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Constructivism and Reflective Practice in Practice: Challenges and Dilemmas of a Mathematics Teacher Educator

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Constructivism has framed many mathematics teacher education practices in the last decade, yet has ultimately not had substantial impact on classroom practices. Using empirical and theoretical evidence from research with my own pre-service primary teachers, I examine some reasons for this lack of impact, particularly in relation to: (a) a gap between teacher education and school classroom practices, (b) a potential conflict between teacher educators' views and pre-service teachers' own views of their learning, and (c) a neglect to examine the discourses within which educational practices are constituted. The challenges these issues pose for mathematics educators are highlighted, along with possible avenues for future developments and inherent educational dilemmas.

As a mathematics teacher educator who also strives to be a reflective practitioner, I continually endeavour to examine 'what works' in my teaching and 'what is actually learned' by pre-service primary teachers. Trying to determine answers to these questions has been a multi-faceted task that has included examination of the research literature in mathematics education, action research and reflective practice, ongoing trialing of 'new' content and teaching formats, observations of students in class and on school practicum placements, analysis of student work samples, discussions with colleagues, formal teaching evaluations and analyses of survey and interview data. In this paper, the key aspects of this journey are outlined and the contradictions that arise when one uses different perspectives to consider what students actually learn are analysed. The assumptions upon which my own and other mathematics educators' curricula have been built are examined, particularly with regard to constructivist pedagogical approaches, and possible pathways forward from the dilemmas I have faced are considered.

Constructivism in Mathematics Education

Constructivism has been embraced by many teacher educators around the world (e.g., Klein, 1999; Steffe & Gale, 1995) and its underpinning ideas are evident in current mathematics curriculum documents (e.g., Australian Education Council, 1991, 1994; National Council of Teachers of Mathematics, 1989, 2000). These trends and reforms have advocated constructivist views of learning and teaching as avenues by which to design and implement mathematics curricula that engender learning with understanding. From a constructivist perspective, learning is a result of one's construction of knowledge through active cognitive and social engagement in one's experiential world (von Glasersfeld, 1991, 1995). This engagement involves individual interpretations of, and reflection upon, physical and mental activity so that one creates viable and adaptable cognitive schemata and ways of acting in the world (Wood, 1995). Thus, in contrast to a view of learning as transmission of facts, concepts and skills in a ready-made fashion from teacher to students, a constructivist perspective explicitly acknowledges that students will learn different things as a result of the 'same' learning activities and experiences. This is because the experiences are not actually the 'same' – they are interpreted and acted upon differently by different people as a result of differing prior knowledge and experiences, learning styles, perceptions, goals, and a range of social factors.

The pedagogical implications of constructivism are that teachers should act as facilitators who provide appropriate activities and support for students to personally construct meanings, rather than receive them ready-made from the teacher (von Glasersfeld, 1995). Teachers need to recognise that students' actions, ideas and errors indicate their current state of understanding, and from the students' perspectives these are sensible and logical (Wood, 1995). Further, teachers need to design learning activities that engender "periods of conflict, confusion, surprise, over long periods of time, during social interaction" (Wood, 1995, p. 337). The related classroom environment should encourage creativity, problem solving, exploration and sharing of ideas. In the context of a mathematics teacher education classroom this would also include a focus on construction of knowledge of how children learn mathematics and how to design appropriate teaching/learning activities and environments to support this learning.

Since the textbooks in use in primary mathematics teacher education adopt a constructivist perspective (e.g., Bobis, Mulligan, Lowrie, & Taplin, 1999; Reys, Suydam, Lindquist, & Smith, 1998), the view of children's learning that is explored is dominated by constructivist learning theory. Constructivism, as a theory of learning, is explicitly outlined in ways that stress viewing children's learning as being a social process (in dialogue with themselves as well as others) of active creation or invention through "reflecting on their physical and mental actions" (Reys et al., 1998, p. 19). Emphasis is placed on principles for teaching and learning activities that foster exploration of mathematical concepts and processes through the use of concrete objects, real world experiences and discussion. The teacher is not viewed as the sole knowledge authority who tells children how they are to think about concepts or perform particular procedures, but rather, as someone who designs activities to provide children with opportunities to build their own meanings and understandings. In this process, children's thoughts and talk about mathematical experiences are viewed as essential. Further, children's prior knowledge, or 'where they are at' in their learning, is explicitly acknowledged as a key factor in what they subsequently learn because it impacts upon how they interpret experiences. Thus, the textbooks detail activities that make extensive use of manipulatives, investigation, small and large group discussion, and student-generated questions and explanations. Drill and practice is presented as a means for consolidating meaningful ideas and skills, rather than as a primary method of mathematics learning, and assessment is presented as a means of determining what children know and understand, rather than what they can mimic.

There have also been studies into the role of constructivism within teacher education. The extent of this research and related implications for practice have not been as pervasive. However, a clear factor that has emerged as relevant is the role of teachers' beliefs. Research about teachers' beliefs about mathematics and mathematics teaching and learning has grown considerably and has taken many directions (Raymond, 1997). In a review of the field, Thompson (1992) highlighted a need for further studies into the relationships between beliefs and actual classroom practices. While it is generally agreed that these relationships are complex and are influenced by a range of cognitive, psychological and social factors (Raymond, 1997; Cooney, Shealy, & Arvold, 1998), the nature of the links is not yet well understood. There is some evidence that the actual classroom practices of beginning teachers are inconsistent with their espoused beliefs about how they should teach (Brown & Borko, 1992). There is also evidence that pre-service teacher education courses do not ultimately impact substantially upon subsequent practice (Ensor, 2000; Foss & Kleinsasser, 1996; Zeichner & Tabachnik, 1981). This final issue is a concern because it undermines what I do as a mathematics teacher educator – if my teaching has so little impact upon what students actually do in classrooms, then how might I change my philosophy, frameworks, or teaching and assessment practices to improve the eventual outcomes? To begin with, it needed to be established what students were learning from my courses.

A First Examination of Learning within a 'Constructivist' Teacher Education Classroom

The research literature, as well as personal experiences, support the claim that many primary teacher education students have negative attitudes towards mathematics as a result of their own school experiences (Biddulph, 2000; Schuck, 1996; Van Zoest, Jones, & Thornton, 1994). Recognising this, along with the fact that I have very limited time with students during their pre-service education, a main goal of my teaching is that I empower students by providing them with opportunities to develop more enriching views about mathematics and the teaching and learning of mathematics. I intend for them to partake in activities in my classes that allow them to experience how mathematics can be taught in meaningful, stimulating and enjoyable ways. In weekly 2-hour small group workshops (25-30 students), as well as in lectures and student-led seminars, they are involved in a range of activities from across all syllabus strands (NSW Department of Education, 1989). They are also asked to consider the role in teaching/learning of constructivist learning theory, problem solving, manipulatives, language, culture, gender, calculators and other technology. Much of the time they work in small collaborative groups (2-4 students), which gives them ongoing opportunities to share ideas and talk about what they are doing. In whole class discussions they are also encouraged to share ideas and learn from one another. I provide the initial activities, sometimes purely mathematical in nature and at other times more related to syllabus use and lesson planning, and then they explore and work with ideas by themselves. During this time I ask questions or sometimes I make comments.

I see the pedagogical environment students experience in my classes as 'constructivist'. It is constructivist in that I provide opportunities for students to explore ways in which mathematics learning can be supported by the use of manipulatives, interactions with peers and communication of ideas, and in particular, these experiences are 'hands-on' as students themselves partake in or design model activities. Students are often asked to reflect on 'what they have learned' in class, either in whole class discussion or through short written activities, and often they are asked to relate this learning to their own school mathematics learning or their school practicum experiences. In this way, their prior knowledge of mathematics teaching and learning is explicitly acknowledged as a key influence upon their current learning. I see my teaching role in this context as that of a facilitator because I do not see myself as an expert who must somehow transfer to my students a wealth of knowledge about mathematics teaching and learning. Instead, even though I sometimes 'tell' things to students, I aim for them to build for themselves a range of understandings and skills for effective mathematics teaching.

Recognising that, according to the literature, if teachers are to teach mathematics in a constructivist manner then they must hold beliefs about mathematics teaching and learning compatible with this perspective, I sought to determine what beliefs my students held. As part of a small research study, funded through an internal research grant scheme, both survey and interview data related to students' beliefs about mathematics and mathematics teaching and learning were collected in 1997. The population under examination constituted first year, second semester students enrolled in a 3-year Bachelor of Teaching degree. They were all enrolled in the first of two compulsory semester-long units in primary mathematics curriculum and instruction.

The students (N = 74) completed a questionnaire at the beginning and end of the semester that focused on their beliefs related to the nature of mathematics, mathematics teaching, and mathematics learning. Following previously tested frameworks for examining these beliefs (Goos, 1995; Mayers, 1994; Perry, Howard, & Conroy, 1996; Schoenfeld, 1989), and sometimes making use of identical or similar items, a 40-item, 5-point Likert response (strongly agree to strongly disagree) questionnaire was designed. It was then pilot tested with another group of first year pre-service primary teachers (N = 24) for feedback on the wording of items and how they were interpreted. In addition, a volunteer sample (N = 14) participated in interviews near the end of semester in which they were asked to share their ideas about mathematics, how children learn mathematics best, what they see as the role of a good mathematics teacher, and how they felt the unit had impacted upon them as developing teachers. Although volunteers, the interview sample was representative of the full cohort of students with regard to gender (3 males and 11 females), final grade distribution in the unit (high distinction = 2, distinction = 3, credit = 6, pass = 2 and failure = 1) and enrolment status (2 mature age students and the remainder with less than 2 years since completion of high school). The interviews were conducted by a research assistant so that the data collected and related findings would have more validity (i.e., the students' responses could have no impact upon their final grade in the unit). The interviews lasted 45-60 minutes, and they were audio-recorded for later transcription and analysis using QSR NUD•IST.

From the questionnaire data (Frid, 1998; also see Table 1), it was found that students did not strictly hold the stereotypical views of mathematics that the research literature implied (e.g., that mathematics is rules and procedures, is right or wrong, and there is only one way to do things). Students' beliefs at the end of semester shifted towards being even less stereotypical (see Table 2).

Table 1
Pre-test Responses to Questionnaire Items on Mathematics Teaching and Learning (N = 74)

Item No.	Item	Pre-test Distribution SA	A	U	D	SD
18	Teachers should provide problem solutions and answers when they are not in the back of the book.	22	39	11	2	0
24	Teachers should let students determine if their methods and answers are right or wrong.	5	38	24	6	1
20	Good mathematics teaching involves class discussion in which students share ideas and negotiate meanings.	27	43	4	0	0
26	Good mathematics lessons progress step-by-step in a planned sequence towards the lesson objectives.	20	44	8	2	0
28	Students should be encouraged to build their own mathematical ideas, even if their attempts contain much trial and error.	18	49	7	0	0
35	Students learn mathematics by being shown the correct ways to interpret mathematical symbols, situations and procedures.	14	45	12	3	0
29	Being able to memorise mathematical facts and procedures is important for maths learning.	6	46	18	3	1
36	Mathematics learning is enhanced if students are encouraged to use their own interpretations of ideas and their own procedures.	6	50	14	4	0
30	Calculators can assist mathematics learning by serving as tools for exploration and consolidation of ideas.	11	42	17	4	0
37	Students who have access to calculators learn to depend on them and do not learn computational skills properly.	11	30	26	7	0

Note: SA = Strongly Agree, A = Agree, U = Undecided, D = Disagree, SD = Strongly Disagree.

Table 2
Post-test Responses to Questionnaire Items on Mathematics Teaching and Learning (N = 74)

Item		Post-Test Distribution				
No.	Item	SA	A	U	D	SD
18	Teachers should provide problem solutions and answers when they are not in the back of the book.	16	41	6	8	3
24	Teachers should let students determine if their methods and answers are right or wrong.	11	38	18	7	0
20	Good mathematics teaching involves class discussion in which students share ideas and negotiate meanings.	42	32	0	0	0
26	Good mathematics lessons progress step-by-step in a planned sequence towards the lesson objectives.	11	42	11	10	0
28	Students should be encouraged to build their own mathematical ideas, even if their attempts contain much trial and error.	33	38	3	0	0
35	Students learn mathematics by being shown the correct ways to interpret mathematical symbols, situations and procedures.	11	42	15	5	1
29	Being able to memorise mathematical facts and procedures is important for maths learning.	3	36	17	17	1
36	Mathematics learning is enhanced if students are encouraged to use their own interpretations of ideas and their own procedures.	28	37	9	0	0
30	Calculators can assist mathematics learning by serving as tools for exploration and consolidation of ideas.	32	41	0	1	0
37	Students who have access to calculators learn to depend on them and do not learn computational skills properly.	6	14	16	31	7

Note: SA = Strongly Agree, A = Agree, U = Undecided, D = Disagree, SD = Strongly Disagree.

For their beliefs on mathematics teaching, students generally simultaneously held ‘constructivist’ as well as some more ‘traditional’ views, and these shifted slightly towards constructivism at the end of the semester. Similar findings emerged for students’ beliefs about mathematics learning. A tentative conclusion was that students’ beliefs reflected knowledge of ways that teaching could foster children’s mathematics learning in meaningful and empowering ways. The findings from the interviews further supported this statement. In fact, they were considered to substantiate it well because, in contrast to the questionnaire data, interview data were obtained in an open-ended fashion. Students were not given ‘ideas’ or ‘categories’ to respond to, but rather, categories were identified inductively during the NUD•IST analyses. The NUD•IST analyses of the interview data, after ongoing refinements and revisions, yielded the tree diagram of Figure 1.

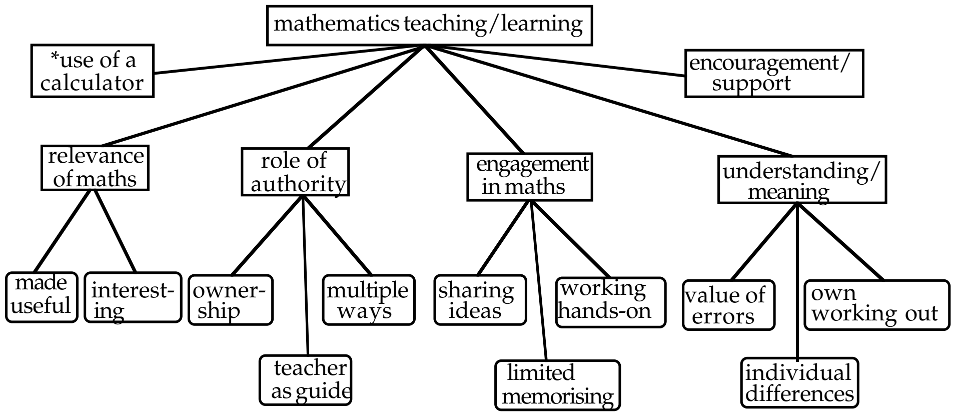

Figure 1. Emergent categories for students' beliefs about mathematics teaching/learning.

The emergent categories (nodes) were determined on the basis of having had at least half of the interviewees give a description or detailed account of constituent ideas defined to comprise a node. For example, the following interview transcript extracts are samples for a selection of nodes:

[relevance of maths – interesting]

…I think that's how kids learn to hate maths, personally, if they're just drilled, drilled. I know drill is good, but give them a break. Let them colour in a shape and tell you what the shape is or let them do something else that they may not know is mathematically centred, and then you can go back the next day and do the addition and things like that. Don't make it monotonous. (Natalie)

[engagement in maths – working hands-on]

I think physical objects in maths are vital, like having things to work and touch and do things with helps, makes it so much easier to understand anything. …I mean I always knew they were there, and they were lots of fun to work with. But I didn't realise how much easier they made learning new concepts and reinforcing old concepts. (Doris)

[role of authority – multiple ways]

…if you can show the students that there are lots of different ways to look at the same question, then the student isn't limited and I think they'll be able to understand a lot more, instead of thinking that there are proper ways and only one way of doing things. (Danielle)

[encouragement/support]

Teachers should question what students have done, without knocking them, and they should also be encouraging when a student comes along with a bright idea. And I think it should be more spread across the classroom, that each child has done something creative in mathematics. (Mindy)

[understanding/meaning - own working out]

> People tend to be able to do things the way they figure it out, the way they find the easiest for them. And the way they find it the easiest is normally the way they figure it out themselves. That's where teachers giving them their own time to do trial-and-error to try to work it out for themselves. Even though they explain it to them, what they are supposed to do, some people still don't understand that. And by giving them the chance to find their own problem solving methods, they can actually solve it better, and in the end possibly link it up. (Melody)

It appeared students had been developing constructivist-oriented views about mathematics teaching and learning. For example, there was awareness and valuing of the need for children to build their own ways of making meaning of mathematical experiences (e.g., Mindy and Melody); there was recognition that learning activities need to relate to children's prior knowledge and real world experiences (e.g., Natalie and Doris); and there was recognition that children (not just the teacher) are capable of developing 'authority' (e.g., Danielle). It acknowledged that students' emerging 'constructivist' views were also likely to be related to their experiences in other units, particularly since other curriculum areas use constructivist perspectives. In addition, the NUD•IST analysis of their views about their experiences in the unit revealed they felt they had changed over the semester in two main ways, by learning (a) about what mathematics teaching and learning is all about, and (b) that mathematics can be learned in fun ways. The question that remained was whether or not students' beliefs were reflected in their school practicum practices.

An Examination of 'Learning in Action' on the School Practicum

Informal observations made in the same semester with third year students on a 10-week practicum indicated that many student teachers were using fairly traditional approaches to mathematics planning, teaching and assessment. Much of their mathematics planning and teaching appeared to be derived from textbooks and worksheets, with much emphasis placed on performance of basic arithmetical skills or recognition and recall of basic information (e.g., naming things). Children were allowed to talk to one another while completing individual work, but there was little evidence to indicate this was aimed at fostering or monitoring students' thinking or development of mathematical meanings. Use of concrete materials was interwoven into activities, but it did not appear, at least at a preliminary observational level, that children were learning much of the underlying mathematics. They were actively doing things and keeping busy, but it was not clear if mathematical connections were being made. There appeared to be an assumption by the student teachers that 'doing things' automatically leads to appropriate mathematical learning. They did not seem to see that for a teacher to act as a facilitator for children's construction of knowledge requires one to focus on what students already know and are able to do, and what they say and do as they are engaged in new activities.

Thus, a colleague and I set out in the following year (1998) to more formally and explicitly study our students' 'learning in action' on the school practicum – that is, the nature of their thinking and actual practices with regard to planning for, implementing, and assessing mathematics learning. We acknowledge that it is not strictly rigorous to make links between the student cohort of the first study (now in second year) and the students in this practicum study (third year students). However, two additional facts are noteworthy in this regard. First, the third year students had undergone virtually the same program with mostly the same instructors. Second, in the subsequent year (1999), observations of and discussions with students on the 10-week practicum (the original group studied, now in third year) were consistent with the formal findings summarised here.

The findings of the study indicated that most of the student teachers (N = 16; all of whom were soon to graduate) operated primarily within what would be considered a direct instruction approach to teaching (Redden & Frid, in press). What is of value in the context of this paper is that the practicum study was designed to obtain observational data as lessons were taught, along with interview data related to the student teachers' intents for and reactions to lessons. In this way, students' underlying beliefs about teaching and learning could be explored in relation to their own as well as an observer's views about what actually happened in a lesson. Within the framework used for data analysis (Figure 2; also see Frid, Reading & Redden, 1998), it was found that students had a strong "focus on oneself as a teacher" (i.e., focus on classroom routines and basic teaching skills). Even when lesson plans or enacted lessons appeared initially to have a "focus on student learning" (e.g. , use of group work or hands-on materials), when one looked below the surface to the student teachers' explanations of *why* things were planned or occurred as they did, a different story emerged. Then, issues concerning a focus on oneself as a 'competent' teacher were prominent (e.g., covering the syllabus or a school's designated program, using one's voice effectively for classroom management and communication, curriculum content knowledge and organising materials efficiently). Little mention was made of the potential impact of the activities or the teacher's actions on children's actual learning. That is, there appeared to be an assumption that appropriate and relevant learning was actually occurring as a result of children's participation in activities provided by the teacher.

Thus, as researchers, we made the decision to share with the student teachers (and the supervising teachers when possible) the full details of the model we were using to frame our analyses (Figure 2). This had been developed from Furlong and Maynard's (1995) research with novice teachers. Our intent was to broaden the student teachers' horizons for their own reflections on their planning and teaching. Subsequently, there was evidence of the student teachers setting goals for themselves that had a "focus on student learning". For example, they said such things as: "I need to clarify how I know when children really understand the concept."

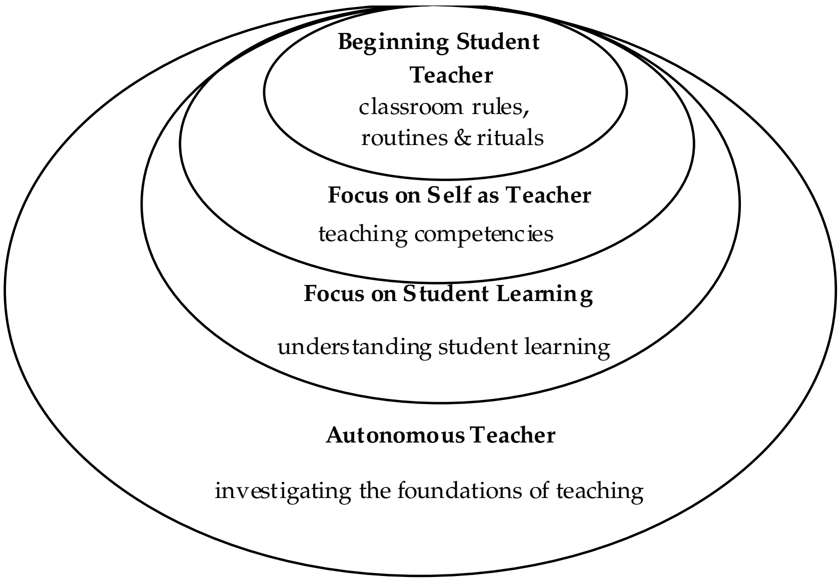

Figure 2. Stages and *foci* of teacher development. (Frid, Reading & Redden, 1998)

It appeared we were able to assist students to begin to make relevant and practical connections between their constructivist knowledge about teaching and children's actual classroom learning. However, in the back of my mind were questions about some of the inconsistencies that emerged in this study as well as in the previous one. To consider myself sincere in my endeavours as a reflective practitioner, I would now have to re-consider and re-search the various findings.

An Alternative Examination of Learning within a 'Constructivist' Teacher Education Program

Three main inconsistencies or enigmas were evident in the research that had initially not been considered problematic: (a) 'contradictions' between particular item responses on the questionnaire, (b) students' references to being 'transmitted' knowledge about teaching from a lecturer or supervising teacher, and (c) how 'successful' teaching is defined. Each of these are outlined here along with alternative examinations of their 'meanings' so that in the concluding section of this paper it can be shown how they are indeed problematic for mathematics teacher educators.

Questionnaire 'Contradictions'

The questionnaire data showed that students generally held constructivist views. There were, however, many students who held simultaneous 'contradictory' views. They strongly agreed with two distinct items designed to be 'opposites' on the questionnaire (see Table 1). The items were adopted from previously trialed instruments that had been designed in the framework of a constructivist versus traditional duality of beliefs. Perhaps a 'duality' was not an appropriate way to view these beliefs, with a 'continuum' being more appropriate, or perhaps the contradictions were due to the ways the items had been interpreted. In either case, the literature had not reported such problems (e.g., Goos, 1995; Mayers, 1994; Perry, Howard, & Conroy, 1996; Schoenfeld, 1989).

From my perspective as the teacher, these 'contradictions' were not initially troublesome because I viewed students' development of constructivist versus traditional ideas as a developmental process that could not be completed during the first year of their pre-service education. Trouble arose when I reflected upon what sorts of things I did or did not do in my teaching, and what that meant in relation to what students see and do during the practicum (a 3 week placement in the first year, at the beginning of the second semester). What I had done in my teaching was emphasise the creative, explorative aspects of children's construction of mathematical knowledge, and what I had not done was give equitable focus to how children might consolidate their ideas or make automatic a variety of skills. Related to this, I had made extensive use of syllabus activities, concrete materials, and hands-on investigation of mathematical concepts, but I had not exposed my students to how typical textbook or worksheet activities – commonly in use in the schools – could be incorporated into similar effective, meaningful mathematics learning experiences. In this way, I had done little to help 'bridge the gap' between what students experienced in my classroom and what they experienced in many school classrooms. Thus, the contradictions from the questionnaire findings could in fact be viewed alternatively, as a merging of the variety of ways the pre-service teachers had been exposed to how children learn mathematics. These pre-service teachers were in fact doing what constructivist learning theory describes as construction of viable knowledge schemata that are built from previous and current experiences.

'Transmission' of Mathematics Pedagogic Knowledge

The findings from the interviews with first year students (Figure 1) indicated students held many constructivist-oriented beliefs about mathematics teaching and learning. In particular, one category that emerged – 'role of authority' – was constituted by views that the teacher is a guide who helps children work with their numerous and varied ideas to develop ownership of mathematics. What was an enigma was that the students did not always apply this same philosophy to themselves. Instead, they looked to lecturers or supervising teachers as authorities or experts who "tell" them what are the correct or best ways to teach. For example, in the practicum study, the student teachers regularly referred to using ideas "given" to them by their supervising teacher. In that way they had "recipes" for lesson activities, and they had classroom management techniques they could "mimic". On a re-examination of the interview data, there was also some evidence (even if not prevalent overall) that some students viewed their learning as a process of being told by the "authority" about principles for mathematics teaching and learning. This can be seen in the following interview extract in which the student does not clearly take ownership of the ideas she puts forth:

> Well we learned in one of the workshops or something, that you never give them the symbols before letting them do things with the concrete materials and I can see how that makes sense, … so I guess that is something I would probably have to keep in mind. (Cathy)

Thus, we see here within teacher education the same apparent dilemma that mathematics teachers face if they adopt a constructivist perspective. We want to avoid "telling" students "answers", and yet we know and they know that we as teachers do possess knowledge that they do not have. In fact, if I reflect critically upon my own teaching, do I not implicitly communicate to students that I do indeed have many of the answers they need? After all, week after week, I determine the topics to be addressed, I demonstrate appropriate mathematics learning activities, I choose which learning theories to consider, and I award grades on assessment tasks. An alternative way to describe my teaching in comparison to what I outlined earlier in this paper is that it is transmission of knowledge. It looks like students are actively engaged in constructing their own mathematics pedagogical knowledge but if they themselves view it as transferring knowledge from the expert to the novice, then have I achieved my goal of empowering them as future mathematics teachers? They have gained knowledge and perhaps a capacity to mimic particular teaching practices, but if they have not also developed capacities to think critically about this knowledge or use it flexibly, then are they in fact empowered? This alternative view of the outcomes of one's own teaching, although perhaps at first unsettling, is enlightening because it can act as a catalyst to explore other ways to approach the situation (as will be done in the concluding section of this paper).

Defining 'Successful' Teaching

In the practicum study, prior to sharing with students the model of Figure 2, students' concerns as developing teachers were with basic teaching and classroom management skills. On further inquiry, it was determined that these initial foci were well aligned with how 'successful' teaching was 'defined' in the practicum by way of the formal evaluation report form (and hence by supervising teachers who must use this report form). In a sense, the evaluation form was putting a ceiling on what the student teachers might achieve. However, when we shared the model with them, it was found that they could broaden their focus to include "student learning" as well as a "focus on oneself as a teacher". Some of the alternatives that need to be considered here arise from whether this shift was a function of exposure to, and genuine consideration of, the model, a product of natural development as a teacher, or an adoption of the lecturer's definition of a successful and competent student teacher.

Whether one of these possibilities is the case, or some other, there are implicit power relations at work. The student teachers, the supervising teachers, and the lecturers are all positioned within multiple discourses, and what counts as "truth" (e.g., what counts as "successful" teaching) is constituted within these discourses (Klein, 1999). Do these individuals recognise that there are power relations at work, and if they do, do they know what one might do to establish empowerment within them? From a poststructuralist perspective, it must also be asked if student teachers could ever be "empowered" by constructivist-oriented pedagogy unless they are given access to ways to deconstruct this (or any other) approach. If this does not occur, then the process could be called indoctrination rather than empowerment. However, avenues by which such awareness of self and social positioning might occur are themselves problematic, and this is true whether it be with regard to defining a successful student teacher, a successful supervising teacher, a successful lecturer, or a successful teacher education program.

Challenges and Dilemmas

As outlined at the beginning of this paper, constructivism as a pedagogical framework in mathematics teacher education has been in use for many years, yet there is not strong evidence that its impact upon pre-service or beginning teachers' practices has been significant or widespread. Some reasons for this lack, highlighted in this paper with reference to empirical as well as theoretical evidence, relate to a gap between teacher education and school classroom practices, a potential conflict between teacher educators' views and pre-service teachers' own views of their learning, and a neglect to examine the discourses within which educational practices are constituted. Challenges for mathematics teacher educators that arise include:

- How might a constructivist perspective on children's learning be used to develop a multiplicity of practices that better bridge the gap between student-centred and more traditional approaches to mathematics learning?
- How might pre-service teachers be guided to be able to recognise and take action upon the underlying assumptions and practices that frame their own or others' views about teaching/learning and their own learning as teachers?
- How might teacher educators use post-structuralist ideas to begin to transform mathematics teacher education?

The school practicum is central within these challenges because they are all underpinned by potential conflicts between what students experience in their teacher education classes and what they might witness in schools. Thus, in my ongoing actions and reflective practices to examine 'what works' in my teaching and 'what is actually learned' by pre-service primary teachers, I am now engaged in trialing and examining teaching frameworks, content and strategies to address these challenges in ways that better bridge the gap between my classes and school practices. Constructivism still underlies these endeavours, and in fact does so in a more encompassing way because there is now more explicit use of reflection upon physical and mental activity related to teaching, and more attention paid to teaching from 'where students are at' regarding their desires to have skills for 'success' on school practicums.

The initiatives have been within the context of the implementation and ongoing evaluation of a new 4-year Bachelor of Education program. Key organising ideas throughout this new program are reflective practice and integrated curriculum, so students' learning about teaching is fostered in ways that allow them to build understandings in realistic contexts. This orientation is consistent with constructivist principles, and hence, my new initiatives are supported by endeavours in other components of students' experiences. Three possible pathways forward designed to begin to transform teacher education classrooms are now outlined together with the dilemmas each raises.

Learning Cycles

Framing mathematics lessons and programs within learning cycles creates multiple possibilities for considering the nature of children's learning, how to support learning, how to integrate curriculum areas, and how to build connections between constructivist learning theory and actual classroom practices. The learning cycle used in the mathematics education classes consists of: (a) *finding out about the learner* (i.e., checking pre-requisite knowledge), (b) *exploration,* (c) *formalisation,* (d) *practice/consolidation*, and (e) *application* (also see Frid, in press). What is emerging as particularly valuable in using this learning cycle is that it shows how the drill and practice routines of 'traditional' mathematics teaching are an essential component of children's learning (as *practice and consolidation*), but are not necessarily an effective starting point for their learning. Another valuable aspect of this model is how it highlights that hands-on, exploratory or investigative work (in the *exploration* phase) needs to be accompanied by explicit identification of the relevant underlying mathematics (the *formalisation* phase). Keeping children actively engaged and busy doing things does not ensure that mathematics is learned. The dilemma that arises from using this learning cycle is that its effective implementation requires knowledge of, and confidence with, mathematics concepts and skills – a deficiency in primary pre-service teachers' mathematics backgrounds that is well documented in the literature (e.g., Biddulph, 2000).

Reflective Practice

Although the notion of a teacher as a reflective practitioner has been becoming a cliché expression in teacher education, there are valuable and varied reasons for why it has been so widely embraced. Key amongst these reasons are the potential it offers for developing capacities in life-long learning, and for fostering critical analysis of, insight into, and subsequent actions within educational contexts and practices (Bullough, 1996; Schön, 1987). Mechanisms have been developing within the new BEd to nurture students' development as reflective practitioners by incorporating ideas from the reflective practice literature, including journal writing, critical incident analysis, portfolio assessment, narratives, and formal reflection essays. There have been diverse reactions to these endeavours by both staff and students. Some students engage willingly and deeply in trying to be reflective and there is indication they find it beneficial to their development as teachers. However, there are others who resist or who turn it into a "repetitive" exercise … "virtually saying the same thing for twelve weeks" (Nancy). They become frustrated because they need and want more practical ideas and strategies for lesson activities and classroom management. We, as teachers, seem to have forgotten to 'practise what we preach' by finding out about our learners and then planning learning activities for 'where they are at' rather than 'where we want them to be at'. The tension and resulting dilemmas for teacher educators arise from finding a balance between development of the individual as a professional and the demands of ensuring technical competency. Another dilemma that arises here is that, by adopting a reflective practitioner stance to teacher education, one runs the risk of implicitly promoting this orientation as the 'truth' about learning to be a teacher.

Professional Portfolios

If there is a risk of reflective practice becoming yet another 'truth game' for mathematics teacher educators to become entangled in (similarly to constructivism), then we must consider avenues by which to reveal this to ourselves as well as our students. Some possibilities can be found in explicitly exposing students to post-structuralist ideas, particularly those related to how individuals and practices constitute and are constituted within discourses (Foucault, 1988). However, two possible dilemmas can then arise. First, there is the dilemma of addressing students' learning from where they are at, which in many cases is with a focus on practical classroom ideas rather than theory. Second, there is the risk of implicitly communicating these ideas as the 'truth'. An avenue currently being explored to attempt to resolve these dilemmas is that of students' developing over their entire BEd a professional portfolio that uses the *National Competency Framework for Beginning Teaching* (National Project on the Quality of Teaching and Learning, 1996). This development of a teaching portfolio requires students to continually reflect upon their own learning in relation to their strengths and weaknesses as teachers and how they can further develop their knowledge, skills and professional capacities (Frid & Reid, 1999; Reid & Frid, 2000). The students themselves are positioned as authorities on their own professional development. They set goals to work towards and they do this within a context of social interactions and discussion (with peers, teachers and lecturers). These facets of portfolio development are all consistent with constructivism, but broaden our previous teacher education constructivist-oriented practices by more explicitly and pervasively engaging students in exploration of what teaching is and reflection upon teaching experiences.

Conclusion

In conclusion, in spite of the dilemmas inherent in the action research based findings discussed in this paper, mathematics teacher educators must continue to explore how differing ideas, frameworks and practices can inform and influence who we are and what we do, as well as what our students learn. In particular, even though constructivism has not yet had substantial impact upon school practices, we must not abandon it as a 'failure', but instead consider if we ourselves have in fact succeeded in implementing constructivist pedagogy. What has been outlined in the concluding sections of this paper are avenues by which to broaden and more fully embrace constructivist pedagogy so that related teaching practices more appropriately engender the development of student teachers as professionals who have technical knowledge and skills as well as capacities for life long learning, flexibility and autonomy.

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