

Teacher Professional Learning in Mathematics: An Example of a Change Process

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Debate about changes in teachers' beliefs and attitudes about mathematics teaching leads us to understand that these changes result from a teacher's personal experience. Professional learning in its various forms is an attempt to change teachers' practices in the classroom, and hence influence student learning outcomes. The paper uses the responses of one mathematics teacher involved in a professional learning project to examine the relationship among the professional learning, classroom practices, and teacher beliefs and attitudes.

The Australian Government Quality Teacher Programme (AGQTP) is a federal government flagship initiative for supporting quality teaching and school leadership, with \$300 million allocated to the programme to the end of 2009. The Department of Education, Science and Training (DEST) website states that the programme's "primary function is to fund professional learning activities for teachers under agreements with state and territory government and non-government education authorities" (DEST, 2007). The programme's two objectives are:

1. to update and improve teachers' skills and understanding in priority areas (literacy, numeracy, mathematics, science, information technology and vocational education); and
2. to enhance the status of teaching in government and non-government schools.

The programme was established in 2000 and since then more than "240 000 professional development opportunities have been taken up by teachers" (DEST, 2007, p. 1). This paper examines the impact of the project of one of those teachers involved in a professional learning project funded within the AGQTP programme.

The State of Victoria, Department of Education and Training states that "teacher professional learning can be defined as those processes and activities; formal and informal, designed to enhance the knowledge, skills and capacity of staff" (2007). This can include on-site or at school learning, which may involve formal activities such as mentoring and working in project teams or informal activities such as the involvement in school discussions about policy. Teacher professional learning may also take place off-site or as outside school learning such as conferences, workshops, on-line training, and modular programs over a period of time or network activities. The State of Victoria, Department of Education and Training conducts programs such as the Principles of Learning and Teaching (PoLT) and state "the initiative provides a structure to help teachers focus their professional learning" (2007). It aims to "capture the essence" of effective learning and teaching as well as providing a basis for teachers to review and develop their teaching practices. The teacher who is the focus of this report participated in a teacher professional learning model that occurred on-site at her school. The model is based around a mathematician in residence (in this case the author who acted in a role as a mathematics educator) providing a form of mentoring. The professional learning model consisted of three week-long visits spaced throughout a year in a rural Victorian primary school. Some

background to the two key elements underpinning the professional learning, teacher change and reflective practices, are described in the following sections.

Teacher Change

Teacher professional learning programs are an attempt to bring about “change in the classroom practices of teachers, change in their beliefs and attitude, and change in the learning outcomes of students” (Guskey, 1986, p. 5). As presented in Figure 1, Guskey proposed an ordered framework to help better understand trends that appear to “typify the dynamics of the teacher change process” (p. 7). This model proposes that change is a learning process for teachers largely determined by their experiences in the classroom. If their experience results in a change in student learning outcomes Guskey proposes that the teacher then uses this to make a judgement about the effectiveness of their teaching. Guskey found when teachers see students attaining higher levels of achievement as a result of a new programme or professional learning then possibly, although not always, there is significant change in the teachers’ beliefs and attitudes.

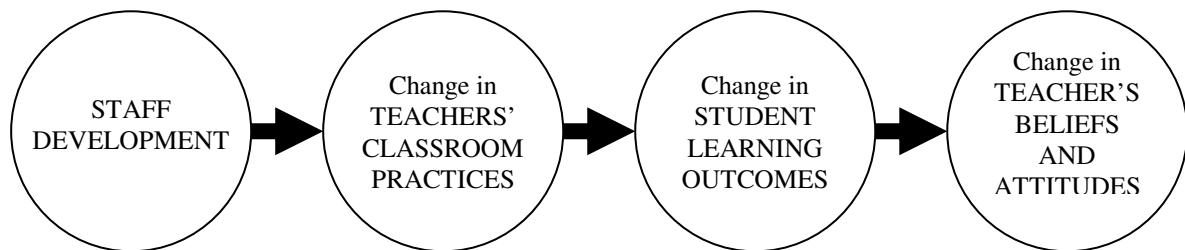


Figure 1. A model of the process of teacher change (Guskey, 1986).

This developmental sequence is reflected in other studies of teacher learning. Brown and Renshaw (2006) argue that change in teaching practices requires teachers to negotiate with past pedagogy, while maintaining the useful skills and techniques that work, and dispensing with the techniques that do not work. This change in teachers’ pedagogical practice takes time (Guskey, 1986; Higgins, 2002, 2003; King & Newmann, 2001, 2004; MacGilchrist, Myers, & Reed, 1997). It seems that for change to occur in teaching, pedagogical professional learning needs to be on-going and requires continual support to be sustained.

This model, in which Guskey argues that teacher’s beliefs and attitudes are developed largely from classroom experience, fits the process developed by the school in the presented case study. In the case of the school, it was felt by the principal that there was a need for teacher professional learning as a vehicle to improve students’ Achievement Improvement Mentoring (AIM) test results and student engagement in mathematics. The teacher professional learning model developed by the principal and the mathematician in residence presented new ideas, theories, and activities for the teachers to try with the support of the mathematician in residence. The teachers tried these in their classrooms to see what happened, and in some cases there were perceived improvements in student learning and motivation. More ideas were tried, and classrooms as well as students observed. It was hoped that after a period of time (initially it was thought in excess of three

years) change in students learning outcomes and perhaps teachers' beliefs and attitudes may be observed.

Reflective Practice

The second component of the process adopted by the school as key to the teacher professional learning model, relates to the reflective practice by the staff in professional partners with the support of the mathematician in residence. Pritchard and McDiarmid (2005) state that one of the key components within effective teaching and professional development is reflective practice. This is the deliberate act of “reviewing and critically thinking about practice with the purpose of increasing learning opportunities for students and teachers” (p. 433). McDuffie (2004) argued that reflective practice is distinguished from “thinking back” to a process which requires teachers acting on their reflections resulting from when a difficulty or a problem has been experienced. In the case study of the school, reflective practice was implemented with teachers, their professional partners and the mathematician in residence. It is these reflections that can lead toward the development of a professional learning community as teachers critically examine and reflect on their practice individually, in groups and as a whole staff. Reflective practice provided the support for teachers in this case study to make changes in their classrooms, and in this paper the case study of one teacher illustrates that it was through this reflective practice that the teacher found a tool in facilitating change. Willis (2002) states that “teachers need to learn how to analyse practice – both other teachers’ practice and their own” (p. 2). The teachers in the project were provided with the opportunity to view other teachers and classes, as well as spending time discussing and reflecting with professional partners and the mathematician in residence about their own learning and teaching experience. Stigler (2002, as cited in Willis, 2002), argued that to analyse means one needs to think about the relationship between teaching and learning in a cause-and-effect kind of way. This is compatible with the Guskey (1986) model in which change in student learning outcomes is a result of a change in teacher’s practices which in turn is a result of staff development or a teacher’s own learning. Hence it can be interpreted that student learning is related to teachers and teacher learning.

The Professional Learning Project

The teacher professional learning project at the basis of this report is centred on an external critical friend termed in the project “mathematician” in residence, conducting teacher professional learning, visiting classes, observing specific lessons, teaching model lessons and team teaching with staff as required. The role expanded to include attending staff meetings and conducting professional learning sessions at these meetings. In this case mathematics was the focus, but as the project developed it is clear that it could be implemented in any or all subject areas. This particular AGQTP project involved three week-long visits to a school in rural Victoria spaced throughout the year. Rather than a random and ad-hoc approach during each of the visit weeks, a timetable was developed and teachers were paired with professional partners, which they selected from their peers. For each teacher, a half hour was spent with the external critical friend prior to each lesson to be observed, discussing the lesson and other concerns or interests regarding the teaching of mathematics. Then a lesson of approximately one hour was taught, with the external critical friend and professional partner viewing and participating as appropriate. After the

lesson, a half an hour (or more) was spent reflecting on the lesson with the external critical friend and professional partner. The aim of the model was to promote teacher learning, with an individual focus on goal setting. This would hopefully lead to changes in the classroom which result in changes in student learning outcomes. A longer term goal was a change in teachers' beliefs and attitude may also be attained.

During the initial phase of the project one of the teachers called Belinda indicated her desire to change her teaching methods and practices in mathematics through her written and verbal comments. It is her journey of her perceived change that is presented in this paper – a single study within a larger study of ten primary school teachers. It is noted that there are significant practical and ethical issues associated with methods of researching change in teachers such as, what is the actual change, how has this change occurred and was this change permanent.

The data collected and presented in this paper are predominately written and verbal responses, as well as comments made by Belinda throughout the project as her process of change is examined. Methods included written observations, written comments and reflections by Belinda and transcripts from video footage as the author was involved in the methodology of design research. Sometimes these responses were prompted with questioning whereas other responses were of Belinda's own reflections. A survey of 25 statements adapted from Barell (2003), which required teachers to respond with a ranking of 1 – 5 (hardly ever – often) on a Likert scale, was implemented at the beginning and at the end of the project. In this paper the survey results are only used to support Belinda's comments.

One Teacher's Response to the Professional Learning Initiative

Belinda is an experienced teacher who has been teaching in excess of 15 years. She has taught at all levels from Prep to Year 6 and Belinda has been a leading teacher and acting principal at different times during her teaching career. She seems confident and involved in school life as is exemplified by her involvement in another project at the school that focused on rich assessment tasks and students expressing their learning and understanding. It is through this involvement that Belinda seems willing to learn and seeks opportunity to do so. From observation, she is a quiet and thoughtful member of staff, and is well respected by the staff and the principal who readily seek her advice.

The case study of Belinda attempts to examine the changes in Belinda's beliefs and attitudes in response to this particular AGQTP project. The data collected focussed on:

- Belinda's initial feelings about the project and how a mathematician in residence may impact on her teaching.
- What impact the professional learning had in terms of changing classroom practices?
- Was there a change in student learning outcomes?

Although the project had only been running for a year, an open mind was kept to see whether there was an indication of the above factors leading to a change in Belinda's beliefs.

Initial Response

At the beginning of the project, three questions were posed:

- How do you feel about having a mathematician in residence?
- How do you feel about having someone coming to view your teaching?
- Would you prefer to attend external professional development?

Belinda's responses to these initial three questions indicated that she supported the concept of having a mathematician in residence and was looking forward to the experience. Belinda wrote:

a mathematician in residence would get to the nitty gritty of what was happening [in her classroom] and what was needed and hopefully real change and progress in both teaching and learning would be attained.

Belinda saw the process as being an advantage for the students by having “an expert on hand” and she was looking forward to “having someone who could watch the kids with me and help me evaluate both their needs and my teaching practices”. She was not worried about having someone in her classroom viewing her teaching, although she did admit that she would be a “little uncomfortable, nervous and apprehensive” as she was not as confident in teaching mathematics and she was also returning to Year 5/6 after a number of years with younger students. Belinda felt that having someone in the classroom would allow the person to work with her and her students. She felt that “a mathematician in residence would get to the nitty gritty of what was happening and what was needed and hopefully real change and progress in both teaching and learning would be attained”.

All teachers were asked to respond via email to the question “After the first week of the mathematician in residence, how do you feel about the project?” Belinda responded with:

After a week working with Pauline [the mathematician in residence] I feel extremely positive about the project. Any apprehensions I had re Pauline watching my teaching proved false as she always concentrated on the positives and had heaps of suggestions on anything I asked about. She also followed up on things immediately and has already emailed suggestions. I have tried several already and can't wait to share them on her return. She was very insightful about the kids learning and was aware of the direction our school wanted to head, as directed in our charter. Pauline also took the lead from the teachers' concerns and needs. She became very much part of our team during the week, which was appreciated by everyone. I found it interesting to go into another teacher's classroom, to participate in a lesson as that is not a possibility often afforded to teachers. The discussion from that experience was also valuable for my teaching.

Belinda's initial feelings of apprehension were dispelled as she seemed to see the advantages of the mathematician in residence for her teaching. The professional learning Belinda had experienced in the form of a full staff development day, as well as the professional partner experience, particularly the reflection and discussion, had already resulted in change in Belinda's classroom practices as she attempted new ideas. These changes were positive as she was keen to share her experiences and continue the learning process. In other words, the discussion about practice, the practical ideas and the observations of the other teachers, all created an apparent openness for Belinda to consider her practice.

Developing Ideas

Throughout the project Belinda seemed open to ideas and tried many new activities with her class. She introduced partner tables games and table tests that the students make up themselves. She wrote “they love (tables) Bingo. I think they are improving their skills also.” Belinda was experiencing positive changes with the students as a result of changing her classroom practices. This was also reflected in her comment “their favourite topic for the term was BODMAS”. One student wrote “It was a whole new thing for me and I was good at it.” Belinda also wrote “I still need to work on negative attitude and motivation to Maths. Comments from the students such as ‘that wasn’t Maths it was fun!’ were offered.” Although some changes in classroom practice had occurred, Belinda still felt that changes in student outcomes were only developing. She wanted to see greater improvements in student attitudes across the whole class. Although Belinda had examples of positive student attitudes, she still felt that overall student motivation and attitude needed more time and perseverance. This is where Guskey’s model could be seen as cyclic as Belinda sought more ideas and strategies through professional learning as she set about making changes in her classroom practice in an attempt to improve student attitudes and motivation. Belinda’s personal goal for the year was student attitudes and this became part of the drive in Belinda’s professional learning. Belinda maintained focus on this goal throughout the year, and this is reflected in Belinda’s evaluations and reflection of her involvement in the project.

Reflection

Some of the best insights into Belinda’s experience were gained at the end of the project therefore, the final reflection component of the project is introduced here. The last day of the project was one of reflection and looking forward. Each staff member was asked to reflect on the project and their own learning. Teachers were asked to prepare a written piece to bring to the last session. Sentence starters and questions were provided or teachers could just write about their experience. Belinda wrote a piece not based on any of the prompts, and this proved to be a great insight into Belinda’s learning. Two main components of this reflective piece will be explored in this section: goal setting and Belinda’s reflection on her own teaching.

Goal Setting

Belinda found the goal setting component of the project helpful.

It made me think about my teaching by setting goals, talking about why I set them and then putting them into practice.

This was a new experience for many of the teachers in the project as they were asked to set large project goals about their own learning, and Belinda’s was to motivate her students. She indicated that this was “still a work in progress”. This perhaps indicates that not all Belinda’s attempts at change were positive and new ideas were continually being tried. This is where Guskey’s model could be cyclic as staff development is on-going as teachers’ classroom practices are continually adapted and refined, leading towards a particular or desired change in student outcomes. As well as project goals, teachers were also asked to set lesson goals and Belinda found the lesson goals to be useful as “I feel I consistently set small goals for each lesson and am achieving them more consistently.” This goal setting is a change in Belinda’s practice as prior to the project: lesson and

personal goals were not being set. The goal setting component of the project continued to provide aims and direction for teachers, providing them with motivation within the project. It was also hoped goal setting would establish some of the sustainability of the project, which would be a change in teachers' practice and perhaps their beliefs as goal setting would be seen as a worthwhile tool in teaching.

Belinda's Reflection: My Teaching

Belinda explained that the professional learning “enabled me to see other teachers in their classrooms, it allowed me to see an expert model lessons at my level and other levels, and most important of all it pushed me to improve my teaching and achieve my goals.” When asked how she improved her teaching, Belinda indicated that she learnt that mathematics needed to be more “real” and that “students need to see a purpose in all that they do” in the mathematics classroom. This was also evident in the survey in which Belinda had ranked the statement “One of my goals is ensuring that students understand and can apply mathematical concepts to life experiences” as high. She felt that students “need to have ownership of the activities” and “that many activities need to have a ‘fun’ element”. Belinda’s perception about improvements in her teaching resulted from positive experiences in her classroom due to new ideas and changes she made. According to Guskey’s model this would result in a change in student learning outcomes. Belinda felt that she had seen an overall improvement in student attitude and motivation. This also came in the form of feedback from her professional partner viewing her class. This acted to reinforce the changes in Belinda’s beliefs and attitudes, particularly her involvement in the project as it continued strongly for another year, and she expanded it into other subject areas such as Science. Belinda noted that:

my own maths teaching is changing in that I try to make activities more real, I involve the students more often in composing and assessing the tasks, I try to include games on a regular basis, I am trying to set more open tasks that students of all levels can tackle and I am becoming more of a facilitator rather than a stand out the front teacher.

When viewed in the first teaching session at the beginning of the initiative, Belinda modelled the “stand out the front” style of teaching where she was driving the lesson, questioning and reflection. The lesson on patterning, felt like a “one off” and no references were made to previous lessons or prior knowledge or learning. During the last teaching session of the project Belinda facilitated a lesson on graphing, in which previous learning was brought into the lesson. The task of drawing a graph was open-ended and students shared their learning during the session and at the end of the lesson they completed a self assessment rubric. Although it could be argued that the final lesson could have been carefully planned to exhibit the “correct” elements of a lesson, Belinda taught her lesson at short notice due to a change in the time table for the week. Also, the questions that students asked could have been responded to with single word answers, however Belinda guided the students to find their own answers by referring to previous lessons in their maths books and looking up information in a “big book” the class had created. Belinda was exhibiting many of the changes she felt had occurred, such as acting as a facilitator and linking the lessons so that the students could see the purpose of the different lessons within the mathematics classroom.

Reworking the Model

Guskey's model argues that change in teacher practice occurs before change in beliefs, and indeed change in practice occurs before changes in orientation. It seems, however, that the model presented by Guskey (Figure 1) is a simplistic representation of a much more complex process. Indeed, although the model presented by Guskey is linear, the actual process seems to be cyclic (see Figure 2). The model presented in Figure 2 is an alternative for the conception process of teacher change. This proposed model shows the change in teachers' classroom practices is a result of on-going teacher learning. This teacher learning has the aim of a change in student learning outcomes. This is a process which is slow and on-going and requires time and the continual input of teacher learning. It is this more complex model that appears to apply to Belinda's situation, as it is the on-going teacher learning that is contributing to change in student learning and a resulting change in Belinda's beliefs. Like Guskey's linear model (Figure 1) it is after a significant or desired change in student learning outcomes is attained, that perhaps a change in the beliefs and attitudes of teachers may be observed. Guskey (1986) mentioned that it was only when teachers used new ideas *and* gained evidence of positive change that changes occurred in their beliefs and attitudes. Belinda continued to try new ideas to attain goals set for student outcomes as she reflected on her own practice. It was after much professional exploration of her teaching that Belinda began to see results in student outcomes and hence felt a shift in her own teaching practice and beliefs. So it seems staff professional learning needs to be ongoing and changes in teachers' classroom practices supported before positive changes are seen in student learning outcomes, which then may result in a change in teacher's beliefs and attitudes.

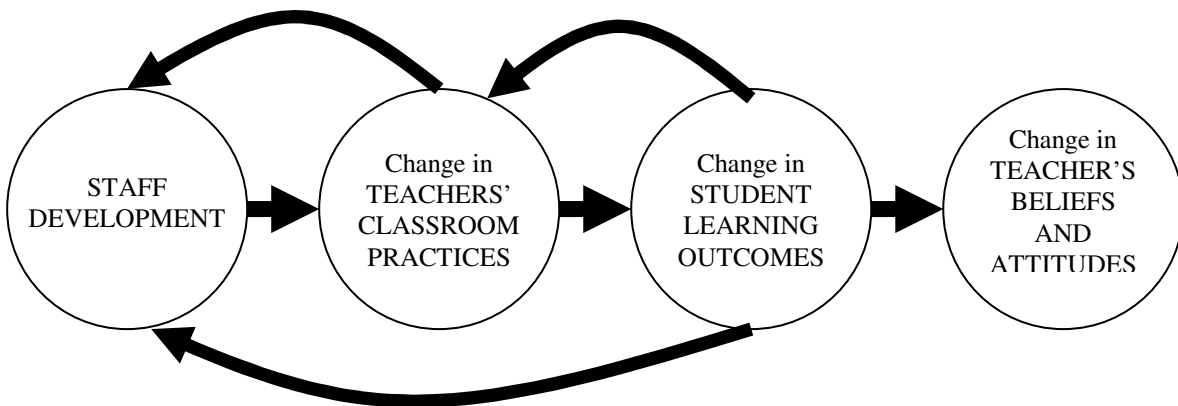


Figure 2. Alternative model of the process of teacher change.

This proposed model has implications for teacher professional learning. It implies that some teacher professional learning needs to be on-going over a period of time and may not reflect an immediate change in student learning outcomes. Teachers need time to implement changes in their classrooms and critically reflect on these changes and those in student learning. This implementation of professional learning and reflective practices can be supported with a person such as a mathematician in residence, who can offer a different

view on the learning taking place. On-going professional learning may need to occur before desired or positive changes in student learning outcomes take place. It appears that it is only when these changes are seen to be positive or having results in student learning that a change in teacher beliefs and attitudes may take place (Guskey, 1986).

Belinda's story is a single study within a larger study of ten primary school teachers. Recommendations for further study include more case study analysis to test the rigour of the proposed alternative model presented in Figure 2 and further case study work with Belinda to examine if there has been a true and on-going change in beliefs and attitudes.

Conclusion

Belinda had identified areas of her teaching that she wished to change such as making activities for her students more “real”. From the beginning of the project, Belinda supported the concept of a mathematician in residence, and she looked forward to examining her teaching practices in her classroom from both a teaching and learning perspective. Belinda took ideas from the professional learning discussions, as well as observations of other classes and adapted suggestions from the reflective discussions about practice and implemented these in her classroom. These resulted in a change in Belinda's classroom practices as she attempted new ideas.

Belinda also found the goal setting component of the project useful as she set both lesson and personal goals, a practice she had not previously used. This goal setting aided in the reflective practice of the professional learning project as Belinda and the other teachers involved in the project analysed both their own practice and that of their peers. Belinda found through this professional learning experience, a tool that helped her facilitate change in her own classroom. The implementation of these new classroom practices, such as the goal setting, led to slow and gradual changes in student attitudes and motivation. As this change in student learning outcomes was gradual, Belinda continued to re-evaluate her own teaching.

Guskey (1986) argued that changes in practice precede changes in beliefs, and it may be that changes in practice precede changes in orientation. It seems Belinda feels that she has changed. Belinda now sees herself more as a facilitator than a “stand out the front teacher”. She has made changes to her teaching and classroom practices that have provided some positive results in both students' attitudes and motivation. This change has been gradual and has encouraged Belinda to continue her own learning and to make different changes in her practice as she looks for improvements in student learning and attitudes. This indeed supports Guskey's model that a change in beliefs occurs from a positive change in student learning outcomes resulting from changes in classroom practices due to professional learning. However, this process appears to be cyclic in nature rather than linear as many changes in practice may need to be made and the professional learning ongoing before a change in student learning outcomes observed.

It is proposed that Guskey's model is cyclic rather than linear as it appears that continual professional learning needs to be experienced to allow teachers to try new ideas in their classrooms and time to reflect and evaluate the resulting student learning outcomes. If these student outcomes are not of or to a teacher's expectations, then further strategies may need to be implemented as a result of further professional learning. In the case of Belinda, she attempted new ideas in her classroom and after a period of time some change in student attitudes was noted; however, Belinda wanted a change across her class, so she tried new strategies as a result of ongoing professional learning. This process continued

throughout the year and as the results in the student outcomes in Belinda's class improved, she found her own teaching and beliefs were also changing. The responses from Belinda supports Guskey's argument that it is when teachers use new ideas *and* gain evidence of positive change that a change may occur in their beliefs. It appears that these changes in student learning outcomes need to be positive before a change in teacher's beliefs and attitudes is observed, and it appears that this may be a result of on-going professional learning and a cyclic interpretation of Guskey's model.

References

- Australian Government Department of Education, Science and Training, Australian Government Quality Teaching Programme. <http://www.qualityteaching.dest.gov.au/default.htm> accessed 17/01/07
- Barell, J. (2003). *Developing more curious minds*. Alexandria, VA: Association for Supervision and Curriculum Development.
- Brown, R., & Renshaw, P. (2006). Transforming practice: Using collective argumentation to bring about teacher change in a year 7 mathematics classroom. In P. Grootenboer, R. Zevenbergen, & M. Chinnappan (Eds.), *Identities cultures and learning spaces* (Proceedings of the 29th Annual Conference of the Mathematics Education Research Group of Australasia, 99-106). Sydney: MERGA.
- Guskey, T. R. (1986). Staff development and the process of teacher change. *Educational Researcher*, 15(5), 5-12.
- Higgins, J. (2002). *Evaluation of Advanced Numeracy Project 2001*. Wellington: Ministry of Education. Te Kete Ipurangi website: http://www.tki.org.nz/r/literacy_numeracy/professional/evaluation_anp.pdf.
- Higgins, J. (2003). *Evaluation of Advanced Numeracy Project 2002..* Wellington: Ministry of Education. Te Kete Ipurangi website: http://www.tki.org.nz/r/literacy_numeracy/professional/evaluation_anp2002.pdf
- King, M. B., & Newmann, F. M. (2001). Building school capacity through professional development: conceptual and empirical considerations. *The International Journal of Educational Management*, 15(2), 86-93.
- King, M. B., & Newmann, F. M. (2004). Key link. *Journal of Staff Development*, 25(1), 26-28.
- MacGilchrist, B., Myers, K., & Reed, J. (1997). *The Intelligent School*. London: Paul Chapman.
- McDuffie, A. R., (2004). Mathematics teaching as a deliberate practice: An investigation of elementary pre-service teachers' reflective thinking during student teaching. *Journal of Mathematics Teacher Education*, 7, 33-61.
- Pritchard, R., & McDiarmid, F. (2005). Promoting change in teacher practices: Investigating factors which contribute to sustainability. In P. Grootenboer, R. Zevenbergen & M. Chinnappan (Eds.), *Identities cultures and learning spaces* (Proceedings of the 29th annual conference of the Mathematics Education Research Group of Australasia, pp. 432 - 439). Sydney: MERGA.
- State of Victoria, Department of Education and Training, *Principles of learning and teaching P – 12 (PoLT)*. <http://www.sofweb.vic.edu.au/blueprint/fs1/polt/default.htm> accessed 4/01/07
- State of Victoria, Department of Education and Training. *Professional Learning*. <http://www.sofweb.vic.edu.au/pd/tchdev/index.htm> accessed 4/01/07
- Willis, S. (2002). Creating a knowledge base for teaching: A conversation with James Stigler. *Educational Leadership*, 59(6), 1-3.