A collaborative development of a quality mathematics assessment task to promote preservice teacher candidates' professional eye

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Teacher educators' community of practice

The Mathematics Teacher Education Collective (MTEC) — a self-study group based at the University of British Columbia, Canada — collaborates to enhance our pedagogical practice in mathematics teacher education through analysing, constructing, and reflecting on variations to assessment tasks. The theoretical framework underlying the establishment of the MTEC is based on Lave and Wenger's (1991) view of learning through a Community of Practice (CoP). "Communities of practice are groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly" (Wenger-Trayner, 2011, http://wenger-trayner.com/theory/). Three characteristics are viewed as crucial to the CoP: domain, community, and practice. The shared domain for MTEC is a commitment to gaining a deeper understanding of practice as mathematics teacher educators. In particular, as members we are interested in better understanding the role and development of tasks for learning to teach mathematics. As a community MTEC engages "in joint activities and discussions, [that] help each other, and share information" (Wenger-Trayner, 2011, http://wenger-trayner.com/theory/), with the goal to build relationships that provide members with opportunities to learn from one other. MTEC members are practitioners in the field. The success of the MTEC is based on the sharing, evaluation and critical reflection of assessment tasks and pedagogical approaches refined by the CoP.

Support through mentoring, dialogue with peers, and moderation experiences are avenues in which higher educators can develop their skills related to assessment for courses (Boud & Associates, 2010). It is recognised that a CoP provides the opportunity for two-way growth of knowledge, that is, MTEC has the potential to broaden the perspectives and knowledge of fellow higher educators by exposing them to strategies and approaches from their peers they may not have considered. Mentoring within the context of MTEC occurs through dialogue within meetings, critical friend observations of teaching, sharing of reflective journaling, and email correspondence.

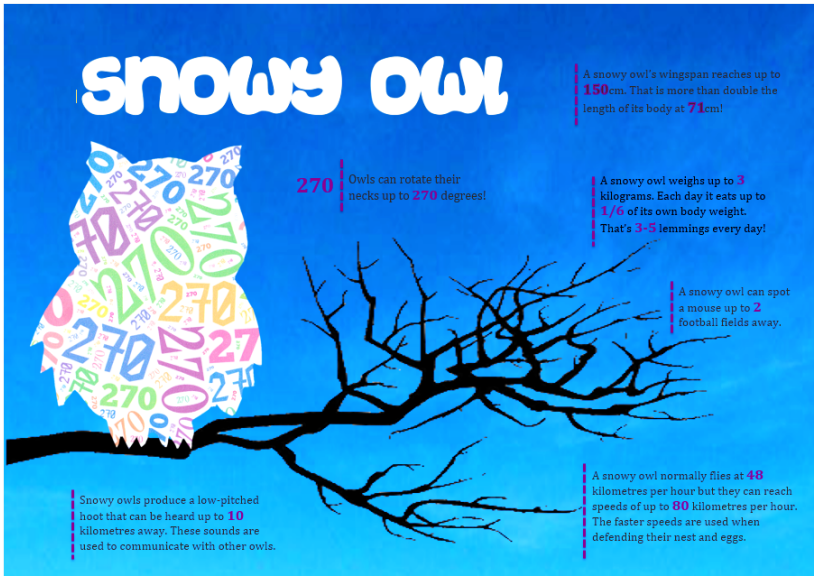
Research on task design in teacher education and on the development of professional noticing has received increased attention over the past few years (Clarke, Grevholm & Millman, 2009; Sherin, Jacobs, & Philipp, 2011). Examining the choice of tasks along with their form, function and focus for use with teacher candidates (TCs) is crucial, argued Clarke, Grevholm and Millman (2009), to better understand how teacher educators can impact the learning of TCs. For example, Sanchez and Garcia (2009), following the work of Llinares (2004), identify the practices of mathematics teachers as including three main activities: 1) organizing mathematical content for teaching; 2) managing mathematical content and discourse in the classroom; and 3) analyzing and interpretation of students mathematical thinking (p. 38-39). Organizing mathematical content for teaching includes designing, adapting and extending tasks that can support

students' learning of mathematics. How then, can we as teacher educators, design parallel tasks that have the potential to support and assess TCs in their learning to organize mathematical content for teaching?

The process of learning to develop practices of experienced mathematics teachers involves what Sherin, Jacobs and Philipp (2013) conceptualize as developing professional noticing or "seeing through teachers' eyes." In summarising their edited works on teacher noticing they asked "Is teacher noticing trainable?" and "why do we (or should we) study teacher noticing?" (p. 11). These questions are directed to teacher educators and researchers studying prospective and practicing teachers. We suggest extending the questions to include teacher educators. What do teacher educators notice about designing tasks for their teacher candidates? What supports their design of particular tasks such as assessment tasks? What can we learn from focusing on the noticing of teacher educators as they themselves seek to develop TCs professional eyes?

Designing an assessment task

In response to a general disengagement in mathematics education by a number of TCs, we created an assessment task to connect more closely with their interests in the hope of reigniting a curiosity in mathematics education. Building on TCs' interest in children's literature we designed a task incorporating books in the mathematics classroom. The task required the selection of a book suitable for children aged 8 to 12 years of age, designing a poster about an object/character in the book with accompanying data facts about the object, design data prompts for each data fact, and develop a detailed lesson plan based on the book. As an example, part of a TC's assignment submission is shown below (see Figure 1).



Prompt 1 - How many lemmings can a snowy owl eat in a year?
Prompt 2 - How much does each lemming weigh?

Figure 1. Excerpt from assessment task

The initial aim for this assessment task was for the TCs to notice mathematics in children's literature. This has remained a main aim but the task has been varied in several ways to increase TCs' professional awareness and performance. It is the self-study reflective practices which determined the variations to the task over time that is the focus of this paper.

Methodology

We have undertaken a self-study approach to this research. Similarly to Marin's (2014) self-study journey, we sought to challenge our practices and beliefs as teacher educators of mathematics. In the 1990s, self-study was legitimised as a research approach by teachers and teacher educators. Self-study built on the action research movement, where reflective practice and teacher-as-researcher gained credibility with the support of prominent researchers (see, Schön, 1987; Zeichner & Liston, 1996).

Self-study requires the contribution of critical friends to offer alternative perspectives and reframing of ideas (Samaras & Freese, 2009). The process of creating, varying, and refining tasks with fellow mathematics educators was modelled on Barnes' (1998) three characteristics of self-study: openness, collaboration, and reframing (p. xii). Contributions to the self-study process comprised of the views of colleagues and students undertaking our mathematics education course. In this paper, we examine the contributions our actions as critical friends had in refining our tasks and reframing our pedagogical approach.

The subjects of the research

We have been teaching in mathematics teacher education for over 15 years. In 2006, Nicol invited Bragg to become a member of the MTEC. The MTEC discuss our teaching practice and the trialing and refinement of tasks with our TCs. Each year, we observe each other teaching tutorial classes providing feedback on our pedagogical approaches and opportunities to enrich the learning environment.

Our students are future elementary teachers. The Australian TCs (2014 cohort n=262; 2013 cohort n=257) who engaged in the assessment task presented in this paper, were in the third year of a four year Bachelor of Education program. In their previous years, they completed one course of Mathematics and one course of Mathematics Education and undertaken 20 days of practicum experience.

Establishing the assessment task

The impetus for this assessment task began as a tutorial activity to teach algebraic thinking based on the children's book *Two of Everything* (Hong, 1993). The TCs engaged in the task (see Muir, Bragg & Livy, in press 2015) and were surprised as to the capacity of a children's book to draw out mathematical concepts. As a result of this positive attitude to incorporating children's literature into the mathematics classroom an assignment task was drafted and we interrogated its quality, clarity, and alignment with our learning outcomes of developing TCs' professional eye. This initial stage discussions assisted in clarifying our goals for the TCs and resulted in reframing our practice as we deliberated and came to agreement about our educational philosophy.

The next phase involved recruiting six TCs enrolled in the course to review the assignment and provide feedback. In the following week the TCs met with Bragg to

discuss their initial impressions of the task's capability for building their mathematical pedagogical knowledge. Any perceived misinterpretations of the tasks were addressed and forwarded to the teaching staff for final endorsement.

Data collection and analysis

The methods used in this study were transcribed audio recordings and notes from academic peer meetings, email correspondence between researchers, personal reflective journaling, and TCs' work samples. In this current paper, we draw on transcription excerpts from audiotaped academic peer meetings, email correspondence, and reflective journaling extracts. We have examined these data for themes and identified important statements that reflected the self-study process as a vehicle for change. This collaborative self-study journey is presented in a narrative form.

Results and discussion

At the outset of this study, we felt committed to developing rich assessment tasks through a collaborative process to draw on our collaborative mathematics teacher educators' expertise and from our reading of the literature on rich tasks for TCs (see for example Clarke, Grevholm, & Millman, 2009). Central to our discussion was a common question that arose, "How can we develop assessment tasks that will develop TCs' professional eye?" This theme was noted in the following email from Bragg to Nicol in October 2012.

My next cohort of students appear disgruntle[d] and discouraged in mathematics education. I want to develop an assessment task which links to their passion as teachers and in which they can see the beauty of mathematics. I also want [to] the task to translate to a practical skill for their future teaching practice. As with our problem pictures task [see Bragg & Nicol, 2008, 2011, 2013; Nicol & Bragg, 2009] *I want them to notice mathematics in their environment and build on the potential of these opportunities to inspire their students in the future. What to do?*

This email was the premise for a MTEC discussion that culminated in the development of the children's literature assignment as described above. The TCs' feedback was positive towards the inclusion of the assessment task and the tutorial activities that were provided to support their enhancement of their professional eye. As highlighted in Bragg's reflection journal excerpt from March 2013:

I have received lots of positive feedback from the TCs in class today. They seem in awe of the potential to use children's literature in the mathematics classroom. I invited them to bring a favourite book to class. We unpacked the potential of the text and illustrations in a children's book to elicit mathematical thinking. I invited them to share their noticing of the mathematical content in their favourite book. They encouraged their peers to share what they also notice as mathematical potential for classroom activities. The TCs are realising books that do not appear to be specifically written with a mathematical theme also offer mathematical opportunities. One student told me today "It opened my eyes to the use of literature in mathematics. It's a great idea and encourages me to actually do these type of lessons on placement."

The purpose of this task was to improve the TCs' professional eye, therefore, it was rewarding to witness the impact of the TCs' noticing of the mathematical opportunities

children's literature offers. While we noted the willingness of the TCs to engage in the assessment task, it was not without its criticisms. The lesson plan aspect of the assignment employed a template adapted from a sample lesson plan format for Japanese Lesson Study (Yoshida, Chokshi, & Fernandez, 2001) and was highly detailed. The vastness of the lesson plan structure was cumbersome and had a negative impact on the TCs' attitude towards the task.

Many students have voiced their dislike of writing the lesson plan with the numerous sections of which they were not familiar, for example providing multiple "anticipated responses" to each of their teacher questions and actions. As an experienced mathematics educator I have written lesson plans following this structure and including anticipated responses. It is quite difficult and time consuming to consider the multitude of alternative responses children might offer to one question, let alone the several questions that we pose within a lesson. These TCs have only had 20 days of experience, not years, in a classroom…Maybe we should remove the lesson plan from the assignment for next year. [Bragg reflective journal, May 2013]

We discussed the value versus the encumbrance of the lesson plan in the assignment. As noted in one meeting "…*the tedium of writing the lesson plan is detracting from the value and wonder of engaging the TCs in the positive experience of linking children's literature with mathematics education*." [audiotape transcription, meeting June 2013]. However, we were cognisant of not removing a section of the assignment because the TCs found it was challenging.

As mathematics teacher educators we value the disquiet that tasks can offer our students to stimulate reflective practice and we seek tasks that can effectively achieve this outcome within the limited time allocation we set with our students. We removed the lesson plan from the assignment criteria and inserted aspects of the lesson plan into the data prompts section of the assessment task as follows, "Select 3 of your 6 data facts. Write a 1/2 to 3/4 page summary for each data fact of how you will utilise each data fact into a mathematics classroom task. Include an anticipated response for each data prompt." [Assessment requirements, 2014]

Currently, we are reexamining the assessment task to explore what further variations to the task we could enact to strengthen the opportunity for the TCs to contextualize mathematics and make connections with their environment through a pleasurable activity.

Each variation to the task produces some expected and unexpected outcomes. Our professional eye is become better trained to the nuances our actions are having on the TCs' experience. The collaborative process through hearing and reflection upon our ideas brings us to new notions about our teaching practice and task creation. It raises reflective questions like "What do we ask ourselves when designing assessment tasks?" and, "What do we want tasks to do?" [audiotape transcription, meeting Nov 2014].

Self-study of the collaborative process of developing an assessment task offers us the opportunity to contextualise our professional growth. Questions will continue to be raised as we seek to improve our teaching practice.

Concluding comments

Self-study has assisted in the reflective process of enacting variations to tasks through valuing open dialogue. We value listening to the multiple voices who contribute to education. We initially listened to the voices of concerned TCs as they shared their despondence towards mathematics education. We listened to each other and our teaching staff as they shared their teaching philosophy and how it could be enacted through an assessment task. We listened to the voices of researchers in the field through their writings. We listened again to the TCs' response and reaction to each iteration of the assessment task. And we listened to our own voices as it was fed back to us through an interrogation of our reflective journals, audiotaped meetings, and email correspondence.

Our collaborative self-study revealed that the meanings we constructed regarding ways to develop our TCs' professional eye are linked to the ways we develop our professional eye. Our professional eye is co-constructed in a socially dynamic forum through our listening and sharing. The result of our work supports the argument that academic collaboration and reflective practice are central in developing quality assessment tasks that support preservice teachers' learning. Therefore, opportunities for collaboration through a Community of Practice to further enhance the value of assessment tasks is advocated.

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