

Exploring avenues of reflective practice with pre-service Mathematics teachers

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Pre-service teachers participated in peer and self assessment activities during a seminar series focused on current issues in mathematics education. Their feedback comments to each other and the various assessment forms they used were analysed to determine what changes took place in what they perceived to be important issues, how the quality of their comments changed over time, what they felt they learned from peer and self assessment, and how they developed in their capacity to reflect critically.

Introduction

Notions related to teachers as 'reflective practitioners' are not new in education, and their importance in the personal and professional development of teachers has received considerable attention by researchers and teacher educators (for example, see LaBoskey, 1994; Posner, 1993). Further, one of the five areas of competence explicitly emphasised in the recently released Australian *National Competency Framework for Beginning Teachers* (Australian Teaching Council, 1996) is that of "Reflecting, Evaluating and Planning for Continuous Improvement". The purpose of this study was to investigate how these 'reflective' processes can be developed with pre-service teachers through involvement in peer and self assessment activities. This 'assessment' avenue for exploration of reflective practice was chosen for two main reasons: (i) it provides opportunity for individuals to experience first-hand some of the 'alternative' assessment practices that recent trends and research in mathematics education support, and (ii) it is different and less time intensive than the common practice of using journals for reflection, thereby providing an avenue for reflection which it was believed people would be more committed to and would find more accessible. In addition, since the activities to be assessed focussed on issues of current concern in the mathematics education community (for example, multicultural classrooms), the assessment and related research program allowed examination of development of pre-service teachers' awareness of mathematics education issues. Specifically, the study focused on the following three research questions:

1. What types of feedback and evaluative comments do pre-service teachers provide when given opportunities to assess their own and their peers' teaching?
2. How do pre-service teachers' capacities to give feedback and constructive criticism develop through involvement in a peer and self assessment program that itself is continuously evaluated and revised?
3. What are pre-service teachers' reactions to involvement in a peer and self assessment program?

Considering the challenges teachers will encounter in their profession, including dealing with students from diverse cultural, language, geographic and socio-economic backgrounds, for ongoing improvement of teaching it is essential for teachers to have capacities to reflect, on and communicate about, their practice. Effective mechanisms by which these capacities can be developed in pre-service teachers at more than a superficial level, and in the context of authentic teaching tasks, need to be examined and understood. This study took steps towards addressing these challenges in ways that would be perceived by the pre-service teachers themselves as valuable and realistic, and in ways that address issues surrounding mathematics teaching and learning in today's society.

Theoretical Framework

A major impetus for this study was the research and development project, the National Project on the Quality of Teaching and Learning (NPQTL). The research-based and teacher-centred development of the resultant *National Competency Framework for*

Beginning Teachers (Australian Teaching Council, 1996) thereby provides validity for an emphasis on reflective practice in teacher education programs. While the *Framework* provides an expression of the need to develop reflective competency and some indicators to aid recognition of this competency, it does not articulate a mechanism to ensure its development. It was with this issue in mind that this study was developed.

A second area of research that informed the focus and development of this study was that of the 'reflective practitioner' literature. This field encompasses teacher education as well as professional development in a wide range of endeavours (for example, see Dewey, 1933; Schön, 1983; Brookfield, 1995). Reflective practice can be conceived of as a collection of strategies that are used as a mechanism to induce teacher growth (Frid, Reading & Redden, 1998). They range from deliberation about the practical aspects of teachers' work to critical appraisal of the meaning, in a moral or ethical context, of the teaching activities. The process of reflection requires explicit and deliberate action as distinct from impulsive action or action required by bureaucratic decree. Also contributing to the framing of this study was LaBoskey's (1994) conceptual framework for reflective teacher education in which the act of reflection is viewed in terms of content, processes, attitudes and teaching conditions. The first three of these categories are reflected in the foci of the research questions, while the conditions are determined by the context of this particular research setting (topical issues in mathematics education).

Finally, the research literature further supported the notion of development from practical to more global concerns in the work of Furlong & Maynard (1995). After working with pre-service teachers, Furlong & Maynard postulated the existence of a developmental path. In this path each of the four stages of development is characterised by a shift in the focus of teacher concern. They assert that initially teachers model themselves on others without considering the implications of their own practice, while in the second stage they focus on themselves as teachers with a concern about their skills and how these skills appear to others. Movement to the third stage then requires a shift from focusing on oneself as teacher to a focus on students as learners. The final stage of development is characterised as autonomy in which the focus shifts to exploring the theoretical underpinnings of one's actions as an educator. This four stage model served in the present study as a guide or framework for exploring shifts in LaBoskey's (1994) notions of content, processes and attitudes that occurred for pre-service teachers involved in reflecting on the mathematics related teaching activities of themselves and others.

Method

A cohort of 120 third (and final) year teacher trainees in a primary school Bachelor of Teaching program were the focus of the study. These students represented regions of the country in which there is often a strong presence of people of aboriginal descent as well as an increasing presence of persons of non-English speaking backgrounds. They were undertaking a compulsory course in mathematics education which has the aim of developing a set of theoretical understandings that could be used to support teaching activities in mathematics classrooms. For example, ideas related to various learning theories in mathematics, and various teaching and assessment practices. As part of the course, the students were required, via a seminar series, to explore ideas related to a number of current issues in education. The current issues included multiculturalism in the mathematics classroom, aboriginality, gender, attitudes towards mathematics, the role of language in mathematics learning, and consideration of the needs of gifted and talented students. The seminars were presented to tutorial groups of approximately 30 students by sub-groups of 3-4 members. It was the evaluations of the seminar presentations that provided the data source for this study.

To provide feedback and an evaluation for each seminar presentation an iterative process was developed. Each seminar group and supervising lecturer provided comments and a mark out of ten on a weekly feedback form and the presenting group of students used these evaluative comments to prepare a presenting group seminar report.

The presenting group also had to design a new feedback form for use in the following week by the next group of presenters. This process was repeated through eight iterations. No attempt was made to provide communication and sharing between the four tutorial groups, nor was there any formative evaluation shared between the lecturers involved in supervising the groups. Hence the data were seen as independent across groups. This provided a restricted form of triangulation to the study. The claim of triangulation is however limited since no guarantees can be made that the students did not share experiences outside of the classroom with students from other tutorial groups.

As a consequence of the above design the data for this study consisted of eight by 120 individual weekly feedback forms, eight by four group seminar reports and eight by four designs of weekly feedback forms. In addition, all students in the study were surveyed at the end of the semester to ascertain their views of the process. This survey data also provided triangulation of previous findings.

The analysis of the predominantly qualitative data involved three phases which could be described as exploration, integration and confirmation. In the exploratory phase the data from three of the tutorial groups were analysed by the relevant lecturers independently of the other lecturer. Specifically, the lecturers aimed to identify categories for students' evaluative comments, typical examples of reflective comments, what appeared to induce or inhibit reflection, and evidence of any longitudinal development in the identified categories. These independent analyses were synthesised in phase two of the data analysis. This integration process required vigorous discussion and clarification of category definition until a consensus between the lecturers was reached and the concepts were well understood by the other lecturer. Thus, the process provided to the analysis a degree of inter-coder reliability. In the final phase the emerging conceptual framework was tested with the data from the fourth tutorial group to provide confirmatory support for the two earlier data analysis phases.

Results

Data analysis provided the following information concerning the three research questions.

Types of Feedback and Evaluative Comments

Much of the feedback provided was superficial in quality in that it focused on whether or not particular aspects of the seminar were included, rather than commenting on the nature or impact of these aspects. For example, when asked to comment on 'What worked well' students often wrote such things as "the brainstorming activity", or "good pace", or "well organised". Similarly, when asked to comment on 'appropriateness' they said such things as "everything was appropriate", "very appropriate for the topic", "yep" and "good".

Early in the semester, comments were generally lacking in substance, consisting of single words or short phrases related to what students thought was 'good' or 'bad'. An extreme example in this regard is the student whose entire written responses to eight prompt items on a feedback sheet appeared as follows: (prompt items that appeared on the feedback form are indicated in italics)

Appropriate: very beneficial

Group encouraged: at times

Originality: yes

Preparation: well prepared

Class participation/class management: everyone involved

Useful strategies provided for future use: yes

Were presenters enthusiastic?: yes

Appropriateness of materials: good

Although these comments are brief, they give some superficial feedback on the seminar when read in conjunction with the item prompts. In comparison, more elaborate comments, although relatively few in number, included such things as “made us think about differing strategies” and “very effective in demonstrating the different attitudes [towards mathematics] that teachers/students can develop”. An example (from Week 2) of more extensive feedback than was generally given by students is:

What worked well?

Introduction - great, got us interested & illustrated the point well.

Eg task - Teddy bears. Purposeful, prompted discussion and cooperation & we had ownership of learning.

- attention from presenters good - they went around the room and talked to us about what we're doing & why.

- regularly changing presenters - everyone contributed & seemed to know what they were on about.

- all points & info were related back to the topic [attitudes towards mathematics] - didn't get off track.

In general, the comments made by students showed a greater tendency to praise than criticise, and when criticism was given it was not always constructive. However, constructive criticism, although not as extensive in nature, was sometimes evident. An example (from Week 1) of a student's feedback that included constructive praise and criticism is:

Good structure, I liked the way you had the lesson plan on the board, so we knew which direction we were heading in.

A bit more time perhaps [could be] spent on giving instruction to the group, especially the writing task.

Use of games was great, and very appropriate. Perhaps analyse games into appropriate year levels.

Overall, the comments tended to fall into three main categories: presentation skills, teaching methods, and content. These categories are consistent with LaBoskey's (1994) conceptual framework for reflective practice.

Comments on presentation skills, of which there were many, included such aspects as level of voice, quality of overheads, and organisation and involvement of group members in the presentation. The comments on teaching methods, more likely to be given when the methods were 'different' or 'original', tended to mention various approaches used such as brainstorming, case studies, games, work stations and role play. Most comments on content were concerned with very simple summaries of what was presented in the seminar or identification of particular content areas of interest. Whenever the quality of the content was mentioned it was generally only to the extent of whether it was “good” or “interesting”. Typical comments included:

We went through different maths curriculum from the ages. (Week 1)

Had a brief talk on language & maths. Then looked at Reading & Writing & Talking & Listening and did some activities and came up with some Teaching Strategies. (Week 2)

Gender issues is a somewhat controversial/interesting topic. (Week 4)

Good list of things to do with ESL students' difficulties. (Week 4)

Web sites excellent idea. (Week 6)

On occasion students presented one or more of these components in conjunction with supportive reasons. Comments involving any sort of synthesis of components of the seminar were sparse and mostly focused on the usefulness of the seminar

presentation. Occasionally there was some identification of personal benefit to be gained. Examples are:

Good to talk about ESL etc so that everyone knows a little bit of background. However, maybe it would have been better if it was related more to maths. (Week 4).

The resources that [Rachel] showed us and the ideas that we came up with were really good. These were useable in a classroom situation. I would use some of the resources in my classroom for the benefit of all the class not just ESL or Aboriginal students. (Week 4)

Few of the students appeared to have made the transition from a focus on the practicalities of teaching to a focus on student learning as described by Furlong & Maynard (1995). That is, although there was some shift towards a focus on the impact of the seminar on their learning about mathematics teaching and learning issues, it did not become a major focus.

Another aspect of the students' feedback was the quantitative evaluation of each seminar by a mark out of ten. These assigned marks generated some speculation, discussion and ill feeling. Students repeatedly expressed in informal discussion concerns about the ability of peers to be objective and discriminating. Others felt that the actual mark should be assigned by the lecturer, not the students. Thus, in spite of workshop, lecture and seminar experiences aimed at broadening students' concepts of mathematics assessment tasks and the role of the teacher in a 'constructivist' oriented classroom (ie. the teacher as *not* being the sole authority), students did not easily change from their previous views.

Development of Ability to Provide Feedback and Constructive Criticism

Evidence of students' development in these areas was examined in relation to two components of the seminar process: the changes to the weekly feedback forms and the reports prepared by the presenting groups.

Changes made to weekly feedback forms: The changes made by students to the format of the weekly feedback forms highlighted a number of aspects. The structure of the items included changed as the weeks progressed. Initially students used one word or a short phrase for a prompt item (ie. a category or question to which the evaluators/students were to respond). For example, one Week 2 form had six items for student response, five of which were one word such as "Research" and the other was the short phrase "Use of Resources/Relevance". As the weeks progressed more items were included, and they became longer in structure and more of them were worded as questions. By Week 6 seminar groups were producing forms that were almost entirely comprised of questions as prompts. However, an overall examination of the sets of feedback sheets indicated that by the end of the seminar series a balance had been struck between the shorter and longer prompt items and between statements and questions.

The content of the items included also changed as the weeks progressed. Most items included on the earlier forms pertained to presentation skills or teaching methods. For example, items such as "organisation", "preparation" and "Was the seminar entertaining?" allude to presentation skills while "discussion", "activities" and "original" invite comments on teaching methods. There was a later shift to inclusion of items related to learning, such as "Did the seminar have a practical use for the classroom?" (Week 7). However, even the final weekly feedback forms for each group still had a high proportion of the items related to presentation skills and teaching methods and very few items suggestive of a concern with participants' learning about mathematics or issues related to mathematics teaching and learning.

Overall, more items on the form or the length of the items did not necessarily lead to more in depth or comprehensive feedback by the students. However, aspects of

changes in the forms did indicate some development of the ability to provide feedback and constructive criticism. The changing structure, balancing questions and statements, of the items suggests that students were attempting to develop tools that they felt were most suitable for providing useful feedback. Of note is that the content of the items changed from predominantly presentation skills and teaching methods to inclusion of some references to actual learning. The overall impression that the forms' development gives is that students' focus of attention changed from the specific mechanical aspects of the seminar to the impact and usefulness of the seminar.

Report prepared by presenting group: The presenting group seminar report produced each week as a result of reading the feedback from fellow students varied greatly in quality. The simplest was a summary of good and bad points from the seminar as identified by peers' comments. Many reports merely listed peers' comments, arranged under the categories provided by the prompts on the feedback forms. Students often listed their peers' feedback comments without any attempts to summarise, categorise or integrate them. Further, there was no attempt to reflect upon the appropriateness of the feedback in light of the thoughts and reflections of the participants themselves. That is, although students were instructed to "summarise" their peers' feedback and to "reflect" upon the seminar by considering their own perceptions and reactions to the presentation, this seldom occurred.

The few reports of a higher quality showed some evidence of self-evaluation, evaluation of the seminar presentation experience, or reflective analysis of peer feedback. For example, part of one group's report was the following:

We feel that by having four work stations with three different activities at each station we provided a wide variety of activities that were well received. Due to time restrictions we realised that students would only be able to visit three stations. Structuring the seminar so that no one missed out on a station would have been ideal but was not possible in the time allowed. This was compensated for by the handout giving a brief description of all the activities. Our planning of the number of activities was ambitious but by sticking strictly to our timetable we finished within two minutes of the scheduled time.

It must be noted that this sort of more detailed, comprehensive reporting was rare, and when it did occur it was consistent with the lecturers' perceptions of the students. Thus, it must be concluded that the value to students' reflective capacities of preparation of the presenting group seminar report must be questioned. The reports did not appear to provide a mechanism by which the students were enabled to develop reflective analysis skills. Hence, a weak feature of the entire seminar process was that only the four presenters benefited from the feedback each week. A better process would involve all students having access to the group seminar reports each week. In this way more material would be available to encourage and support development of reflective actions.

Reactions to Involvement in the Peer and Self Assessment Program

Comments made by students on the end of semester survey showed that they identified both strengths and weaknesses of the seminar evaluation process. These were mostly global comments such as: "It was helpful to hear what your peers thought". In a few cases comments on aspects of both teaching and learning were reported. An occasional comment focused on the learning aspect of the process: "Great idea. You look at the seminar in a different way, more as a teacher. What works and what doesn't, and at the same time you are learning." On the more specific question relating to the issue of receiving feedback from peers, most students felt it was a useful process despite drawbacks such as lack of anonymity of comments and lack of effort by some students.

Students were divided on the benefits of producing a group report on the evaluations produced by their peers. Some saw the process as worthwhile, as it helped

them to reflect on possible improvements for their teaching. However, there was a general lack of support for the idea of a follow-up group report, and this appeared to result from the degree of effort or commitment to the process rather than from a problem with the process itself. That is, students indicated they had not entered whole heartedly into the process, making comments such as: "Was difficult as a group, we left it up to one person. Workload has caused it not to be done."

This apparent lack of commitment to the task was supported by students' responses to the end of semester survey item for which they were asked to indicate on a 5-point Likert scale the degree of effort they put into "recording your thoughts/comments about each seminar". For each of the four tutorial groups the mean score fell between "little" and "some". In comparison, when asked to report similarly (ie. on a Likert scale) their "effort" put into "thinking about what is happening in each seminar" the mean score for each of the groups fell between "some" and "much". This indicates that some students were making a superficial effort at reflection, while overall students had not accepted either the concept of professional growth, or the role of reflection in promoting professional growth. The issue seems to be associated with the observation that it is not enough to provide an opportunity for developing the skills associated with reflection because the value of reflection needs to be explicitly developed. In making these rather 'negative' observations it needs to be said that some students had indeed recognised the value of the process of reflection, making comments such as: "It would defeat the purpose of peer evaluation if we did not consider the information given us." However, overall there was little evidence of a commitment to the process of reflection except at a relatively trivial level. Certainly there was no evidence of what has been described in the literature as 'critical' reflection.

Many students thought the process of changing the evaluation form was worthwhile, but they were unsure of the quality of the forms produced. This might have been due to the difficulties students experienced in revising the form. For example, they expressed much indecision in determining criteria on which to base changes. Additionally, there appeared to be an equity issue in which students found it difficult to understand how consistency in criteria for awarding grades could be achieved with a constantly changing evaluation form. An example of a comment in this regard is: "Changing criteria could have led to marking problems or inconsistencies." These sorts of comments indicate that students were more concerned with a 'fair', norm referenced assessment system.

Further support for this view was provided by the emphasis students placed on the system of awarding marks. While appreciating the opportunity to hear the views of their peers, many thought that the lecturer should provide the final grade. It was as if the lecturer was a superior who was the sole source of 'valid' grades. These beliefs are indicative of Furlong & Maynard's (1985) lower stages of teacher development and do not reflect the 'autonomous teacher' stage in which lecturer and student collaborate on an equal basis. Nearly all students were 'troubled' by the suggestion that they should calculate their mark by finding the mean of the marks awarded by their peers.

Conclusions

Students' seminar presentations displayed capacities to use a range of teaching methods appropriate for mathematics learning (eg. brainstorming, hands-on activities, group work, discussions, writing tasks). There was however little evidence that students had 'integrated' the foci of the study, the use of peer and self assessment and the use of reflection as a learning tool, into their personal repertoire of teaching and assessment strategies. Considering the research findings in the context of the conceptual frameworks outlined previously, some additional tentative conclusions can be drawn. First, with regard to the National Competency Framework, there was little indication that these beginning teachers would meet the criteria specified for "Reflecting, Evaluating and Planning for Continuous Improvement". Second, it would appear that there is a need to address explicitly the value, content and processes of reflective practice if students are to

be supported in their growth to shift from a focus on mere teaching skills to a focus on student learning and the overall contexts of mathematics education.

A number of issues for further consideration arise from the findings of this study, including:

1. The degree to which 'time' as well as the nature of experiences is a factor in the development of reflective capacities needs further examination. It was not expected that the time frame of this study would be sufficient for substantial progress to be made by students, but it was also not expected that progress would be so minimal in either the quality of the seminars presented or the nature and extent of reflective skills developed. Although students had a range of experiences both at university and in the classroom upon which to examine topical issues in mathematics education, they did not appear to have developed much capacity to do so. Hence, the degree to which the total time frame of a student's pre-service education impacts upon the extent of progress also needs further examination.
2. Implicit in the design of this study was an assumption that ideas and skills in one area of education (eg. alternative assessment ideas in mathematics education) might 'transfer'. Also, there was an assumption that skills involved in analysis of others' teaching transfer to self-analysis capabilities. The nature of such transfer, and in fact the validity of such assumptions, need further consideration because they did not appear to happen to any degree in this study.
3. Students' attempts at reflection were more superficial than those that had been expected. Their lack of reflective capacities, in spite of previous experiences, is indicative of the non-triviality the reflective process and the non-triviality of the mathematics education issues selected. In addition to being provided with activities focused on developing specific reflective skills, students need to develop an awareness of the value of reflective practice, be it related to mathematics education issues, or any other area of education. Development of reflective capacities is 'hard work'.
4. Related to issue (3) above, yet worthy of independent mention is the notion of the 'valuing' of reflective practice. That is, this study highlights that, to effectively develop students' reflective capacities, an awareness of the value of reflective practice needs to be developed. This notion could be linked to, or seen as a subset of, LaBoskey's (1994) attitudinal dimension.

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