Engaging Mathematics Teachers in Professional Learning by Reflecting on their Pedagogical Practice

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This study engages mathematics teachers in reflecting on their practice by collecting data electronically from their students during the course of a mathematics lesson. This method of data collection eliminates the burden of manual collation and produces immediate feedback for analysis while the lessons are still fresh in the teachers' minds. It is possible to pose a number of standard questions across all lessons as well as questions formulated by the teachers as being of interest.

This paper is an unusual format in that it represents a proposed research project rather than being a report on completed research. The intention is to engage with others with an interest in using innovative data collection instruments to facilitate teacher learning, and to seek feedback that can help to optimise the use and utility of these instruments. At the time of writing the instruments have been prototyped, but at the time of presentation some piloting will have been completed and preliminary results will be available.

Background and Rationale

The following section gives the background and rationale for the project in terms of canvassing possible ways of improving teacher learning, the constraints imposed on these by the secretive nature of teaching, and the role that teacher reflection could play in forming the basis for professional communities.

Processes for Improving Teacher Learning

The constraints that teachers face in introducing changes to their practice are manifold, and the teachers themselves may not be fully conscious of them. Arguably such constraints do not come into sharp focus until a teacher is attempting to make a change to their teaching. It is within this context that the research proposed here will take place, under the auspices of the Australian Research Council funded Task Types and Mathematics Learning (TTML) project. The TTML project works with approximately 50 teachers from 17 schools in Victoria who are interested in improving their mathematics pedagogy. As a result it is well placed to explore these constraints more fully since the participant teachers have already demonstrated a willingness to implement changes to their practice, which will plausibly bring the constraints of their circumstances into sharper relief.

One suggestion for improved teacher learning draws upon the educational practices of other professions such as law and architecture where 'case knowledge' is commonplace. Shulman (1986) proposes that a case literature could be used in teacher education via simulations and teaching laboratories to help inculcate the kind of professional judgements and practices required of good teachers. Shulman (1986) believes such an approach could form the basis of professional teacher examinations – controlled by teachers rather than bureaucrats – and that it could also inform research programs by incorporating both content and process knowledge to amass a body of case literature. Further, given the inherently accessible nature of cases, teachers themselves would be able to make valuable contributions from their own practice, and empowered as research contributors to their own profession.

Reflective Practice and the Secret Lives of Teachers

Such an approach seeks to formalise the kind of stories Connelly and Clandinin (1995) characterise as *secret*. On their analysis teachers are unlikely to be willing to share anything more than *cover stories* because of the hostility they perceive to be present in the educational *landscape* they inhabit. And even if teachers did reveal their secret stories they would likely become frozen in time and place, losing the dynamic, spontaneous, and transformative qualities they might once have possessed. Instead it may be preferable for teachers to reflect on their own practice.

The importance of engaging teachers in reflexive practice is acknowledged by Sullivan and Leder (1992) who propose peer observation as one strategy for improving practice, but also advocating the investigation

of whether self-reflective teachers are more or less directive, more or less experienced, and whether reflexive teaching is trait or skill based. It is worth noting that these could prove to be possible limitations for this study in terms of its applicability to the broader teaching profession given the targeted cohort is teachers who appear to be committed to long term professional development.

Feinman-Nemser (2001) claimed that the problems with conventional teacher education and professional development are that teacher training is "weak … compared to teachers' own schooling and on the job experience" and that professional development is usually "sporadic and disconnected" (p.1014). She advocates for an overhaul of teacher learning in order to bring about content rich student-centred teaching which encourages and enables teachers to develop their own curriculum, their own knowledge of practice, and to become practical intellectuals.

Feinman-Nemser (2001) surveyed a number of "promising" reform programmes and catalogues the qualities she sees as what makes them promising approaches to teacher education. Feinman-Nemser (2001), echoing the views of Connelly and Clandinin (1995), acknowledges the private nature of teaching, and the inherent lack of opportunities teachers have to observe colleagues or discuss pedagogy with them, but then goes on to expound the deleterious effect of these aspects of teaching have on inducting graduate teachers into the profession. In effect new teachers' mentors have little or no experience of mentoring, and the culture of teaching they are being inducted into is one of finding one's own way in isolation.

Reflection and Professional Communities

As far as professional development is concerned Feinman-Nemser (2001) advocates new approaches which replace external experts with teachers doing the talking and thinking – with a particular emphasis on conversation that involves detailed descriptions of practice, evidence and alternatives. Teachers would form professional communities to share, encourage, critique and support each other and could form partnerships with universities to draw on their resources. Feinman-Nemser (2001) proposes that teachers would design their own curriculum and leverage their professional community affiliations to refine their efforts and increase both their performance and conceptual understanding of pedagogy, producing problem-based, student centred mathematics lessons.

It is worth noting that the TTML project appears to deliver on many of these suggestions, making it an ideal context within which to explore teacher learning. Gaining entry into the classroom of a teacher known to be interested in enhancing their practice is the first step in this project, but the second is to engage these teachers in reflection on their practice.

This project hopes to achieve this by providing a means of collecting teacher-centric data. This approach will be used as the basis for then exploring how such information is viewed by teachers – whether they find it useful for reflecting on their practice, whether or not such customised feedback encourages them to look at modifying their practice, and whether such a process of data collection and analysis brings to teachers a sense of being empowered/disempowered, stressed/relieved, or interested/disinterested in collecting further data on the impact of their teaching.

Zimmerman (2006) has identified a number of factors explaining why teachers appear to be resistant to changing their pedagogical practice including fear of the unknown, feeling threatened socially/professionally/politically, habitual practices, having experienced failed attempts at change previously, and not perceiving there being any need for change. This study would hope to explore the extent to which immediate student feedback alleviates or exacerbates the influence of such factors.

Method

Overview

The proposal here involves firstly working with teachers to formulate two questions they wish to obtain student feedback on based upon areas the teachers perceive to be strengths and weaknesses. Feedback on these and two other standard questions will be obtained in real time from students intermittently during a mathematics lesson. After the lesson the collected data will be analysed with the teacher, followed by a short semi-structured interview to collect data on the teacher's experience of the process and their views on its utility.

The TTML project has recruited teachers from three clusters of Victorian schools. The clusters are located in Berwick (a burgeoning outer suburb in a growth corridor 45 km South East of Melbourne), Malvern (a well established inner suburb 5 km East of Melbourne), and Geelong (a regional centre 80 km South West of Melbourne). The project was designed to run over the course of three years, incorporating regular professional development meetings for participants.

Participating schools belonged to either the State or Catholic sectors, with considerable levels of support for the project being shown from within the Victorian Government Department of Education and Early Childhood Development and the Melbourne Catholic Education Office. The TTML project targeted the middle years of schooling (Years 5 to 8). Fifteen of the participating schools are primary schools and three are secondary colleges.

Teachers from one TTML cluster of schools will be invited to take part in this study, consisting of approximately 15 teachers, with levels of experience ranging from first year out through to several decades of teaching practice. The pool of potential teachers is predominantly female with approximately 30% of participants being male.

Teacher Feedback Questions

It was hoped that having teachers reflect on their practice and being able to test their assumptions would be of interest and benefit to the participating teachers. Teachers often have a strong sense of what they do well and where they struggle, so this approach would provide them with an opportunity to obtain student feedback directly and quickly.

To these ends teachers were asked to think about and nominate two areas they would like feedback on from their students – one which they felt catered to a strength of their teaching (e.g., I relate well to the students), the other which addressed an area they felt less confident with (e.g., I struggle to explain fractions clearly). These areas of interest would be expressed as two questions that teachers could have their students answer every five minutes throughout a lesson. For example the two areas suggested above might become;

1. How well do you think Ms Teacher understands your learning needs right now?
2. How well do you now understand what Ms Teacher has been explaining?

The number of questions posed is not restricted by any technical consideration per se, but rather by the desire to minimise the disruption to the flow the lesson by maximising the speed with which students can provide their responses. It is also possible to vary the response rate from every five minutes to any other interval, or to have the responses triggered by the teacher directing the class to submit their data, or having students control their own response rates. These options will be discussed with teachers as possible variations after the initial set of data has been collected, including the possibility of having students nominate questions for the class to provide feedback on.

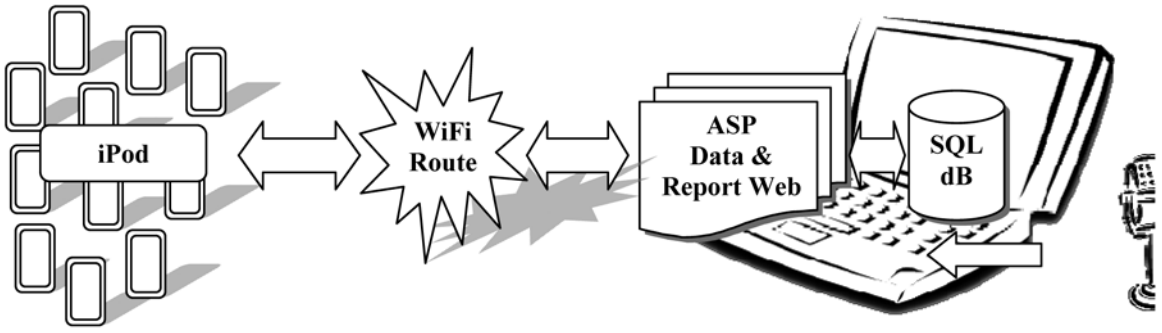

Figure 1. Diagram of the relationships between hardware and software components of the RTFS.

Once the teacher questions have been formulated, they would then be loaded into the Real Time Feedback System (RTFS). This consists of a web page hosted on a laptop computer which can be used to serve the page to a set of 25 iPod Touch devices via an 802.11g Wireless (WiFi) router located in the classroom. Although any portable browsing device would be suitable, the iPod Touch has a unique navigation interface whereby the

entire surface is a touch sensitive screen that can be zoomed in or out as desired by either tapping the screen, pinching thumb and forefinger together, or spreading thumb and forefinger apart. Each iPod is configured to browse the locally hosted web page so that each student could be given an iPod to use and to respond by tapping on a visual Likert scale as prompted. The data submitted by students will then be processed by a web application utilising Active Server Pages (ASP) and stored in a relational database also hosted on the laptop. Various triggers and stored procedures within the database enable an administrative web page to produce web based reports that can present the student feedback in graphical formats. Audio of the lesson would also be recorded onto the laptop to provide a timeline for subsequent analysis.

Given the novelty of the iPod devices, it will be important to ensure that students are given an opportunity to familiarise themselves with the navigation system and to have a chance to explore the device generally prior to formal data collection. The iPods ordinarily have a number of other features and functions that have been disabled for the purposes of the project, restricting them to web browsing capabilities only.

A set of other ASP web pages are incorporated into the system as a means of inducting students into the use of the iPod navigation interface. These pages have simple instructions that give immediate feedback when students succeed or fail to tap the correct section of the screen. It will be possible to track student progress on these induction tasks and offer additional assistance as required until all students have mastered the requisite navigation skills. As it may not always be possible to conduct the reflection, induction, data collection, and analysis in a single day it may sometimes be necessary to spread them across two, ideally consecutive, days.

During the feedback sessions students will be provided with the iPods at the start of the mathematics session and given the opportunity to refamiliarise themselves with the browser interface having gone through the navigation induction previously. They will be assured that all of the data they submit will be completely anonymous, and that the iPod will flash every five minutes to remind them to submit another set of answers.

Two additional standard questions are included in the RTFS to collect data on how interesting the students are finding the lesson, and how hard they feel they are trying. It should be noted that the emoticons used as Likert prompts are animated gif images rather than static images.

Others have used technological prompts previously, as reported in Moore, Prebble, Robertson, Waetford, and Anderson (2005) wherein individual students were given tape recorders which played tones every few minutes during a lesson. These audio prompts signalled for students to make entries on an accompanying paper and pencil instrument. The chief difference between such approaches and the RTFS is that the data is also collected, collated, and processed by the same technology which delivers the prompt.

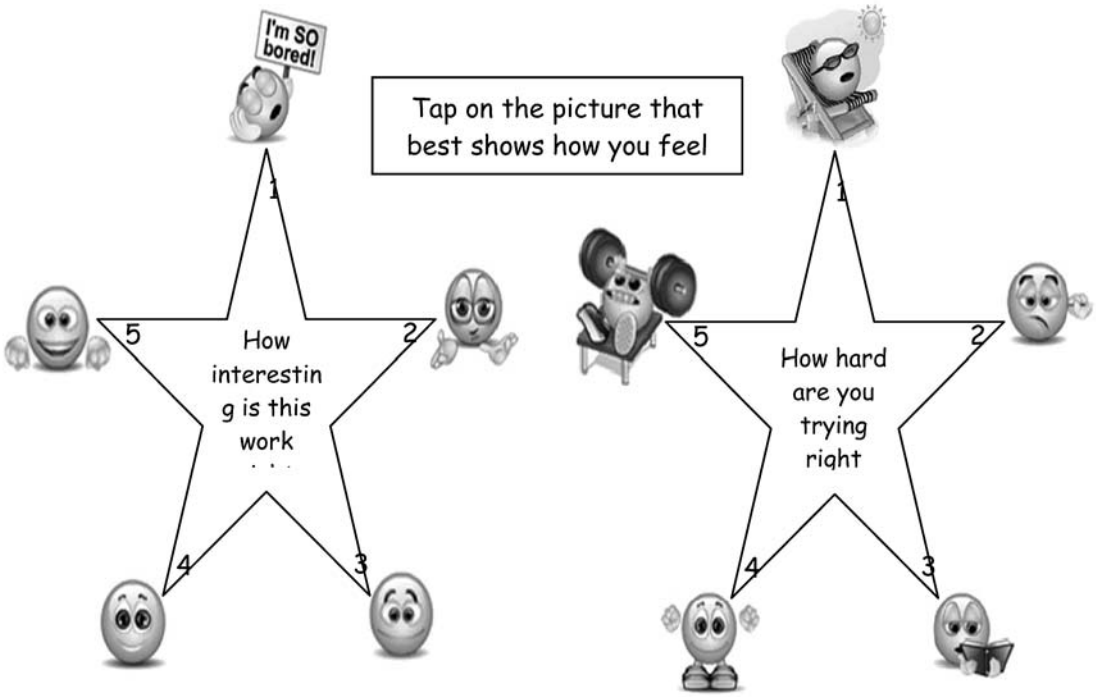

Figure 2. Samples of feedback screens from RTFS.

Analysing and Discussing the RTFS Results

Upon successful collection of student feedback, it will then possible to spend some time going through the data collected with the RTFS. The overall aim of this analysis is to have data on hand that the teachers have collaborated in collecting, the relevance of which will be self evident, and provide a grounding in reality for the ensuing discussions. Initial analysis and discussion will centre on the graphs of student responses to the four questions, mapped against what was happening in the class at the time – as ascertained from the audio recording.

It is possible to view the response graphs on the laptop at any stage of the data collection cycle, so it would also be possible for a teacher to monitor student feedback during the lesson itself and modify their teaching as they saw fit, however the intention initially is to reserve analysis until after the lesson has been completed. It would also be possible to display the results to the entire class by using a data projector if this was thought to be of value, or if the question/feedback stimulus warranted it.

Teachers would be given the opportunity to borrow the equipment for further data collection if they find it of interest and/or use, and one possible measure of the usefulness of the RTFS approach could be the extent to which teachers are interested in taking up this offer to explore other configurations such as using live data monitoring, data projectors, or student generated questions.

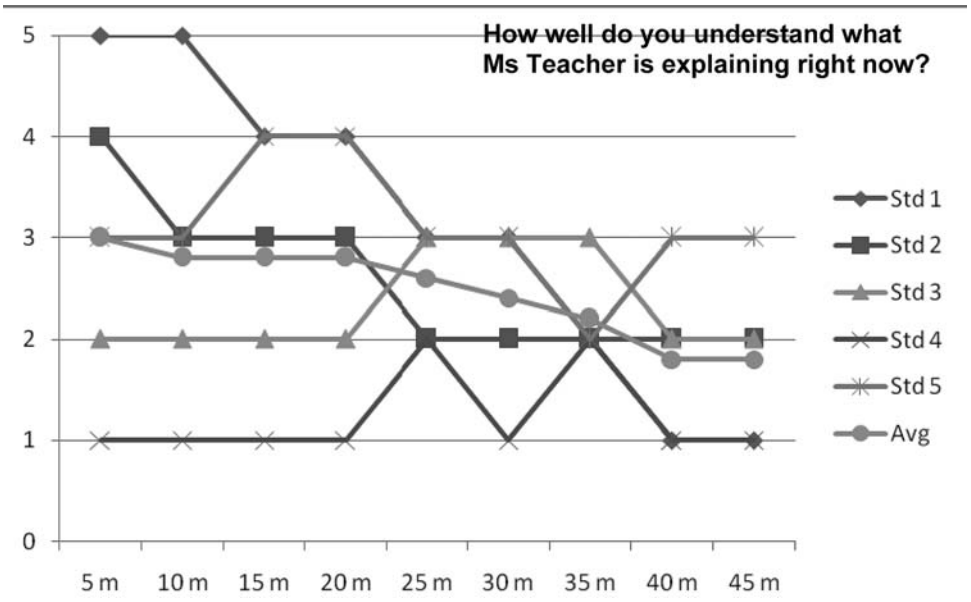

Figure 3. Sample report from RTFS.

The central questions to be explored are:

1. What sense can you make of these results, what do you think we can conclude about your questions?
2. Is there anything here which you find surprising or confusing?
3. How do these responses strike you? Are there any patterns you think are meaningful?
4. Is there anything that you would do differently in light of these results? What obstacles do you think you would have to overcome in making these changes?
5. How useful/helpful do you think this kind of process is in terms of yours or others' professional learning?
6. Could it be made more useful? How? Would live data feedback be of any use to you? Could you imagine using it with a data projector displaying a feedback 'worm' to your class? What sort of situations might that be useful?
7. Would you recommend this to a colleague or would you be interested in borrowing the equipment to run more of your own feedback sessions?

Piloting

At the time of writing only rudimentary testing has been conducted, however a full pilot will have been completed by the time of presentation. It is anticipated that there may be problems with students being overly distracted by the instruments, and as a result the instruments themselves subverting the measurements they are intended to make – a macroscopic parallel to the Heisenberg uncertainty principle.

Although some disruption to classes is inevitable, it is quite likely that students will be less excited by the technology than adults typically are. The rate of technological uptake by students is so high that it is quite possible that many students will have their own iPod Touches or equivalents (Nielsen, 2005). Also by restricting the iPod functionality to web browsing only, and restricting the browsable sites to only those part of the RTFS website, should help to minimise this concern.

Having students contribute questions might be a useful means of harnessing their interest as might be the projection of live feedback results, or displaying a graph of their personal responses and the average response on their iPod after they submit data. It would also be possible to utilise the iPods as dynamic worksheets, using them to provide students with feedback on responses to milestone questions and integrating the RTFS data collection into this process. Interestingly, Moore et al. (2005) found their technique significantly improved the on-task levels and work quality of their subjects, suggesting that the RTFS approach might be adapted to bring about similar improvements in students attending to the mathematics lesson.

In any case, the key purpose of this use of instruments is to provide a vehicle for teacher reflection, so the issue of data accuracy and class disruption is of a second order. Sustained use of the RTFS would rapidly diminish the novelty factor, desensitising students to the recording process, and teachers could have more confidence in the data they collect. The aim of this project is to establish whether using technology in this way holds any promise as an aid to pedagogical reflection.

Conclusion

This nascent nature of this proposal necessarily entails considerable uncertainty about the approach, however the primary goal is to offer teachers a useful tool that will enable them to actively research their own teaching. If successful, this system could prove to be a valuable adjunct to other forms of teacher learning by providing teachers with immediately relevant data to research questions of their own derivation. Arguably any approach that enhances teachers' capacity to reflect on their own practice, based upon empirical data of direct interest to themselves and under their own control, would appear to be worthwhile.

References

Connelly, M., & Clandinin, J. (1995). Teachers' professional knowledge landscapes: Secret, sacred, and cover stories. In J. Clandinin and M. Connelly (Eds.), *Teachers' professional knowledge landscapes*, New York: Teachers College Press, 3-15.

Feinman-Nemser, S. (2001). From preparation to practice: Designing a continuum to strengthen and sustain teaching. *Teachers College Record, 103*(6), 1013-1055.

Moore, D., Prebble, S., Robertson, J., Waetford, R., & Anderson, A. (2001). Self-recording with goal setting: A self-management programme for the classroom, *Educational Psychology*, *21*(3), 255- 265.

Nielsen (2005). *Australia's kids overtake their parents online*. Retrieved March 1, 2008, from http://www.nielsen-netratings.com/pr/pr_050808_au.pdf

Shulman, L. (1986). Those who understand: Knowledge growth in teaching, *Educational Researcher*, *15*(1), 4-14.

Sullivan, P., & Leder G. (1992). Students' influence on novice Australian teachers' thoughts and actions regarding mathematics teaching: Two case studies. *The Elementary School Journal*, *92*(5), 621-642.

Zimmerman, J. (2006). Why some teachers resist change and what principals can do about it. *NASSP Bulletin, 90*(3), 238-249.