleholds that present challenges to the way mathematics education researchers interact with the mathematics content knowledge of pre-service teachers. We outline opportunities to expand our agency in the enterprise of teaching, learning, and researching school mathematics and that of our pre-service teachers.

Mathematics education researchers have established that content knowledge is a vital component of the mathematics knowledge for teaching and have documented its relationship to student learning (e.g., Hill, Rowan, & Ball, 2005). Researchers have also turned their attention to the mathematics content knowledge of pre-service teachers due to its importance in the development of their teaching practice (e.g., Beswick & Goos, 2012). To further these efforts, we offered the concept of foundation content knowledge as a way to visualise “the mathematics content knowledge that pre-service teachers bring with them and are able to demonstrate at the beginning of their initial teacher education programmes” (Linsell & Anakin, 2012, p. 8). One of the key features of foundation content knowledge is a growth-oriented disposition that views a pre-service teacher's current mathematics content knowledge as a starting point for developing knowledge structures for teaching, including further mathematics content knowledge (Linsell & Anakin, 2013). Our aim is to present a conceptual analysis of the challenges we encountered as we incorporated a growth-oriented disposition into our research and teaching practices. We identify historical hangovers, tacit habits, and pedagogical strangleholds that are at odds with a growth-oriented disposition. We conclude by arguing that a growth-oriented disposition challenges us to expand our repertoire of ways in which we interact with pre-service teachers and their mathematics content knowledge.

Historical Hangovers

Mathematics education researchers have powerful research tools at their disposal to make productive inquiries into the teaching and learning of school mathematics. As an applied field, we have a history of appropriating research orientations and tools from other disciplines such as mathematics, psychology, and sociology (Lerman, 2000). We have a privileged role because we move knowledge between our parent disciplines and the practice of teaching and learning mathematics in schools. Our in-between role creates a unique opportunity to nourish and shape knowledge as it is being decontextualized from one domain and recontextualised in the other. As a community, however, we have yet to fully realise the potential of our intermediary position (Skott, Van Zoest, & Gellert, 2013). We continue to frame our research about mathematics knowledge with acquisitionist metaphors of knowledge that support the enactment of mathematics pedagogy as the

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transmission of facts that are reinforced by learning resources with deficit-orientations. For example, we continue the tradition of analysing learners' error patterns and using negative psychological constructs (e.g., Linsell, & Anakin, 2012). When we use phrases such as "lack of knowledge", we suggest emptiness, and when we engage in "diagnostic assessment", we are problem finding. Our methods and vocabulary suggest that we have a penchant for pathology. We find our literature and methodologies imbued with deficit-oriented language that shapes the design of research, our theories of mathematics content knowledge, and the teaching and learning resources we produce. In sum, we have appropriated deficit tools as tacit habits that are in conflict with a growth-oriented disposition.

The Power of Affect

The constructive power of affect, as a component of knowledge rather than a separate entity, has yet to be integrated into our theories and studies of pre-service teachers' mathematics content knowledge. Models of mathematics knowledge for teaching focus on cognitive and practical dimensions of knowing at the expense of acknowledging and harnessing the power of affect and its relationship to knowledge (e.g., Ball, Thames, & Phelps, 2008; Rowland, Huckstep, & Thwaites, 2005). There is a paucity of research about the relationship between affect and pre-service teachers' mathematics content knowledge in Australasia (Lomas, Grootenboer, & Attard, 2012). In New Zealand, a declining trend in positive attitudes towards mathematics was noted in samples of Year 4 and Year 8 students, and pre-service primary teachers (Biddulph, 1999). Over half of the pre-service teachers sampled from two cohorts, reported feeling negative about mathematics. The National Education Monitoring Project's data collection exercises in 2001, 2005, and 2009 show that negative attitudes reported by Year 4 and Year 8 students have remained relatively consistent (Crooks, Smith, & Flockton, 2010). If the pattern of attitudes reported by Biddulph has persisted then there may be a large proportion of future teachers whose negative mathematics experiences may be translated into anxiety about their developing mathematics teaching practices (Cooke, Cavanagh, Hurst, & Sparrow, 2011).

Disrupting Tacit Habits

Due to our role as knowledge producers, mathematics education researchers are in a privileged position to nourish the teaching and learning of mathematics in schooling contexts. The language we use and our pedagogical habits impact a student's potency to learn mathematics. When we explicitly structure the learning environment around pre-service teachers, by articulating the next steps for learning and the rationale behind them, we increase the likelihood that pre-service teachers will be motivated to develop their mathematical knowledge (William, Lee, Harrison, & Black, 2004). To be successful with this endeavour, we must disrupt our tacit habit of seeing learner knowledge as lacking. Re-framing our deficit orientation with a glass half-full metaphor is an insufficient metaphorical shift. If we shift our focus to the possible qualities of that knowledge, rather than on the volume of knowledge alone, then this metaphor is transformed into one of fluency – a conceptual blend – incorporating the fluidity of knowledge-in-use and increasingly proficient participation in mathematical activity. The idea that mathematics content knowledge has no end point, is already present in models of the mathematics knowledge for teaching in concepts such as "profound understanding of fundamental

mathematics” (Ma, 1999) and “horizon knowledge (Ball, Thames, & Phelps, 2008), and has been explicitly foregrounded in the concept of “profound understanding of emergent mathematics” (Davis & Renert, 2013).

Releasing Pedagogical Strangleholds

In addition to disrupting the ways we research the mathematics content knowledge of pre-service teachers, a growth-oriented disposition releases pedagogical strangleholds. There is a fundamental difference between thinking about knowledge as information to be transmitted or as the appropriation of cultural tools (Radford, 2006). Socio-cultural models have mechanisms that account for how individuals internalise knowledge, as do behavioural and cognitive models of learning. Socio-cultural models, however, also recognise the position and agency of learners in the process. Not all cultural tools are readily appropriated by everyday experiences or written descriptions of phenomena. The base-ten place value system is a cultural tool that requires a teacher to selectively structure a learner’s environment and interact with him using specific language and materials so that he can appropriate a diverse set of mathematical ideas that will transform the way that he can think about quantity. From a socio-cultural perspective, knowledge has an expanded meaning that includes conditional, situated, and flexible features. When knowledge is appreciated as knowing, this foregrounds what learners can say and do, as opposed to what they cannot do. There is still an important role for the teacher educator; it is no longer as an expert transmitter, but as a learning resource, one amongst many possible sources of expertise available in a pre-service teacher’s learning environment. This distributed notion of expertise can be found in Vygotsky’s concept of “obuchenie” (Scrimsher & Tudge, 2003). Mathematics education researchers and teacher educators can model obuchenie in their practice by deliberately positioning pre-service teachers as active, responsible, and collaborative agents who are capable of engaging with their learning of mathematics in metacognitive ways.

By enlarging our pedagogy to include focus on progress as well as attainment, pre-service teachers can be offered ways to become positively engaged in the process of learning. A focus on progress allows for opportunities to acknowledge that there are more or less appropriate or useful instantiations of that knowledge rather than an idealised correctness or an absolute amount of knowledge that can be demonstrated about a particular mathematical idea. If our attention is focused on progress within developmental frameworks representing students’ mathematical knowledge (e.g., Ministry of Education, 2003) then small steps can be celebrated rather than comparisons made between standardised rankings. Inevitably, comparisons will be made because certain demonstrations of knowledge are valued at particular points in the schooling system and upon entry to initial teacher education programmes. If, however, the majority of interactions that learners have with mathematics are growth-oriented then pre-service teachers will be exposed to positive messages of progress, opportunities to increase their participation, and will be given opportunities to act with expertise.

Conclusion

In this conceptual analysis, we identified historical hangovers, tacit habits, and pedagogical strangleholds that are at odds with a growth-oriented disposition. Our use of deficit-imbued tools has the potential to shape pre-service teachers’ teaching and learning

experiences detrimentally. By challenging our tacit habits and identifying pedagogical approaches with a growth-oriented disposition, we outlined opportunities to expand the agency of ourselves, as mathematics education researchers, and that of our pre-service teachers, in the enterprise of teaching and learning school mathematics. As mathematics educators, we have yet to reach a critical mass to disrupt our tacit habit of framing the mathematics content knowledge of pre-service teachers as if it were a glass half-empty. We are challenged to develop new habits that frame the mathematics content knowledge of pre-service teachers as a process of becoming fluent.

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