Preservice Teachers and Numeracy Education: Can Poststructuralism Contribute?

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Numeracy is the confident and critical application of mathematical ideas in a variety of contexts. Numeracy has an ontological dimension, it is a state of being numerate, that has its genesis and growth in mathematics education and life. Preservice teachers are expected to teach their students for numerate participation in a global world, although they themselves oftentimes lack the necessary mathematical foundations and strategic and critical skills. In this paper I describe how an awareness of the poststructuralist processes of subjectification and positioning informed my teaching in numeracy education, and the possible effects.

In keeping with changing times, where robustness and flexibility of mathematical thought are of the utmost importance in problem solutions, definitions of numeracy go beyond the notion of computational competence to stress effective participation in life and work. As stated by the Queensland School Curriculum Council (QSCC) (2001, p. 2):

> Numeracy involves abilities that include interpreting, applying and communicating mathematical information in commonly encountered situations to enable full, critical and effective participation in a wide range of life roles (Queensland School Curriculum Council, 2001, p. 2).

Beyond the mind and the purely mathematical, numeracy signifies a state of being where one manifests "practices and dispositions that accurately, efficiently, and appropriately meet the demands of typical everyday situations involving number, space, measurement and data" (QSCC, p. 3). The notion of 'confidence' has now also come to the fore, with Education Queensland (2007), for example, stressing that teachers must be well enough equipped to ensure that their students have the confidence to apply mathematics in their everyday lives (Minister's Foreword). Indeed, their *Framework for Action*, *2007-2010 is titled Numeracy: Lifelong Confidence with Mathematics (Education Queensland, 2007).* Given that many preservice teachers, especially those keen to teach in primary and early years' classrooms themselves lack robust mathematical knowledge, confidence and a positive disposition in application of mathematical ideas and strategies, one wonders what magic wand can be waved in teacher education to bring about their enlivened and appropriate use of mathematics in the learning context of a classroom.

While a variety of cognitive, psychological theories can well inform the construction of robust mathematical knowledge, they tend to fall short of adequately explaining that dark chasm that exists between knowledge construction and responsible application, especially in regard to teaching practice. Here I am referring to the tenuous link that often exists between teachers' knowing about and approving more inquiry based teaching practices and the actual facilitation of "cultures of sense-making", where the child is at the centre of the learning process, constructing personally meaningful solutions (QSCC, 2001, p. 4). Oftentimes it is assumed that there is a linear link between knowing and doing, but teachers often revert to traditional ways of working even when they are well versed in, and approve of, more innovative and inquiry-based methods (Foss & Kleinsasser, 1996). Related to this is the phenomenon whereby some teachers and preservice teachers feel uncomfortable with proposed 'new' methods and resist them from the start. For example, as Nicol (2006, p. 31) found in her research with preservice teachers, they collectively agreed that "teaching in ways that respect students' thinking and sense-making was not worth the time, the effort or the consequences". Clearly pedagogic challenges present themselves for teacher educators who hope that their students will teach a rich and robust mathematics in ways that inspire their pupils with confidence and a passionate regard for mathematics and its responsible use in the world. Although this appears to be a tall order indeed, it may be that new philosophies and ontologies can overlay (but not obscure) the cognitive and psychological in teacher education to inject new energy and understanding into teaching for numeracy.

We teach in postmodern times characterised by change and uncertainty. In this paper I use the poststructuralist concepts of subjectification and positioning to unsettle the taken-for-granted meta-narratives of learners (in this case, preservice teachers) as rational and autonomous agents of change. The concept of subjectification reminds us that all preservice teachers have been and still are *subject(ed) to* teaching strategies and practices that make imaginable what they might be as teachers in the future. That is, the way in which novice teachers are able to establish themselves as active participants in the mathematics education discourse in teacher education has implications for their future teaching. It is an empowerment issue, and important that they are able to recognise themselves as having a real presence, and the knowledge and skills to be able to teach in generative ways. Taking heed of the imperative to position preservice teachers positively in learning to teach for numeracy, I attempted to turn around the broader discourse of 'deficit' which currently frames much of what is done in teacher education to embrace the potential that each novice teacher brings.

Methodology

Poststructuralist thought with its emphasis on subjectification and positioning of learners within a discourse such as mathematics education makes visible how relationships of power support or suppress learners' recognition of themselves as capable participants in that discourse. As Foucault (1982, 231-2) cautioned, when one looks at relationships of power "everything is dangerous". All practices and interactions are dangerous because they are constitutive of the learners' developing identities as numerate beings (or teachers of numeracy). In numeracy education where it is hoped that positive dispositions, confidence and critical application of mathematical ideas will be facilitated, it is crucially important that teaching strategies and interactions comply. In school and at university, strategies are needed that make available to all learners robust mathematical knowledge, that respect the learner as active participant and initiator of reasoning and sense-making in mathematics, and that help the learner make connections between mathematical ideas and life. These are the strategies I attempted to employ in my teaching; they have to do with positively positioning the learner as an active agent in sense-making in mathematics (and learning to teach for numeracy) and could be summarised as comprising:

- Robust mathematical and pedagogical knowledge (needed to be powerful in the mathematics education discourse)
- The sense that one has a legitimate 'presence' as active learner able to 'struggle' through/engage in a growth process
- The encouragement to go beyond the given, to initiate and follow new pathways.

Researchers in teacher education will note that these recommendations are very similar to those that have influenced mathematics education at the level of policy for many years. However, in poststructuralist thought subtle differences are seen to exist in the interpretation of learners and learning that frame these strategies. For example, the learner in poststructuralism is in no way thought to be an autonomous, rational being; s/he is buffetted and challenged by the practices, rules and regulations of the institution, within which there is a scrambling to establish oneself as competent. The learner is de-centred, in no way at the centre of learning but at the mercy of pedagogical strategies and practices, including the robustness of the knowledge presented for construction; collectively these support or suppress a realisation of self as numerate. On the other hand, Education Queensland (2007, p. 4) takes a more autonomous view of the learner and says: "All students can succeed in mathematics and develop a positive attitude and confidence in using mathematics." While the intention is good, in a way this reading of the learner as naturally competent if only s/he chooses to put in the effort, is dangerous; this is because the onus is put on the learner to be positive and competent when really the machinations of the classroom can render this unlikely. For example, if in my attempts at 'value adding', say in having preservice teachers investigate and work through self-generated computation methods, I cause them to 'lose face' (perhaps due to their not knowing number facts, or not being able to demonstrate flexibility of thought when using number combinations), any cognitive gain is eradicated by a constituted sense of not being able to cope in a learning context where "Everything is dangerous" (Foucault, 1982, 31-32).

Then, too, there are different views of the productivity of the learning process. Education Queensland (2007, p. 4) takes a long term stance and says: "Students' enjoyment in classroom mathematics influences their confidence with numeracy outside the classroom." This makes it sound as if students 'have' enjoyment, as a commodity, that ensures confident application of mathematical ideas after school. Again, this is dangerous because enjoyment does not ensure anything; a difficult issue in mathematics education is that teachers and students can spend untold hours 'enjoying' tasks that have nothing mathematical about them at all. The poststructuralist position is that as intellectual knowledge is constructed, so too is a mathematical identity (a sense of oneself as active, competent participant, or not) and tampering with the external environment, for enjoyment, is always problematic. Rather, it could be said that students need appropriate levels of challenge and satisfaction in doing and using mathematics within a culture of sense-making (QSCC, 2001,

p. 4). Learning to establish oneself as numerate does ideally have a measure of satisfaction about it, but this comes from within, from the acquisition of robust knowledge, rigorous and flexible thinking processes and a recognition of oneself as capable, competent and agentic in doing and using mathematics appropriately. In teacher education, then, the aim is not to 'have enjoyment' but for the preservice teachers to find an 'at homeness' and satisfaction in ways of doing mathematics that focus on thinking and reasoning, that encourage them to justify and generalize as they struggle out solutions for themselves.

Building Repertoires of Teaching Practice

Education Queensland (2007, p. 4) in *Numeracy: Lifelong Confidence with Mathematics* stipulated that teachers need various knowledges when they are to teach for numeracy. They need knowledge of mathematics as a discipline, of how students learn and transfer mathematical knowledge and skills, and how teaching impacts on student use of numeracy. I attempted to develop the mathematics through these pedagogical emphases, rather than the other way around, where various 'methods' might be used to achieve the construction of mathematical knowledge. I began in the first year numeracy subject by tackling the preservice teachers' knowledge of mathematics as a discipline. My hope was that by coming to appreciate the relationships and orderliness of mathematics these preservice teachers would learn some mathematics, learn to appreciate mathematics as a discipline worthy of study and have a structured approach to their teaching later on. Perhaps they could construct some foundational knowledge so that they could begin to recognise themselves as active agents in teaching numeracy without being put 'on the spot' too often.

I hoped that these students would construct some 'key ideas' that would frame their teaching, and that they would engage in and be able to make explicit details of the reasoning process. Mathematics as a science of pattern and order was highlighted, and the novice teachers were encouraged to 'see' and appreciate that order. The National Council of Teachers of Mathematics (NCTM) (2007, p. 2) proclaimed "It is striking that given the robustness of the link between instructional attention to important relationships and students' level of understanding, typical classrooms in the United States focus on low-level skills and rarely attend explicitly to the important mathematical relationships (Hiebert et al., 2003; National Advisory Committee on Mathematics Education, 1975; Rowan, Harrison, & Hayes, 2004; Weiss et al., 2003)." I considered it important to redress this issue and placed 'up front' the mathematical relationships that students in school would need to construct. I encouraged the preservice teachers to expand on them and suggest tasks to develop this knowledge as well as 'real world' applications. For example, when dealing with 'Number' they were given an A4 sheet of paper that read:

These are some key ideas you will want the students in your class to construct (adapted from Van de Walle, J. 2007):

- Every number is related to every other number in a number <u>relationship</u>. For example, 8 is 2 less that 10; made up of 4 and 4 (or 3 and 5); and is ten times 0.8.
- Number <u>relationships</u> are the foundation of strategies that help children remember number facts. For example, knowing 4+4=8 allows one to quickly work out 4+5= . If one knows 2X5=10, then 4X5 and 8X5 can easily be calculated.
- Each digit in a written numeral has a 'place' value which shows its <u>relationship</u> to '1'. For example, in 23.05 the value of the '2' is 20 ones, while the value of the '5' is only five-hundredths of one.
- Fractional parts are equal-sized shares or <u>portions of one whole</u>. The whole can be one object or a collection of things. More abstractly the unit is counted as 1. On the number line, the distance from 0-1 is the unit.
- Fractions can be represented as common ($^3/_4$) or decimal (0.75) or as a percent (75%).

Throughout the subject the students struggled with developing a numeracy for teaching; they took each dot point and, in groups or on a chatline constructed mathematical expressions and models that represented these ideas. For example, they made a resource that could be used in the classroom to demonstrate the three representations of fractional amounts above, and completed mental computations based on the use of number relationships and computational strategies (making explicit their thinking and reasoning strategies). The mathematical ideas and the process of their learning were unfamiliar to many of them, as they were more used to being shown a procedure in learning mathematics. Nevertheless, the responses on the chatline were generally positive:

> Maths was my least favourite in school (primary and high school) yet for the first time in my life I'm thoroughly enjoying the subject. It's great! As I said to my husband, I feel as though at school I 'did' maths but now I'm 'learning' maths … and it's a massive difference.

> This is a basic maths subject yet I'm not only learning how to teach maths concepts – in some cases I'm actually learning the material for the first time. I totally endorse teaching students to understand concepts through exploration of relationships and with practical examples – it gives the material both 'life' and relevance, therefore motivates them to pursue it.

> I find it a bit enlightening that the theories of maths can be related to so much of our planet. You can find math in nature, in the universe, in street directories even!!! I had never really thought about that before – as much as I have struggled with my fears of this subject (to the point of being physically sick one night) I am beginning to appreciate the fact that maths is not something only 'clever' people do … .

> For my part, I can't believe how much I've enjoyed this subject - & I never thought I'd say that. I absolutely loathed maths at school because for my entire schooling maths was never fully explained, no enthusiasm was injected, we just had to keep up and as long as we passed the exam, that was it.

The knowledge construction that I have mentioned above had to do with investigating and getting to know the relationships and pattern of mathematics and the thinking and reasoning processes that rely on and cement these relationships. This knowledge involved personal (and group facilitated) investigations of mathematical ideas. However, there was another arm to knowledge production in the form of the procedural knowledge that would be needed for teaching; for example, novice teachers need to know how to denote and track generalisations in algebra, how to write measures correctly, how to speak and write the language of mathematics. To this end I produced a web based interactive program that introduced them to the basic language and concepts that would be taught in the primary years of schooling, stressing the language and recording of mathematical ideas and connections to the world. Many of the prospective teachers had not been at school for many years, and even those who had, were not adept in using and correctly recording the language of mathematics. While much of the procedural in teaching mathematics could be dealt with in tutorial groups for the on-campus students, those on-line had to rely fully on the program on the web.

Analysis and Implications

An interesting assumption of poststructuralism is that 'relevance' in learning pertains to any interaction that helps ensure a student's admission to and generative participation in, a learning community. Because identities are seen to be constituted in discursive practices, it is important that these practices collectively provide:

- Robust knowledge (needed to be powerful in any discourse)
- The knowledge that one has a legitimate 'presence' as active learner able to 'struggle' through/ engage in a growth process
- The encouragement to go beyond the given, to initiate new pathways.

These were the aims framing the development and implementation of the numeracy subject. Although the comments above indicate that most student teachers seemed to feel quite positive about their involvement and learning in the subject, there are many issues for the teacher educator to explore further.

The first issue might be that it is very difficult if not impossible to get anything like an 'objective' reading of what was really going on here with the students' learning. Power relations always pertain and the comments students make are nuanced by the knowledge of the lecturer's reading of chat room and tutorial conversations. It is unlikely that students reliant on a pass in the subject would complain too bitterly about the content or delivery; one reason for this might be their previously constituted notion that when you fail or find things difficult in mathematics it is your own fault, in that you are just not 'good' at it.

Although change can come from changing the discourse and discursive practices, there was also the chance that in changing them I would run the risk of totally alienating those students firmly wedded to previously constituted notions of what mathematics is and how it should be taught. It became clear to me during tutorials that many of the students really struggled with the transition from 'doing sums' to the use of mental computation strategies, for example. This notion was further reinforced in the exam where some students resorted to known algorithms even though the instructions were to use a variety of mental strategies and show thinking and reasoning processes as we had done in chat groups and tutorials. This I saw as a problem with two distinct implications. On the one hand these students had not constructed new knowledge for teaching, which included the mathematical as well as ways of learning that focused on thinking and reasoning mathematically. I had wanted them to come to know new ways of ‘being’ in mathematics, new ways of constructing mathematical knowledge; through active collaboration in groups where they ‘made’ new knowledge together. Because of their reticence I also became aware that no matter what one does in the name of inducting novice teachers into a numeracy for teaching, there can be no certainty as to who will pick up and run with new ideas and who won’t. Any change is always piecemeal and diffuse, depending on past and present discursive engagements. One has to learn to live with uncertainty.

The second dot point above indicates the importance of the affective dimensions of the learning environment; in poststructuralist thought this involves not so much the emotions but positive positioning in the discourse. It is taken to be important, if students are to be well positioned and agentic in educational discourses, that they feel themselves to be fully ‘present’ with the ability and right to speak and be heard. This is a problem in so many ways for the preservice teachers. There are some who do not come to tutorials because they find the experience too embarrassing and draining because of their lack of mathematical knowledge and their anxiety. Then there are the practicum teachers who will not permit the prospective teachers to take an authoritative and equal position; rather than assume they can do it, they sometimes assume that they can not (and quite often, of course, the preservice teachers can not). On top of all this, they are so used to having to come up with what the teacher wants that they may find any deviation from the norm stressful. And last but not least is the intriguing question of whether the on-line students are as well positioned in the discursive relations as the face-to-face; or are they potentially better served because they do not have to ‘endure’ lecture and tutorial sessions where they stand to lose face amongst their peers and the lecturer?

Conclusion

Preservice teachers are expected to teach their students for numerate participation in a global world, even though they themselves oftentimes lack the necessary mathematical foundations and strategic and critical skills. In this paper I have used the poststructuralist concepts of subjectification and positioning to contemplate what I considered to be a ‘value adding’ to numeracy education in preservice programs. That ‘value adding’ comprised an explicit concentration on mathematical patterns and relationships and connections to the classroom and life, which the preservice teachers developed and investigated in the numeracy subject. As well there was an emphasis on ‘new ways of being a learner of mathematics’ with the explicit recognition and application of thinking and reasoning processes and the communication of mathematical and pedagogical ideas. However, not everyone agreed with the ‘value’ of the value adding, though some students appreciated the new emphases:

> I think if we had been taught mathematics this way it would have been a subject I would have enjoyed more and subsequently been better at. When you understand what you are doing you enjoy the work much more = just like this subject.

> Numeracy is a contraction of ‘numerical literacy’ … it’s not just about number-crunching, but about understanding mathematical purpose, patterns and relationships. Many of us have spoken about how much this numeracy subject differs from the maths we did at school. Think about it- what is the difference? The answer is the answer to this exam question. We aren’t just being told how to do maths anymore … we’re being taught how and why to do maths and to show our reasoning. It’s this deeper understanding which brings mathematics to life as it makes it meaningful.

While ‘bringing mathematics to life’, on many levels, was certainly the aim, the process remained fractured, arduous and contingent. Poststructuralism tells us that we should expect it to be so. The preservice teachers with whom we work have been subjected to discursive strategies that made them feel ill; rather than gain a sense of empowerment through self-initiated reasoning processes they have come to dread any further encounters with mathematics:

> Am a little nervous about this subject. Always remember being at school and dreading the double maths period. I recall spending much of it writing notes and planning the weekend, why oh why didn't I pay attention?
>
> Just reading the subject outline made me break out in a cold sweat.

This does not augur well for their teaching for numeracy in school; regardless of what they say about their studies in teacher education, we should perhaps be circumspect about their ability and willingness to challenge and support their students in the construction and confident application of rigorous mathematical ideas. It is more likely that some at least of these young teachers will avoid mathematics at all costs, or dress it up as 'play' or 'active learning' which can become empty replicas of the real thing, though less threatening (to them, the teachers). Speaking poststructurally, what we have here are young teachers who have not been able to establish themselves as numerate subjects at school and found themselves marginal to the operation of the discourse and the discursive practices. Because they were at the periphery they have come to know themselves (were positioned) as 'poor' at mathematics and much more research needs to be done to establish how or if this can be turned around. Certainly, it seems unlikely that the program of study at university could successfully overwrite already constituted discursive alienation, even though they may construct some new teaching and mathematical ideas. However, one thing poststructuralism contributes is to put the ball firmly in our court; it is up to researchers in teacher education to remain vigilant, to take nothing for granted and to track conscientiously the effects of our teaching on numeracy education in schools.

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