A Professional Learning Tool to Help Stimulate Mathematics Teachers to Reflect on their Pedagogical Practice

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This paper reports a case study from a project that worked with teachers using a networked system to obtain feedback from students and collate their responses during mathematics lessons. These data were immediately available in graphical format for teachers to review as a reflective prompt while events of the lesson remained fresh. The study sought to establish the kinds of reflections this approach stimulated and whether teachers found it useful. Overall it appeared this approach prompted higher levels of reflection.

Introduction

This paper reports one case study obtained from working with teachers who were participating in a larger Australian Research Council funded research and professional development study, the Task Type and Mathematics Learning (TTML) project. The TTML project worked with approximately 50 teachers from 17 schools in Victoria who were interested in improving their mathematics teaching. This paper focuses on one of the TTML teachers and their initial responses to using the Real Time Feedback System (RTFS) as a professional learning tool. The RTFS allowed the teacher to collect student responses to aspects of their classroom teaching in real time, with the potential for immediate, data driven reflection and review.

Background

There is considerable interest in teacher reflection as a form of ongoing professional learning, and in ways to elicit these reflections from teachers. This study spanned three closely connected areas within the mathematics education field: professional learning; reflection; and teacher change.

Professional Learning

Muir and Beswick (2007) conducted an extensive review of the professional learning literature and derived three main themes or principles of effective approaches to professional learning:

- Professional learning is more likely to be effective if it addresses teachers' pre-existing knowledge and beliefs about teaching, learning, learners and subject matter.
- Professional learning is more likely to be effective if it provides teacher with sustained opportunities to deepen and expand their content and pedagogical knowledge.
- Effective professional learning is grounded in teachers' learning and reflection on classroom practice. (Muir & Beswick, 2007, pp. 75-6)

The TTML project engaged teachers in all three of these dimensions, however the focus of the current study was exclusively on the first and third items only. In this study teachers were invited to compose a set of prompts or questions for which they were interested in obtaining feedback from their students. The teachers were encouraged to devise prompts that covered areas of interest to themselves, which provided an opportunity for them to explore aspects of their existing pedagogical practices, attitudes and/or beliefs. These prompts were then loaded into the RTFS so the teacher could collect data from their own classrooms and reflect upon the results.

To some extent the first item is subsumed by the third in that reflecting on ones' own practice automatically incorporates and addresses ones' existing knowledge, beliefs, and attitudes to

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teaching, learning, and students. When reflection becomes an ongoing part of a teachers' practice it would have the potential to address all three areas comprehensively.

Reflection

Encouraging teachers to reflect on their practice is a strong theme in the professional learning literature. Dewey (1933) called for teachers to engage in "reflective action" early in the 20th Century. He argued that teachers should adopt three attitudes he identified as prerequisites to reflection: wholeheartedness; responsibility; and open-mindedness. A teacher might be forgiven for thinking of these prerequisites as somewhat idealistic. For instance, responsibility is described as taking account of the personal, intellectual, and social consequences of every pedagogical decision a teacher makes on each of their students. However, in setting up an ideal Dewey (1933) gave form to an alternative understanding of teachers as facilitators and guides rather than authoritarian deliverers of pre-ordained knowledge (Kirschner, Sweller, & Clark, 2006).

In a similar vein Zeichner and Liston (1996) delineate between the historical view of teachers as passive technicians and Zeichner and Liston's (1996) notion of the reflective teacher. For them a reflective teacher "questions the goals and values that guide his or her work, the context in which he or she teaches…[and] examines his or her assumptions" (p.1). They contrast this with the view of teachers as technicians delivering programs conceived of by others, located elsewhere.

Rather than passive consumers and of curriculum, Zeichner and Liston (1996) see teachers as experts who understand the constraints and complexities of teaching due to their direct involvement in their classrooms. That is, unlike external researchers, teachers possess what Schön (1983) described as *knowledge-in-action*, by virtue of the very act of teaching. Schön (1983) goes further and claims that because of its implicit, spontaneous, and unconscious nature, knowledge-in-action is largely inaccessible to researchers, creating a disconnect between the "high ground" world of external research and the problems teachers face in the "swamp" of their classrooms.

Teacher Change

Teacher change arising from their classroom experiences is central to Guskey's (1986) linear model of change. Guskey (1986) suggested that changes to teachers' beliefs and attitudes resulted from them observing changes in student learning which arose from the teachers implementing changes in their classroom practices (see figure 1).

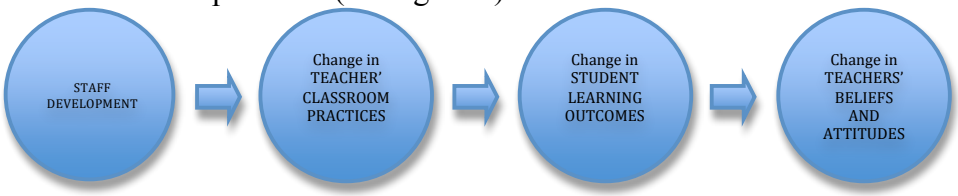

Figure 1. Guskey's (1986) model of the process of teacher change (p. 7).

This model is largely consistent with Schön's (1983) reflective practice in that change stems from teachers' classroom experiences and observations. There are two key differences, however. Guskey (1986) posits changes being initiated through a process of, largely external, staff development and ending with a change in teachers' beliefs and attitudes. By contrast Schön's (1983) reflective practitioner would be providing their own, largely internal, staff development opportunities through reflection on their own classroom practices which would in turn bring about a shift in their beliefs and/or attitudes in a cyclical fashion (see figure 2.).

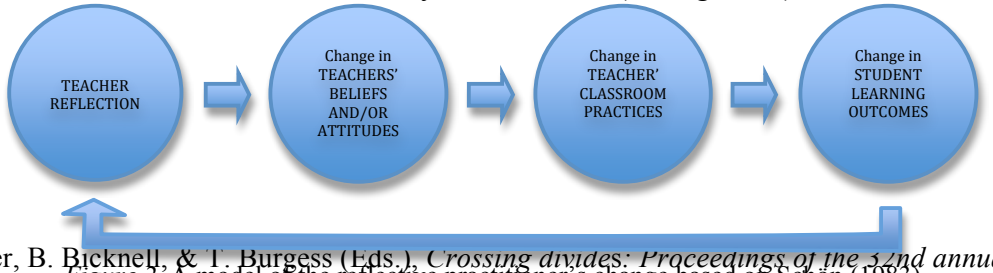

Figure 2. A model of the reflective practitioner's change based on Schön (1983).

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Crucially, Guskey (1986) has the impetus for change as an external source whilst for Schön (1983) it is an internal one. Feiman-Nemser (2001) offers a middle way for teacher change and professional learning by casting teachers in the role of researcher; videotaping and analyzing their own and colleagues classes, interviewing students, and examining samples of student work. Such an approach utilises externally developed methods to prompt internal reflection.

This study adopts a similar position to Feiman-Nemser (2001) by placing an externally sourced research tool into the hands of teachers to facilitate their internal reflection. In this way the study seeks to ascertain whether such a merging of these 'first steps' (external and internal) through use of the RTFS is able to stimulate the kind of reflection that might lead to attitudinal and pedagogical changes.

Method

Overview

In this study TTML participants were provided with an electronic data collection tool, the Real Time Feedback System (RTFS) – described previously in O'Donovan (2008). The RTFS enabled these teachers to pose a set of questions that each of their students would view and respond to during a mathematics lesson using *iPod Touches*. The collected data were available in graphical format for the teacher to review at the end of each lesson in a semi-structured interview.

The case study reported here is based upon the second occasion the class had used the RTFS, so the students were familiar with the devices, how to operate them, and what was expected of them. It was, however, the first time the teacher had reviewed the graphical feedback because the first session was a trial run and no actual data were collected at the time.

Teacher's Feedback Questions

Teachers were asked to formulate some questions they wished to obtain student feedback on, drawn from areas the teacher felt to be amongst their strengths and weaknesses. These and two other standard questions were then asked of students every five minutes or so during a mathematics lesson. The number of questions asked was intentionally kept small so as to minimise disruption to the lesson. Students selected responses based on a five point Likert scale.

The set of questions used in this case study were;

1. How interested in this work are you right now?
2. How hard are you trying right now?
3. Do you agree that Ms Heinz (pseudonym) understands your learning needs right now?
4. How confident do you feel about what you are doing right now?

Teacher Discussion

After the lesson the collected data were analysed with the teacher, followed by a short semi-structured interview to collect data on the teacher's experience of the process, their views on its utility, and any observations they cared to make on the results.

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Case Study

The School

Sesame Primary School was a Government school situated in an affluent Melbourne suburb. The school had 530 students enrolled with five grade six classes, four being a mixture of grade five and six student (composite 5/6) with the sixth class composed of grade six students only.

The Assistant Principal was committed to having teachers develop individualised learning plans for each student and matching the curriculum to their needs. This Assistant Principal placed a particular emphasis on challenging students rather than selecting tasks based on what students may or may not find engaging "We've moved beyond 'this is a great task, the kids will enjoy it'". The desire to challenge individual students was described as the primary reason behind structuring mathematics session so that students were grouped according to mathematical ability and allocated ability-appropriate tasks. All students were given access to all tasks, however, and encouraged to attempt tasks allocated to other ability groups if they wished.

The Teacher

Background

Elise was a very experienced Primary teacher with over 20 years of service in three different Victorian Government schools. She had been teaching in Sesame Primary School for seven years and was looking forward to taking long service leave in the near future. Elise was also involved in the Australian Government Quality Teaching Project (AGQTP) at the time, in addition to taking part in the TTML project. She appeared very committed to improving her teaching practice.

Setting

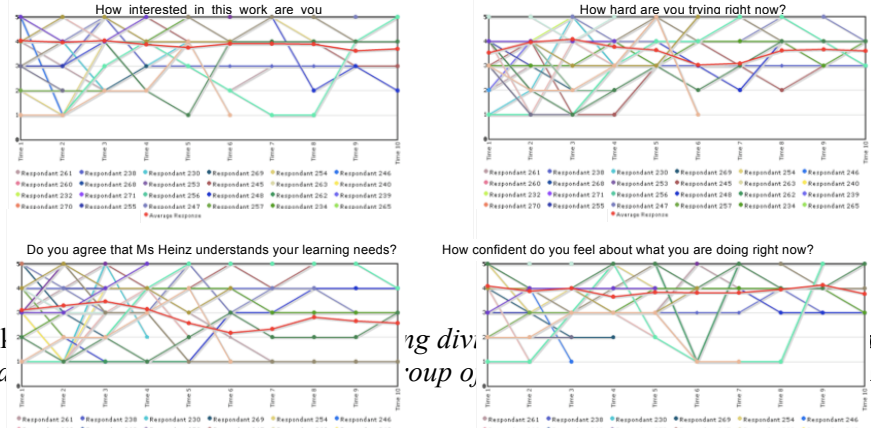
Elise Heinz had a composite grade 5/6 class at Sesame Primary School. Her class had 26 students, 14 grade 5 and 12 grade 6. Of these 16 were boys and 10 girls. The class was situated in a stand alone portable that offered limited space for Elise and her students to move around. Her classroom was arranged with an electronic white board at the front and students clustered around groups of two rectangular tables joined to form squares. Displays of student work were ubiquitously as well as commercial educational posters (e.g., human anatomy, maps, wildlife etc.).

For mathematics sessions Elise allocated students to one of four ability groups. Her typical mathematics lesson consisted of an introduction to the topic and then students would assemble into their groups and select tasks from those on offer for their particular ability group.

After the introduction Elise would nominate a particular group of 8-12 students to work with – usually those of lower ability – and this would become the 'teaching group' while other groups of students worked on tasks without assistance. After the teaching group was given further instruction for a period of 10-15 minutes, Elise would roam the room helping students as needed.

Results

The following graphs (figure 3) were obtained from one of Elise's mathematics session. Note that each coloured line represents the five point Liker scale feedback from a single student within a five minute time period.



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Elise chose to explore the graphs as a group and was particularly interested in any of the responses that showed a decrease in interest, effort or confidence, and when these occurred;

> As an average it's not too bad, they've pretty much maintained their effort across, you know, there's a couple of dips, but you know it's not sort of start up high and then gone mmmlerrrrrrr [*sound accompanied by hand gesture moving sharply down*] as the lesson's gone along, it's kind of maintained ... the yellow's interesting …
>
> The dips are interesting though, it's kind of pretty steady there then it dips and then goes back up again, I was wondering, it would be interesting if I knew exactly what time that was. And what made it go back up again?
>
> And then there's these rebel kids who stop answering half way through!

Elise appeared to accept that the graphical responses and patterns accurately reflected students' sentiments and she seemed satisfied that the tool was capturing data of relevance to her e.g., she drew some comfort from the fact that interest levels did not plummet (go "mmmlerrrrrrr") as the lesson progressed. Elise also identified three students who stopped responding part way through the lesson, dubbing them "rebels". She was also keen to identify at what point in the lesson the dips in interest occurred.

In looking to explain these patterns Elise felt that it would be critical to identify not just what was happening at the time of the fluctuations, but also which line represented which student;

> I don't know what happened to the brown one, it's sort of disappeared, maybe it was Liam when he started playing with Google maps or something instead of answering questions! I think it is interesting and useful if you can correlate it to the part of your lesson you were at, because then you know oh I've bored them silly with an introduction, or they loved the hands on bit, or you know, the lesson really goes a bit too, you know 10 minutes too long.
>
> This brown one again, it just dies in the middle in everything! I wish we knew who that was!

Her focus on the "rebels" highlighted the need for her to be able to put names to each line of feedback. Elise felt that removing the anonymity of student responses would be crucial to making the RTFS be of use to her in improving her planning and timing of activities within her lessons.

Elise's emphasis shifted from how she might use the RTFS to alter her lessons to considering how she might be able to use the RTFS as a diagnostic tool for tracking students over a longer period of time. Once again this reinforced for her the importance of linking the identity of each student to their feedback;

> If you know in your own room who each respondent is, then you can see if a child's consistently … like … they might look like they're working but they're bored silly. They're not being challenged enough or, it's too hard for them so they're disengaged, if you knew which colour was which child and you could compare it across a few weeks then you could see if they were always feeling the same way.
>
> I think if they, in two or three weeks time, if you could do, say, similar types of tasks, but you knew who the kids were, you could see if the same kids were always disengaged, or if I was going to use it as a tool I'd be wanting to do those sort of comparisons.

For Elise the RTFS offered the possibility of identifying bored students who might otherwise go undetected over a long period of time. She felt that patterns might emerge which would not only identify disengaged students generally, but identify whether students were only disengaged by particular types of task.

The disengagement theme was not Elise's only concern for her students, she was also acutely aware of the ambiguity of the question concerning how confident students' felt with the

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mathematics they were working on. She also commented that high scores in the confidence question might not be an optimal result;

> That looks great at first, but then you sort of think, is that, is it too easy for them. If they're feeling really confident about it it's either that it's been explained well enough and they know what they're doing and they think 'yep I can approach this, I can have a go at it', but if it's super confident maybe it's not challenging enough, but then if it's way down then it's too hard, so maybe, you know, aiming for something about a 3 may be better with that, you don't want it to be too hard.
>
> I can look at that and say 'oh great they all feel confident!' if I don't really think about the reasons why they're feeling confident … it gives me a feeling for what they're feeling, but … not … the nitty gritty of it.

Elise was clearly moving beyond a superficial analysis of the results, delving not only into reasons that might explain the patterns, but thinking about what kind of results she would consider to be a good outcome. She also continued to identify limitations in the existing data set, sensing that there wasn't quite enough information for her to be able to draw any definitive conclusions.

This line of reasoning prompted Elise to consider modifying the questions she would use so as to further unravel whether her students' confidence was due to good instruction or due to a lack of challenge in the task.

> It would be interesting if there was a question like, maybe, 'how challenged do you feel by this' because then comparing that with the confidence, if it was high challenge and high confidence you'd sort of think they're still feeling challenged or ... you know they're feeling pretty good about it ... or 'does the task you're doing offer you a challenge?' something like that, because then you'd know whether they were feeling confident because … if they said it was of no challenge then you know they're confident because it's too easy.

This interrogation of the data helped to shape the way in which Elise wanted to use the RTFS in future to enable her to gain greater insight into the way her students were experiencing her lessons so that she could better extend their learning and understanding of mathematics.

Reflection Analysis

One way of analysing Elise's reflections is to compare them with Van Manen's (1977) reflective categories, Technical; Deliberative; and Critical. Technical reflection relates to practical concerns focussing on "means rather than ends", Deliberative reflection contemplates the "nature and quality of educational experience", and Critical reflection addresses itself to the "worth of knowledge" itself (pp. 226-7). Van Manen (1977) proposed these categories within the context of a philosophical analysis rather than as a research tool, so a somewhat more pragmatic rendering of these categories is provided by Muir and Beswick (2007);

> Technical Description: The participant describes general accounts of classroom practice, often with a focus on technical aspects, with no consideration of the value of the experiences.
>
> Deliberate Reflection: The participant identifies 'critical incidents' and offers a rationale or explanation for the action or behaviour.
>
> Critical Reflection: The participant moves beyond identifying 'critical incidents' and providing explanations to considering others' perspectives and offering alternatives. (p.79)

By these definitions it appears that Elise's reflections progressed through all three categories. Her initial responses were quite Technical in the sense that she provided generalised observations about the overall picture of the feedback looking for obvious patterns, focussing on the dips and rises – there was no thought given to the values underlying these patterns. It is understandable that this would be the case given that it was her first encounter with the data, so looking for patterns as a first step to understand what it had to say about her lesson is to be expected.

Once Elise had gleaned the essential nature of the graphs her reflections shifted from Technical to Deliberate. At these times she was wanting to identify the points in the lesson at which the dips and rises occurred, wishing to explain the critical incidents within the lesson that may have brought these about.

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However, the majority of her time was arguably spent on Critical reflection. There were several examples of this type of reflection, the first being her desire to identify individual students. If she had remained within the realm of Technical or Deliberate reflections Elise would have been quite content with depersonalised data, having little regard for the view from individual student's perspectives. Her interest in individual students extended even further with her movement beyond the obvious data patterns onto exploring of them in greater detail. For instance, Elise's rejection of the positive 'confidence' feedback demonstrated her genuine desire to challenge her students and increase their mathematical learning, rather than drawing comfort from the superficially good results. In fact Elise sought to modify the RTFS itself to help her delve further into this question;

> Can you have subset questions that if they did say they're feeling really confident they get asked whether it was because it was explained properly, or it's too easy, or you put me in the wrong group...

This suggests Elise was reflecting critically on significant aspects of her practice, including the clarity of her explanations, suitability of her task selections, and her allocation of students to appropriate groups. Elise appeared to view the RTFS as a possible source of quality information that could have very practical implications for the way she structured her class and lessons.

Another example of her consideration of her students' perspectives was when considering whether they felt she had helped them or not whilst teaching them as a group.

> Even thinking about the group I worked with, they were a really hard audience to get started on this introduction…these are kids who aren't bad at maths, but they're just sitting there looking at me saying 'oh god, come on it's Wednesday morning, leave me alone!' and there's just nothing coming out of them, and it could almost reflect that, but as soon as they started working on it without me, they kind of worked a bit harder, or maybe they think 'well I'm not working I'm just sitting here listening to her' … maybe I could try swapping maths with music …

Elise was aware that the dips in reported effort may have been due to them being slow to warm to the task, or that perhaps her students do not feel that they are working hard during periods of direct instruction. Both are potentially valuable insights for Elise, each of which could impact on her teaching. If students are slow to warm to mathematics in the morning, she could change her schedule and spend the time more profitably on more creative or artistic subjects. Alternatively if it is just that students do not feel like they are making an effort during her explicit teaching she might minimise the time spent on her talking to a group and/or make them more interactive.

Overall Elise seems to have engaged in fruitful reflection on her mathematics lesson, spending relatively little time in technical reflection and a considerable amount of time in critical reflection.

Discussion

Critical reflection, or its equivalent, has been put forward as a vital part of teacher learning for nearly a century (Day (1999), Dewey (1933), Martinez & Mackay (2002), Schön (1983), Zeichner & Lister (1996)). Many definitions of critical reflection emphasise its role as a process of self development, political action, and social reform, all of which appear to fall well beyond the ken of a typical classroom. For instance Day (1993) argues that we need to "ensure that the reflective process really can lead to empowerment so that the micro-political world of the classroom is seen within the social-political world of the school and the broader macro-political world of society" (p. 90). Similarly Valli (1997) describes critical reflection as "the only form of reflection that explicitly views the school and school knowledge as political constructions" (p. 78). And Van Manen (1977) suggests that critical reflection "implies a commitment to an unlimited inquiry, a constant critique, and a fundamental self-criticism" (p. 221).

Not only does critical reflection carry these weighty responsibilities but it is also described as having a personally transformative or quasi-spiritual dimension. For example Tremmel (1993) describes reflection in terms of Zen Buddhism mindfulness and that "Zen, which is not totally dissimilar to Schön's approach to reflection-in-action, helps us transcend to that wider range of

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practice" (p. 443). Zeichner and Liston (1996) explain that reflective teaching "can be an intensely personal and challenging endeavour" (p. 19) and advocate a collegiate, collaborative and cooperative environment very similar to Palmer's (2004) mutually transformative 'circles of trust'.

Viewed from these transformational perspectives, much if not all of Elise's reflections are reduced to being merely technical in nature. For instance Valli (1997) described technical reflection as when "teachers judge their own teaching performance on the basis of externally imposed criteria" (p. 75). Since the assistant principal had articulated the central role challenging students plays in being a good teacher, Elise's concern with challenging her students is arguably no more than an attempt to enact the desires of her school's administration – or at the very least using this as the yardstick by which to measure her own efforts.

However, this would be a harsh reading of Elise's reflections. The idealism inherent in some of the reflection literature seems to place an almost super-human responsibility on teachers, somewhat reminiscent of the high expectations some women place on themselves to be perfect mothers. It is perhaps instructive to consider Winnicott's (1958) notion of the *good-enough mother* as a parallel here, where a perfect mother is both unrealistic, unsustainable, and ultimately unhelpful to the development of the child. Perhaps it is better to conceive of a *good-enough teacher* as being something to which teachers can realistically aspire, and actually attain.

Desforges and Cockburn (1987) highlighted the contract that exists between teachers and students which is almost the antithesis of reflective teaching because, as Sullivan and Leder (1992) noted "students' actions and responses in the classroom are important determinants of the way teachers teach" (p. 625). Students, parents, and schools themselves can actively resist the efforts of a teacher who wishes to bring about transformative practice. The point is poignantly made by Desforges and Cockburn (1987) in quoting a teacher who had attended a professional development session; "I don't know why I keep going to meetings to learn more about becoming a better teacher. I already know how to teach ten times better than I ever can" (p. 12).

Conclusion

The RTFS appears to have been effective in prompting Elise to engage in data driven reflection on her teaching. The extracts presented in this case study demonstrate that she was rapidly drawn into critical reflection, using Muir & Beswick's (2007) definition, in her seeking to understand the graphical representations of her students' feedback and, in turn, develop insights into the perspectives of these students. This process seems to have enabled her to then consider what this feedback might mean for her own practice, and how she might adopt alternative strategies to enhance her students' learning. Elise also proposed improvements to the RTFS to make it a more useful tool for her in future data collection and reflection.

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