

Quality Teaching Rounds in Mathematics Teacher Education¹

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The purpose of the study reported in this paper is to evaluate the effectiveness of an implementation of teaching rounds as a practice-based approach to pre-service teacher education in mathematics. The teaching rounds implemented in the study utilised the New South Wales Quality Teaching model pedagogical framework as a tool for learning about and reflecting on teaching practices. The evaluation was conducted through a mixed methods approach using a combination of surveys and analysis of student assessment tasks. The major findings of the study are that pre-service teachers found practice-based experience and the subsequent reflections using teaching rounds very valuable compared to other learning experiences. We also found that pre-service teachers undertaking a Masters teaching degree were significantly more insightful about planning for and reflecting upon teaching practice than those undertaking an undergraduate degree. We believe these two facts have implications not only at our institution but also at a global level for policy makers in other institutions providing pre-service education.

Keywords · pre-service teachers · practice-based teacher education · Quality Teaching model · teaching rounds · professional learning communities

Introduction

It is widely accepted that teaching quality is a major determinant of the success of any educational system. Therefore, the preparation of the future teaching workforce holds great interest for policy makers and the general community. Teacher education models vary considerably between countries and also between institutions within the same country. In Australia, new national teaching standards have led to some standardisation of approaches

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across institutions; however, large variations remain in terms of the mix of theory, application and practice that pre-service teachers receive.

In mathematics education there is ongoing debate about the types of knowledge teachers need in order to be proficient educators in the classroom. While there is general consensus that mathematical content knowledge (MCK) is essential, there is little consensus on the breadth and depth of content knowledge that is required to effectively teach at different school levels (Goos, 2013; Speer, King, & Howell, 2014). Since the 1980s, there has also been general acceptance of the notion of pedagogical content knowledge (PCK) as explained by Lee Shulman (1986). PCK is widely used in the mathematics education literature as a means of understanding the particular types of knowledge unique to teachers. This type of knowledge includes, for example, knowledge of student misconceptions about specific mathematics topics and how teachers might respond to these and knowledge of effective analogies for illustrating mathematical concepts. While PCK is recognised as being of crucial importance for effective mathematics teaching there is little agreement between teacher educators about how to promote its development in pre-service teachers (Rowland, Turner & Thwaites, 2014) although there is evidence that it must develop from or alongside a sound MCK base (Goos, 2013).

In addition to the development of MCK and PCK, the development of general pedagogical knowledge (PK) is also recognised as being essential teacher knowledge that can influence student learning (Gore, 2014). This knowledge is related to how teachers facilitate the development of a quality learning environment in the classroom context, while ensuring that students are engaged in work of high intellectual quality. While pre-service teachers can develop PK and PCK as part of their university studies, it is recognised that much of this knowledge is best learned within teaching contexts in the school classroom in collaborative ways (Hess, 2009).

One way that this type of collaboration can be facilitated is through the establishment of 'communities of practice' or 'professional learning communities' (PLCs). These types of communities can take multiple forms and have been recognised for some time (Vescio, Ross, & Adams, 2008) as promoting professional growth (Stoll, Bolam, McMahon, Wallace, & Thomas, 2006; Wenger, 1998). While PLCs are often used by professionals to improve their practice, they also offer the potential to be used as a teaching tool in practice-based teaching environments. By using them in this way, it could be expected that similar benefits to those experienced by professionals working collaboratively may be gained by pre-service teachers who are given opportunities to learn together as they practice their craft (Le Cornu & Ewing, 2008). In addition, there is evidence that teacher collaboration is most beneficial when reflections are founded on a sound theoretical framework allowing for an analytical approach to discussions about teaching practice (Gore, 2014).

In this paper we employ the well-established Quality Teaching model, described below, as the basis for pre-service teacher discussion and reflection within a practice-based teaching experience.

The Quality Teaching model

The Quality Teaching (QT) model is an evidence-based pedagogical framework which is comprehensive in scope and applicable across all subject areas and grade levels. The QT model is based on the Productive Pedagogies model (Hayes, Lingard, & Mills, 2000) which in turn was a refinement of Authentic Pedagogy (Newmann & Wehlage, 1996). It was developed as a

framework to guide teachers' professional self-reflection and has been used extensively in New South Wales (NSW), and Australian Capital Territory public schools in Australia since 2003.

The QT model features teaching practices that have been linked to improved student outcomes and can be characterised as representing three dimensions of pedagogy: pedagogy that is based on promoting high levels of intellectual quality, a quality learning environment, and makes explicit to students the significance of their work (NSW Department of Education and Training, 2003b). Each of these three dimensions is elaborated through six elements as detailed in Figure 1. For a full explanation of each element please see NSW Department of Education and Training (2003a).

Dimensions			
	Intellectual Quality	Quality Learning Environment	Significance
Elements	Deep knowledge	Explicit quality criteria	Background Knowledge
	Deep understanding	Engagement	Cultural knowledge
	Problematic knowledge	High expectations	Knowledge integration
	Higher order thinking	Social support	Inclusivity
	Metalanguage	Students' self-regulation	Connectedness
	Substantive communication	Student direction	Narrative

Figure 1: Elements and Dimensions of the Quality Teaching model

QT rounds are a professional development approach based on the pedagogical underpinning of the QT model. The process of running QT rounds involves a PLC of practicing teachers first observing classroom practice and subsequently discussing and analysing it. To do so, they examine the experience by looking at each and every element in the QT model individually, carefully considering how that element was present in their observation. Then, through turn-taking, they describe and assess how the experience has impacted students in order to inform and improve decision-making about student learning.

QT rounds have proven to: increase both quality and equity in teaching; provide measures of teaching quality that resonate with teachers; offer a powerful framework for enacting a research-based clinical approach to teacher development; and ensure strong professional and social support for teachers at all stages of their careers (Gore, 2014).

In this study, the QT model and QT rounds approach were used with mathematics pre-service teachers (both undergraduate and postgraduate), in their first year of their teacher preparation programs, to enable them to undertake detailed and focussed discussions after

participating in a practice-based teaching experience in a high school. The efficacy of this approach was evaluated through an examination of pre-service teachers' perceptions of this activity in comparison to other learning experiences in the course, and through an analysis of the teaching artefacts produced during the course.

Research Questions

The purpose of the research reported on in this paper was to evaluate the effectiveness of QT rounds as a practice-based approach to pre-service teacher education in mathematics. The study addressed the following two *research questions*:

1. Are QT rounds an effective approach for practice-based pre-service teacher education in comparison to other commonly used approaches?
2. What factors influence pre-service teachers' ability to plan lessons and reflect on their practice-based experience using QT rounds?

Methodology

To evaluate QT rounds as a practice-based approach for pre-service teacher education in mathematics, QT rounds were incorporated into a course undertaken by a mixed (undergraduate and postgraduate) cohort of pre-service mathematics teachers in the first year of their mathematics secondary teaching program. The research was undertaken in the second semester of 2014. The course, run by the School of Education, focused on the development of teacher PCK for middle school and non-calculus based high school mathematics. It first facilitated student discussions of video-recorded teaching practices using the QT model; this approach was then incorporated into a practice-based experience in a secondary school. The video-recorded teaching examples were derived from a second year mathematics course delivered at the same institution and run by the School of Mathematics and Physical Sciences. This course, entitled 'Thinking and Working Mathematically', is taken by all pre-service teachers in their second year and also by a variety of other students in the institution who wish to acquire mathematical problem solving skills. To evaluate the effectiveness of the QT rounds, a *mixed methods approach* was used to analyse data obtained using a survey with Likert scales and open-ended questions and student assessment tasks. The survey was designed to answer the first research question and assessment tasks were used to address the second. These instruments are described below.

During the course, pre-service teachers were informed about and studied the QT model and how it can be used in the form of QT rounds to improve teacher practice. The students had been previously introduced to the QT model in a general Education course, but this was their first exposure to the model as it is applied in mathematics teaching. They initially practised analysing teaching practices using QT rounds with mathematics classes that had been video-recorded by the lecturer in mathematics. The mathematics lecturer whose teaching was analysed in the video-recording participated both as the subject of the analysis and as a discussant in the rounds in Week 7 of the course.

Subsequently, pre-service teachers participated in their first practice-based learning experience. During the experience, referred to as a 'micro-teaching experience', pre-service teachers were required to attend a homework club at a local high school at least once. Homework clubs are a popular way for high school students to gain understanding of difficult



topics, work collaboratively in solving challenging questions, or prepare for high-stakes testing. Homework clubs generally run after normal school hours making it easier for our pre-service teachers to find times to attend which did not conflict with their university commitments. A total of four high schools offered their homework clubs to the pre-service teachers participating in this study. The micro-teaching experience consisted of helping high school students in a homework club by providing guidance, tips or working out difficult problems while being observed by a partner who took notes on their teaching based upon the QT model. Partners subsequently swapped roles and repeated the process. Immediately after both partners had completed their micro-teaching, they conducted a reflective conversation about their teaching following the QT rounds process that had been practised in class. As an assessable item of the course, pre-service teachers had to write a reflection about their conversation as well as a full lesson plan on a topic they had encountered during the micro-teaching. It is important to note that due to the nature of the homework clubs and the range of students who attend them, pre-service teachers had no opportunity to prepare a traditional lesson. Also, high school students sometimes worked individually and quite often in small groups, so pre-service teachers had to adapt their teaching style to suit one-on-one tuition or small group coaching depending on the situations they encountered on the day or days they went to their chosen school.

Sample

Pre-service teachers participating in this study (N=40) were part of a mathematics education course focusing on teaching strategies. The course was comprised of two distinct sets of pre-service teachers undertaking the first year of their respective programs, a cohort of 28 undertaking the Bachelor of Teaching (Mathematics), an undergraduate initial teacher education degree, and a cohort of 12 undertaking the Master of Teaching (Mathematics), a postgraduate degree for pre-service teachers that hold a previous degree in Mathematics/Science/Engineering and are training as teachers. This course was taken in the first year of education studies for both cohorts.

Of the pre-service teachers in the sample, 40% were female and 30% were enrolled in the Master's degree. Also, 42.5% of pre-service teachers were under 21 years of age, 27.5% between 21 and 25, 17.5% between 26 and 30 and 12.5% over 30 years of age.

Instruments

Two instruments were used to address the research questions.² For the first question, a survey was designed to obtain pre-service teachers' perceptions of the QT rounds as a medium for helping them understand mathematics teaching compared to other non-practice based approaches to teaching (for example lectures and tutorials). The survey comprised four questions; two of them consisted of Likert scales, and the other two were open-ended questions. Of the two Likert scales, the first used a ten-point scale and was used to survey pre-service teachers about their perceptions of the relative effectiveness of different learning activities in the course. The scale ranged from 1 to 10, where a '1' indicated the activity was *Not useful at all* and

² The course assessment marks were de-identified for the purpose of this research, and individual categories in the rubric were analysed by researchers in the team who were not teaching the course. Further, responses to the survey were anonymous and hence could not be linked to an individual student's assessment tasks. Students were made aware of both of these facts.

a '10' indicated the activity was *Extremely useful*. The second of the two Likert scales was used to appraise the QT discussions conducted during the course. The responses were recorded on a seven point ordinal scale, with responses indicating the level of agreement with the provided statements about the discussions as Very Strongly Disagree, Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree, or Very Strongly Agree.

The second research question was explored using students' *assessment tasks*. This included lessons plans and reflections on the QT rounds conducted during the micro-teaching experience to assess pre-service teachers' ability to understand teacher practice and plan for student learning using that understanding. To do so, they were asked to work in pairs and subsequently (individually) submit a summary of their conversation with their partner (non-assessable) as well as:

1. A **lesson** designed to teach a concept addressed in the micro-teaching experience. This lesson was required to incorporate at least two (2) different teaching strategies seen in class and one (1) higher-order thinking assessment task.
2. A **reflection** of how their lesson plan would work towards achieving the presence of Deep Knowledge (DK) and Explicit Quality Criteria (EQC), as well as at least three (3) other elements of the Quality Teaching model. These three elements must have arisen from the conversation with their partner.

The lesson was marked in four categories: structure (20%), teaching strategies (20%), assessment (10%), and QTM in the lesson (10%). The reflection was marked according to the depth of their analysis (30%). There was also a category relating to academic literacy throughout the document (10%). Each of these six categories was scored on a scale from 0 to 10 and then adjusted according to the percentage weighting of the category resulting in a total score out of ten. Thus, the possible ranges of scores for each of these six categories after accounting for their relative weights were: structure and teaching strategies (0 to 2); assessment, QTM and academic literacy (0 to 1); and analysis (0 to 3).

An outline of the marking rubric used to provide feedback to pre-service teachers on the different aspects on both the lesson and the reflection is presented in Table 1.

It is important to note that the task described above ultimately assessed pre-service teachers' PCK. Through preparing the lesson plan and reflecting upon their teaching, pre-service teachers develop their knowledge and understanding of PCK elements such as teaching strategies, student misconceptions about specific mathematics topics, or effective analogies for illustrating mathematical concepts.

Table 1
Outline of marking rubric for assessment task

		0-4	5-6	7-8	9-10
		Unsatisfactory	Developing	Developed	Outstanding
Structure of lesson	20%	Lacks structure, motivation, or timing.	Weak structure, motivation, or inappropriate timing.	Structure has minor flaws. Appropriate motivation & timing.	Highly structured, innovative & motivating. Effective use of time.
Teaching strategies used to convey	20%	Teaching strategies are not appropriate for	Appropriate matching. However,	Appropriate matching. However,	Exemplary matching of effective



lesson content		the lesson content	understanding is limited and/or shows significant errors in parts.	understanding is uneven and/or there are minor errors in understanding.	teaching strategies with lesson content.
Assessment elements in lesson	10%	There is minimal evidence that questions would elicit higher order thinking.	The assessment is appropriate, but the scaffolding has significant errors in parts.	Student devises appropriate higher order thinking.	Student devises appropriate, innovative & effective assessment.
Quality Teaching in lesson	10%	QT is not evident in this lesson.	Some QT elements are present but show errors in parts.	Appropriate inclusion of DK, EQC + 3 other elements of QT.	Use of DK, EQC + 3 other elements of QT greatly enhances the lesson.
Critical analysis in written reflection about Quality Teaching	30%	Crucial elements of the QT model have been misunderstood.	QT understanding is limited and/or analysis shows significant errors in parts.	QT understanding is uneven and/or analysis contains minor errors.	There is evidence of exemplary and critical understanding of QT in the lesson analysis.
Academic literacy	10%	Very poorly written Significant errors that impede understanding.	Poorly written 3-6 significant errors that impede flow of reading.	Reads well 1-2 errors that do not impede understanding or flow of reading.	Reads very well No significant grammatical or spelling errors.

Analysis

This section will be divided into two subsections, each answering one of the research questions.

Are QT rounds an effective approach for practice-based pre-service teacher education in comparison to other commonly used approaches?

Of the 40 pre-service teachers participating in this study half (n=20) responded to the survey. Of this, 40% were female, and 45% were enrolled in the Master's degree. 30% of these pre-service teachers were under 21 years of age, 40% between 21 and 25, 10% between 26 and 30 and 20% over 30 years of age. In terms of the proportions of males and females, this subsample was identical to the total sample (N=40). The proportion of Masters-level participants was slightly higher in the subsample and consequently so too was the proportion of older participants.

A summary of pre-service teachers' responses to the section of the survey assessing the usefulness of the various learning activities used in the course towards helping them become an effective teacher is provided in Table 2.



Table 2
Usefulness of learning activities (n=20)

Learning activities	Mean	SD
Micro-teaching experience	9.10	1.09
Assessment for learning (reflection on micro-teaching experience)	8.40	1.11
Assessment for learning (lesson planning)	8.35	1.19
QT discussions of high school teachers teaching maths (Week 2)	8.25	1.64
Lectures	8.15	1.15
Peer teaching during tutorials (Weeks 3-6)	8.10	1.73
QT discussions after micro-teaching experience	7.50	2.09
QT discussions of university lecturers teaching maths (Week 7)	7.50	1.99
Assessment for learning (essay about teaching strategies)	6.89	1.55
Assessment of learning (quizzes)	6.20	2.20

As shown in Table 2, the micro-teaching experience was on average highly rated on the ten-point scale, along with the assessment tasks where they were asked to plan a lesson based on their reflecting upon the micro-teaching experience. Conversely, the other two assessment tasks, which were not linked to the QT model or micro-teaching experience, were not seen by pre-service teachers as contributing as greatly to their learning, although they were still on average perceived as useful.

Pre-service teachers' open-ended comments supported the results in Table 2 and identified that they had thoroughly enjoyed the micro-teaching experience and the reflections that followed. This sentiment is reflected in the following two representative examples of pre-service teachers' comments:

The best activity was getting to go to schools and help students with their work after which a lesson was to be planned. This helped greatly to reflect back on how I taught the mini lessons and how it could be taught better [...]. The quizzes were good for a brief recall of each week's lesson, though it may have not scored as high compared to other activities in the context of becoming an effective teacher.

The micro-teaching experience was the most useful experience because it provides a practical context. The essays about teaching strategies are the least useful, but are still very much worthwhile as they provide a basis for encountering teaching practices.

In the second part of the survey, pre-service teachers were asked to elaborate on the discussions which followed their micro-teaching experience and observations of teaching that were conducted during the course. They first responded to several Likert-type items which used a seven-point ordinal scale and expressed their agreement with a set of statements about the discussions. Their responses can be found in Table 3. A summary of pre-service teachers' responses to the section of the survey appraising QT discussions is provided in Table 3.

For each of the seven statements about the micro-teaching experience, 100% of the pre-service teachers responded positively in two areas, whilst 16 or more of 19 responded positively to four other areas (with the remainder neutral) and one area had 15 of 19 respond positively (with one disagree and the remainder neutral).



Table 3
Appraisal of Quality Teaching discussions (n=19)

	Disagree*	Neutral	Agree	Strongly agree	Very strongly agree
QT discussions help me define the way I think about teaching	0 (0%)	1 (5.3%)	6 (31.6%)	10 (52.6%)	2 (10.5%)
QT discussions during class helped me feel part of a PLC with my peers	0 (0%)	3 (15.8%)	9 (47.4%)	6 (31.6%)	1 (5.3%)
QT discussions during the micro-teaching experience helped me feel part of a PLC with my peers	0 (0%)	3 (15.8%)	11 (57.9%)	4 (21.1%)	1 (5.3%)
I would like to continue using QT discussions in my professional practice in order to maintain a PLC with my peers	0 (0%)	3 (15.8%)	8 (42.1%)	7 (36.8%)	1 (5.3%)
I would like to continue using QT discussion in my professional practice in order to enhance student learning outcomes	0 (0%)	0 (0%)	9 (47.4%)	8 (42.1%)	2 (10.5%)
I would like to have micro-teaching experiences in other Education courses	1 (5.3%)	3 (15.8%)	6 (31.6%)	5 (26.3%)	4 (21.1%)
I would like to observe practising teachers and participate with them in QT discussions	0 (0%)	0 (0%)	8 (42.1%)	5 (26.3%)	6 (31.6%)

* In this column we have compiled the answers: Very strongly disagree, Strongly disagree and Disagree

All activities in the course were viewed very favourably by the pre-service teachers. All innovative aspects of the course: micro-teaching, QT discussions and the creation of a PLC were highly valued. This was evidenced by comments such as:

In general, almost every activity was extremely useful to help become an effective teacher. This was one of the most relevant and useful courses for a mathematics teacher in training.

Two issues emerged from this research which may have implications for course design. The first is that pre-service teachers felt that the number of participants in the rounds needed to increase from two in order for them to be fully effective:

It was helpful to have the micro-teaching experience in a pair, but it was hard to find the time to take turns to help and evaluate the other. I found that in a larger group with people who really understand teaching and the QT, it was more helpful to have discussions in.

The second issue had to do with the perceived inadequate level of MCK that some of the pre-service teachers see in their peers. One participant expressed it in the survey as follows:

The divide between Bachelor, and Masters students, feels quite severe in Mathematics, with many Bachelor students having disappointing levels of Mathematics at this stage.

This observation was examined in the research we present in the next section, which analyses factors influencing pre-service teachers' development of PCK as evidenced in their



final assessment for the course. The comment made by this pre-service teacher was investigated by comparing undergraduate and postgraduate assessment tasks completed during the course.

What factors influence pre-service teachers' ability to plan lessons and reflect on their practice-based experience using QT rounds?

In the analysis of the 40 pre-service teachers' tasks we found a deep engagement with the Quality Teaching model and consequently reflections written by pre-service teachers were very focused and insightful. It appeared that thinking about quality teaching with reference to a practice-based teaching experience allowed the pre-service teachers to develop a deep understanding of all dimensions of the QT model detailed in Figure 1.

Age, gender and degree (Masters or Undergraduate) were each assessed for their association with pre-service teachers' abilities to plan lessons and reflect on their practice-based experience using QT rounds. Two-sample t-tests were used to consider whether or not assessment scores for each of the six assessed categories within the rubric, and the overall final score, were associated with each of gender and pre-service teachers' MCK. The pre-service teachers' program (Masters or Undergraduate) was used as a proxy for MCK considering Masters-level pre-service teachers had already completed a degree with a minimum of two Mathematics courses at third year level whilst the Undergraduates, in contrast, were in their first year of a Bachelor of Teaching (Mathematics) program and had not completed any courses at second or third year levels.

Since only older age groups would be represented in the Masters level program, we additionally considered the subset of undergraduates to determine whether scores for each of the six assessed categories within the rubric, and the overall final score, were associated with age. Tukey's t-test was used since age was grouped into one of four categories.

None of the six categories' mean scores, or final overall score was statistically significantly associated with gender at the 5% significance level, $p > 0.09$. Table 4 presents the results of the t-tests assessing whether or not pre-service teachers' MCK was associated with assessment scores for each of the six assessed categories within the rubric and the overall final score. For all categories apart from Academic Literacy, scores were statistically significantly associated with degree program at the 5% significance level, $p \leq 0.02$.

Table 4
Testing for differences in scores due to pre-service teachers' program level

Category	Mean score			Standard Error of Difference	p-value
	Masters	Undergrad	Difference		
Structure	1.58	1.22	0.36	0.147	0.0208
Strategies	1.75	1.31	0.44	0.124	0.0014
Assessment	0.82	0.56	0.25	0.097	0.0156
QTM	0.86	0.65	0.21	0.067	0.0041
Academic Literacy	0.85	0.76	0.09	0.056	0.1085



Analysis	2.63	1.92	0.71	0.201	0.0012
Overall	83.50	64.86	18.64	4.943	0.0007

Of those enrolled in the undergraduate program, scores in the categories were not statistically significantly associated with age group at the 5% significance level, $p > 0.06$, suggesting mathematical maturity, MCK, rather than maturity due to age was important to students' depth of knowledge and understanding of PCK.

Conclusions

The purpose of the research reported on in this paper was to evaluate the effectiveness of an implementation of QT rounds as a practice-based approach to pre-service teacher education in mathematics. When analysing the surveys to address our first research question, we learned that pre-service teachers found the practice-based experience and the associated QT rounds very valuable in comparison to other methods they have experienced in the course, and indeed other courses to date. However, it became apparent when addressing the second research question through the analysis of assessment tasks that the value of the experience varied between the different cohorts participating in the research. We found that there was no statistically significant difference in the marks obtained by males and females in any of the six categories, though we observed slight differences with regards to age. While these differences were only marginal in most of the six categories, it prompted us to consider that a certain level of maturity may provide pre-service teachers an advantage in regards to developing PCK. However, based on our proxy (degree program) we found that MCK, rather than simply age, appeared to be associated with assessment scores. Whilst age was associated with the degree that the pre-service teachers were undertaking, it was observed that of those enrolled in the undergraduate program there was not a statistically significant association between assessment scores and age. Whilst not conclusive, these results suggest that a higher level of MCK rather than a person's age is likely to be associated with higher assessment scores, on average.

As pre-service teachers progress through their degree, varied opportunities for practising their teaching skills are needed, but it is important to time these opportunities carefully to maximise their impact. It seems that a lack of MCK may hinder undergraduate pre-service teachers' ability to fully engage with or understand their practice and thus impact on their capacity to develop PCK. This finding about the connection between MCK and PCK for secondary school pre-service teachers corroborates previous findings reported by Beswick & Goos (2012) in primary settings.

Another issue to note based on the comments made by students is that the number of participants in the rounds needs to increase as pairs seem to not provide enough input and depth to the QT discussions. This finding is consistent with Gore (2014).

In summary, we find that practice-based teaching experiences, with associated reflective opportunities for discussion, are effective in developing pre-service teachers' knowledge of quality teaching and PCK development. This approach was rated more highly by the pre-service teachers themselves in comparison to other approaches commonly used in teacher training programs. However, the extent of PCK development in the QT rounds was mediated by the MCK of the participants. It appears that a deficiency in MCK is an important limiting factor in PCK development. This finding provides support for postgraduate teacher training in



preference to undergraduate, as it appears that undergraduate students are not able to maximise their 'learning about teaching' due to a lack of depth in their MCK.

Further Research

Student surveys indicated that the QT discussions following the micro-teaching experience, although positive, were less so than the micro-teaching experience itself. We believe that QT discussions involving the pre-service teachers and senior practitioners (teachers in local high schools or the mathematicians whose teaching was analysed in Week 7) would improve the experience. Changes to reflect this aspect of QT rounds (where an experienced teacher discussed his or her practice with a group of pre-service teachers) will be included in the next iteration of the course. Further research will be conducted to assess whether the effectiveness of QT rounds is more apparent incorporating this approach.

In addition, it is important to point out that our study had a broader impact through the inclusion of Mathematics staff and students from our institution who were video-recorded to be subsequently analysed in Week 7 of course. These secondary aspects have not been formally investigated in this paper and deserve further examination, as they exemplify the spirit of boundary encounters across faculties which has the potential to re-define certain aspects of mathematics pre-service teacher education (Goos, 2014). In particular, it would be interesting to explore whether the experience changes mathematicians' and mathematics students' assumptions about the degree to which a classroom is a private space, the nature of teaching, and the importance of pedagogical content knowledge in the teaching of mathematics.

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