

# Communications

## Praxis in mathematics teacher education: introduction to a series of short communications

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In this set of communications, we share moments of our practice as mathematics teacher educators through the lens of praxis, which offers a way to focus attention on different aspects of our actions. Praxis is a term with old roots and with contemporary meaning. Aristotle distinguished praxis from technical action and abstract theoretical contemplation (Kemmis, 2010), its essence being morally committed, informed action (Kemmis & Smith, 2008). Aristotle's concerns include ethics and that action is best informed by theory developed from the practice of self-aware individuals. A second approach, following Marx's historical materialism, is to consider human collective action as social praxis (Kemmis, 2010). This sense of praxis informs Freire's understanding of the relationship between education and human freedom. Education, for Freire, gives the possibility of engagement in praxis that allows "human nature [to be] expressed through intentional, reflexive, meaningful activity situated within dynamic historical and cultural contexts that shape and set limits on that activity" (Glass, 2001, p. 16).

We locate our accounts in the developing strand of teacher education self-study (see, for example, Loughran, 2002; Tzur, 2001). Our narratives arise from intersections between self-study research methodology and Mason's discipline of noticing, which he describes as "a collection of practices both for living in, and hence learning from, experience, and for informing future practice" (Mason, 2002, p. 29). We write as mathematics teacher educators, but with goals far beyond that of "preparing" and "training" new mathematics teachers; rather, we illustrate how we constantly shift and negotiate our own positionings as mathematics educators. One reading of these communications is as a response to Mason's (2009) call for the field of mathematics education to "build up a vocabulary for how we compare observations, turn them into data, and negotiate meaning amongst ourselves" (p. 11).

We first met at a conference [1], where we shared that a common aspect of our practice as teacher educators was to make direct use in our courses of prospective teachers' reflections on their life in school, including their reflections about the complexity of the teaching and learning of mathematics and its social and political dimensions. Experiences from classrooms, colleagues and pupils in school, which can be confusing and troublesome to prospective teachers, form the basis for dialogue between each of us and our prospective teachers. The centrality of reflection on the complexities

of learning mathematics and learning to teach mathematics is at the heart of our praxis. Common threads are respect and care for the personhood of prospective teachers, a willingness to challenge or create challenging experiences and a passion for inquiry. Woven between these threads is a concern, through our own praxis, for prospective students to cultivate their own praxis as teachers.

As mathematics educators working in diverse cultural contexts our understandings and enactment of praxis—our praxes—are different. In this set of communications, we each offer a short account, a moment, that illustrates some dimension of our praxis. If praxis is a lens, it is a multifaceted one and each of our positions and narratives represents a different way to focus the lens, draws attention to different images and serves our different, though overlapping, visions for mathematics teacher education. Each account begins with the author providing a brief positioning that offers some element or aspect of what we each mean by praxis, followed by a short illustrative narrative and reflections on our learning.

The communications exemplify different facets, or moments in a process, in/through praxis. The narratives of praxis presented in the communications are each premised on a belief that the learning experience of prospective teachers influences the learning experience of the students they teach or will teach. Inquiry, meaningful relationships with self, others and mathematics, as well as awareness, reflection and agency in mathematics classrooms can only be realised if they are also manifest in mathematics teacher education.

### Note

[1] This article has its origins in the first *Mathematics Education and Contemporary Theory Conference* that took place in Manchester, England, in July 2011, where the authors participated in a working group on teacher education.

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## The new specialised Norwegian teacher education

HANS JØRGEN BRAATHE

The praxis of teacher education in Norway, like elsewhere in the western world, is impacted by neoliberal discourses

(Ozga & Jones, 2006), with the focus on performance within the school system and a repositioning of teachers. These changes in turn influence the praxis of mathematics teacher education. Mathematics teacher educators have a tradition of great freedom to develop the curriculum and to conduct local evaluation of student teachers. This freedom has decreased in recent years because of the focus on performance. Mathematics teacher educators in Norway now have to teach from nationally given curricula. Centrally given final tests for the student teachers have also been proposed by the government and will be introduced in 2015. These “controlling” elements have concerned teacher educators, who experience that their professional autonomy is threatened. In this account, I will illustrate the resulting dilemmas in my own teacher education praxis and point to how mathematics teacher educators address these dilemmas.

Praxis is understood as positioning professionals normatively in practice. The conception underpinning praxis in this account is “collective social, educational, praxis” (Kemmis, 2010, p. 20). Teacher education in Norway for primary and lower secondary schools has historically been for a class teacher who will teach all subjects. Combined with a political ideology for late specialisation in school, this discursive positioning of teacher praxis has been the background for the practice of mathematics teacher education in Norway. It positioned all teachers for primary and lower secondary schools as teachers of mathematics.

In 2006, Norway introduced a new primary school curriculum, Kunnskapsløftet [1], which defined a new political context for education. It sets national competencies; it gives local freedom to organise teaching and learning; and it sets national control for achieving results. This national control takes the form of National Tests. Following the introduction of the new curriculum, teacher education was reformed in 2010 into two different specialisations: GLU [2] 1-7 for grades 1 to 7, and GLU 5-10 for grades 5 to 10. This reform seeks to address a political concern that “Norwegian students have poorer results than the government wants” (Ministry of Education, 2008, p. 10). The solutions (and responsibilities) are tied largely to teacher education and teachers. The new approach has a stronger emphasis on teaching academic knowledge, with clear leadership and authority conveying a somewhat “nostalgic” view of the skilled teacher. This approach represents a definitive break with the social democratic ideology that positioned the teacher as a generalist with a wide spectrum of cross-curricular and social responsibilities, qualified to teach all school disciplines from 1st to 10th grade. Instead, GLU positions the new primary and lower secondary teacher to work in the Quality era school defined by Kunnskapsløftet, introducing age specialisation in either grades 1 to 7 or 5 to 10, as well as subject specialism in fewer disciplines (Ministry of Education, 2009).

To illustrate how the new curriculum positions teachers differently and challenges the traditional class-teacher identity, I will give a short excerpt from a focus group, conducted in a primary school in 2009. In this school, they had reorganised the teaching so that one teacher at each grade level had the responsibility for all mathematics teaching (Braathe & Otterstad, 2010, p. 72). The focus group interview was conducted in Norwegian and audio-taped (which I have

translated into English). Questioned as to their opinion of this change, one of the teachers responsible for the teaching of mathematics answered:

*Teacher:* Mixed. It’s very nice to have just one subject to deal with then. That’s often the subject you’re burning a little for and find some fun and such with. You feel that they have an ok teaching situation when we do it that way. At the same time you lose a little overview of students. When we talk about the students you do not know much about the nice writing font and such, so you cannot take part in all discussions.

*Hans Jørgen:* You’re now more of a maths teacher and not the general teacher who teaches maths as well, which is common. What do you think about that?

*Teacher:* Yes, one feels more of a math teacher, then, you know. Specially in the last few years when there has been much, there are national tests now in the autumn when the 4th grade, Yes, it is, there is some focus on it.

The teacher has been positioned with different responsibilities and teacher identity than previously and from what they were trained for. The new role also implies responsibility and a position of power, and at the same time removes responsibility for mathematics from other teachers on the team. The teachers at the school who now have this new mathematics-teacher identity can feel themselves under pressure. The collective educational praxis (Kemmis, 2010) in the school has changed, due to national ideological shifts.

The positioning of the new specialised Norwegian mathematics teacher is an example of the influence of neoliberal discourses on educational policy in Norway and represents a new praxis. Stray (2011) argues that schools in this shifting praxis are described in policy documents as having a social *mission* rather than, as previously, a social *mandate*. This description also changes the discursive positioning of the teachers, influencing teachers’ professionalism and autonomy. A mandate gives autonomous teachers responsibility and trust; having a mission means being accountable for achieving the results defined by the mission. In this representation of praxis, it can be argued that the teacher is not capable, competent and professional unless they can show that the students’ learning and development meets prescribed outcomes. This shift to a focus on valuing teachers in terms of competencies challenges my practice as a mathematics teacher educator who seeks to educate a moral mathematics teacher with responsibility for the development of the whole child. It attempts to require me to educate academic specialists focused on performance, and threatens a tradition within mathematics teacher education that focuses on the child and a combination of mathematics for teaching and pedagogical theory related to teaching of mathematics. These dilemmas are strengthened by the “controlling”

elements introduced into the praxis of mathematics teacher education in Norway. These praxes, the one for the educated mathematics teachers illustrated above, and the emerging praxis of mathematics teacher education, together threaten the autonomy of the teacher educator. Mathematics teacher educators go from having a mandate with responsibilities and trust, to become part of a quality era mission within the new educational discourses. This awareness gives rise to discussion and resistance within the praxis of teacher education in Norway. We must enter the political domain and argue for taking back responsibility for, and being trusted to keep control of, both curriculum and evaluation.

## Notes

[1] The official translation of the Norwegian name for this new curriculum plan is Kunnskapsløftet or “Knowledge Promotion”. The name indicates a desire to focus on knowledge, indirectly criticising a former focus on democratic and social aspects of schooling in Norway.

[2] GLU is an abbreviation for Grunnskolelærerutdanning [Primary teacher education].

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## Emotionality and relationship in teaching mathematics: a praxis of embodiment and uncertainty

### MARK BOYLAN

Learning and teaching mathematics as human practices are intrinsically emotional and relational. I believe that every activity in the mathematics classroom has an emotional texture. Every activity involves relationships between teachers and learners, learners and each other and with mathematics. Part of my praxis as a mathematics teacher educator is to develop prospective teachers’ awareness about the relational and emotional aspect of teaching and learning and to consider the implications of this. Further, I want them to develop their own praxis as teachers, one that embraces emotionality and relationality.

In this communication, I briefly explore how different

dimensions of relationality can be attended to in mathematics teacher education pedagogy: the ways in which moment-to-moment interactions are shaped by the interplay of the micro (the personal and immediate) and the macro (the structures of mathematics education). I share how a concern with the personhood of prospective teachers can inform my praxis and theirs. Attending to biography is a means to reflect on personhood and is also a source for learning and change. My orientation is to their becoming as a teacher rather than (only) the acquisition of knowledge or development of skills. One way that I address both of these concerns is through embodied activities.

One example of an embodied activity that I use with prospective teachers is from a first session of a module called “The Pupil Experience of Learning Mathematics”. The module is part of an initial teacher education course for prospective mathematics teachers in the UK. An important focus here, in England, is the labelling of learners by what is described as “ability”, this being the key way in which teaching and learning is organised. We begin with a “people maths” activity involving forming shapes in various ways. This raises the question “what is mathematics?” We then discuss the prospective teachers’ written reflections on their mathematical biography, their thoughts on open pedagogies, as well as their thoughts about teaching mathematics in attainment groups (referred to as “setting” in the UK).

The prospective teachers discuss their biographies and respond to the activity in pairs and small groups. I then ask them to physically place themselves on various continua so as to position themselves in terms of their experiences and their beliefs: for example, responding to statements about the experience of problem-solving mathematics, or about their identity as mathematicians (or not) or about all-attainment teaching. Voices are invited from different positions on the continua. I ask them, literally, to stand up for their views, which makes visible, concretises and pauses the on-going process of discursive positioning (Harré & van Langenhove, 1999) that occurs in social interaction and identity work. Positioning is the discursive construction of personal stories that make actions intelligible and meaningful as social acts. People position themselves in relation to each other and to wider social roles and identities.

The discussion during this activity leads to the laying out of a simple system. The prospective teachers take roles to represent basic aspects of school students’ experience of mathematics, teacher, pedagogy and peers. The classroom system is then expanded into the social, with others taking the roles of politicians, curriculum designers, employers and media. By circulating and moving between roles, the prospective teachers can examine different perspectives. It is important here to have the prospective teachers take the role of students with different relationships to mathematics, particularly those with different biographies to their own.

I then ask them to get into groups with others who have had similar mathematical experiences. They create a still or moving scene that visually shows what is common in their experiences. These representations are enacted in turn, with the rest of the group invited to provide a commentary, interpretation or to name the scene. In the representations, we see mathematics being pushed on to learners with anxiety,

sadness, frustration and isolation as well as more positive experiences of receiving support and guidance and of success. These emotions create a tableau of the emotional landscapes of school mathematics. We come to know that experiences can be very different, that “not everyone is like me”.

I invite enquiry about how the experiences that have been represented have come to be so. What are the personal, social, cultural, political and historical forces that construct learners’ experiences of mathematics? New groups are formed to consider statements focused on issues of social justice, equity and ethics in mathematics education. The prospective teachers are asked to choose statements that they strongly agree with and strongly disagree with. As they engage in debate they are asked to “role reverse”: that is, to take on the views or beliefs of others as their own and to provide arguments to justify the views that they disagree with.

As a teacher educator reflecting on my account, I identify four aspects of my pedagogy as important: a concern for emotionality, relationship as systemic, epistemological provisionality and embodiment as a pedagogical tool. Through embodied activities, I strive to develop an understanding of emotionality as an intrinsic aspect of being a teacher (Boylan, 2009). By exploring systems in a visceral way, I seek to make visible and concrete the way that educational practices exist in relationships within ecosystems of practices (Kemmis, 2012). Recognising that different perspectives and ways of understanding the world are possible offers an epistemological challenge to those students who have not reflected on the implications of living in a world in which people have different epistemological and ethical paradigms.

The process of enactment models the uncertainty that arises from acknowledging polyvocality as a characteristic of identity. By posing the question “why do I have these beliefs?”, a disorientating dilemma (Mezirow, 2000) may be provoked as unconscious “certainties” are disrupted. This disruption can extend prospective mathematics teachers’ fields of awareness to embrace wider issues and gain an understanding of relational and social dimensions of learning mathematics and their positionings as mathematics teachers. The enmeshment of the personal and social necessarily means that understanding is steeped in uncertainty and provisionality and entails a “praxis of not being so sure” where “questions are constantly moving and one cannot define, finish, or close” (Lather, 1998, p. 488). The process of embodied positioning exemplifies this praxis of uncertainty as the representations created are dynamic and changing. By asking prospective teachers to look at a system from another standpoint, visceral experiences are possible that entail recognising that there are multiple perspectives on a given situation.

Considering these aspects of my praxis as a teacher educator—the emotional, systemic and epistemological, through embodied activity—I recognise the importance I place on the alignment of my praxis and the praxis I seek to encourage. The type of relationships I encourage within the learning communities I foster are ones I would hope would be found in the classrooms of at least some of the prospective teachers who have worked with me. I discomfort and trouble unexamined assumptions about mathematics educa-

tion because this may mean the teachers develop classrooms with similar space for uncertainty and provisionality, for not being sure. I believe that mathematics classrooms can and should be sites for embodiment and emotional expression, and so I try to create sites in teacher education that give space for embodiment and emotion. By examining the systems within which mathematics teaching is located, a bridge is created between prospective teachers’ concerns and motivations to address alienation from mathematics, to an appreciation of the political and social conditions that shape school mathematics so that it is alienating for many. Thus, my praxis aligns with concepts of committed action for social change.

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## Reflections on bright moments in teaching through inquiry

### KATHLEEN NOLAN

As a mathematics teacher educator, I embrace an understanding of praxis as “theory-driven practice and action” (Nolan, 2010a, p. 726). In other words, I maintain that “[p]raxis seeks to create not a contentious dichotomy between theory and practice but instead a dialogic, dialectic relationship that highlights a continual interplay between them” (Nolan, 2010a, p. 726). To live out this interplay between theory and practice, I conduct self-study research into my practice as a teacher educator. Presently, this research is focused on two key contexts: as the instructor of a “mathematics for teachers” course for prospective elementary school teachers (Nolan, 2010b) and as a faculty advisor for prospective secondary school mathematics teachers in their field experiences (Nolan, 2012). In both cases, I use Bourdieu’s social field theory—primarily the concepts of habitus, field, and cultural capital—to unpack the data gathered through self-study approaches. Through an understanding of structure and agency issues, Bourdieu’s social field theory helps me address enduring questions related to how mathematics classroom pedagogy is, for the most part, resistant to change. With a strong commitment to inquiry approaches to teaching and learning mathematics, I seek to understand why inquiry is not being embraced to any noticeable extent in school mathematics classrooms.

In this communication, I present an example of my

theory-driven practice and action (praxis) in the particular context of designing and teaching a “mathematics for teachers” course taken by prospective middle years (grades 6-8) teachers during their four-year undergraduate teacher education program at the University of Regina, in western Canada. The course is premised on the idea that “prospective teachers require experience learning *through* (not merely *about*) inquiry-based pedagogy” (Nolan, 2010b, p. 154) prior to becoming a teacher in their own mathematics classrooms. The designing and teaching of the course could itself be described as a form of praxis inquiry, where my praxis inquiry as a teacher educator is centred on prospective teachers’ engaging with teaching and learning mathematics through inquiry:

Related specifically to teacher education, praxis inquiry seeks to explore the life and learning of students through a critical study of, and engagement in, the interplay among pedagogical, sociocultural, and systemic contexts, all of which have significant impacts on learning environments. (Nolan, 2010a, p. 726)

I characterize and promote inquiry pedagogy (or, teaching and learning through inquiry) as a set of approaches that, at their core, involve the construction of mathematical understanding through student investigation, collaboration, and communication (Chapman & Heater, 2010; Leikin & Rota, 2006; Ma & Singer-Gabella, 2011). When it comes to teaching and learning mathematics through inquiry, both teachers (teacher educators) and students (prospective teachers) must possess a certain level of comfort with ambiguity and uncertainty (Towers, 2010).

In the words of Phelan (2005), “[t]he intent of inquiry-based teacher education is to make learning to teach, and teaching itself, a complex and uncertain enterprise that demands ongoing, thoughtful inquiry and discernment” (p. 340). I can appreciate the challenges faced by prospective teachers (and teachers in general) in making a transition to teaching through inquiry, especially if they have primarily experienced learning through direct teaching. As I teach my “mathematics for teachers” course, I personally identify with the challenges of this transition on a daily basis, both in my own discomfort with taking pedagogical risks as I attempt to model inquiry pedagogy and in my students’ discomfort and resistance to these pedagogical approaches (Nolan, 2010b). But, amidst the daily toil and trouble, there are stories of bright moments to be shared.

As an example, consider this brief story of Hanna, a second year prospective elementary school teacher. At the completion of the “mathematics for teachers” course, I interviewed Hanna (and several other students) as part of my research study. I wanted to understand in what ways (if any) their views on teaching and learning mathematics had changed throughout the semester by engaging in this course. During the interview, Hanna expressed how frustrated she was at the start of the course: “for the first month it was like oh my gosh, I just don’t want to be in this class. Like that’s my honest opinion of what I first felt and I was like, this is just silly”. Later in the same interview, she reflected:

And it was funny because I would understand on a day

to day basis, but like I said when it came back to thinking about the whole class, it took until the end to realize the whole entire class actually was—like what we were doing, our assignments, everything—like everything combined was problem solving. It wasn’t just the teaching aspect of it. But it took the whole semester to realize that everything came together including the exam, the teaching, homework assignments. I think a lot of people left with kind of the same feelings. Like being frustrated at first, in the end looking back “oh, it was a pretty good class”.

Hanna’s honest reflection on her experience of the course was refreshing, especially in how she concluded the interview:

I think it clicked, I think everything just came together in maybe the last week. Last two to three weeks maybe. I was like, oh yeah! Oh yeah! And then everything just made sense and all your strategies I guess. I was like, oh *that’s* what she was *trying* to do! Like she wasn’t trying to frustrate us.

I fully expect that many of my students in this course over the years have felt that I was intentionally “trying to frustrate” them, not having previously experienced a version of learning mathematics that challenges the traditional rules and procedures approach. It could be said that I engage in this sort of praxis inquiry to learn how I can better teach and learn through inquiry and to learn what prospective teachers require to understand and consider teaching and learning through inquiry in their own classrooms. In the language of Bourdieu’s social field theory, I work to disrupt their structurally aligned habitus-field fits, in the hope that they will consider taking risks and trying an uncomfortable habitus (in the form of inquiry pedagogy) on for size. The blend of praxis inquiry, teacher education, and Bourdieu’s social field theory holds promise for studying the relations between theory and practice, and structure and agency in mathematics classrooms. Put another way, “the concept of critical praxis holds promise of strengthening pre-service teacher education and teacher education research” (Arnold, Edwards, Hooley & Williams, 2012, p. 293).

Praxis inquiry in mathematics teacher education has many valuable outcomes. Personally, as a mathematics teacher educator, my praxis keeps me balanced in my teaching and research life. I could not imagine teaching prospective teachers in mathematics curriculum courses without simultaneously researching my own practice, since the interplay and intersections are so important. With regard to the specific praxis project of teaching and learning through inquiry, I have come to understand that:

becoming and being an *inquiring teacher* who values learning *through inquiry* demands that teacher education programs strive for a more informed understanding by all (students, teachers, parents, administrators) of just how complex teaching (mathematics) is. In other words, teacher educators must emphasize how [teaching and learning through inquiry] is itself an inquiry process, and thus cannot be packaged with fixed recipes and shelved for purchase by the consumer teacher. (Nolan, 2014, p. 282)

Understanding praxis as “theory-driven practice and action” (Nolan, 2010a, p. 726) challenges mathematics teacher educators and researchers to activate and reflect on practice-driven theory and, in doing so, to connect methodologies and theories with the political and practical concerns in the world.

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## Theory vs. practice or theory vs. experiences

### PÄIVI PORTAANKORVA-KOIVISTO

Learning mathematics should be a gripping exploration. Part of my praxis as a mathematics teacher educator is to challenge prospective teachers to face their beliefs and their experiences of school mathematics, and to engage them to develop, design, and organize their practices, so that this exploration could take place in their future classrooms. In my pedagogy, this means that I organize activities to help prospective teachers to conceptualize mathematics as a social activity and to understand more about the social dynamics of mathematical teaching and learning.

In Finland, all mathematics teachers study in departments of mathematics and pedagogical studies form only a minority of their master’s degree. Pedagogical studies are

undertaken during one academic year and they include studies in education, like the psychology of development and learning, education for diversities, and social, historical and philosophical foundations of education. The rest of these pedagogical studies comprise subject didactics and teaching practice. By subject didactics, we mean methods, learning environments, and school assessment courses. As a result, most student mathematics teachers have considerable knowledge of mathematics, but they are not accustomed to using it to construct mathematical problem solving activities. The prospective teachers begin their studies with what I call a one-dimensional view of mathematics teaching and learning based on their own experiences from school, and they undertake the activities in my didactics course like they were still at school, pondering whether they themselves like to learn mathematics this way or not. Through their teacher education, this view fortunately expands into a more multidimensional view in which theory and practice are intertwined and the prospective teachers begin to see themselves as teachers.

Recently, the question of what mathematics teachers need to know in order to maintain their professional skills has received attention. A number of theories have been proposed beginning with Shulman’s (1987) framework and the idea of pedagogical content knowledge. Subsequent developments include Hill, Rowan and Ball’s (2005) construct of mathematical knowledge for teaching, Pierson’s (2001) TPCK adding a technology component, and Rowland, Huckstep and Thwaites’s (2003) knowledge quartet for primary teachers’ mathematics content knowledge as evidenced in their teaching. Although these constructs theorize the teaching and learning process, they move away from prospective teachers’ authentic experiences of school. Teachers and learners and the discipline of mathematics are located in social spaces and lived experiences and I would argue that these spaces and experiences dominate our practice. My practice as a mathematics teacher educator has been formed according my experiences as a teacher, as a mentoring teacher in a teacher training school, and as a teacher educator. My PhD study had a significant role in changing my practices.

In my narrative, longitudinal study (2005–2008), the research material consisted of written reflective essays, as well as transcribed conversational interviews (Portaankorva-Koivisto, 2010). The participants were six Finnish prospective mathematics teachers who were reflecting on investigational, collaborative and experiential approaches in teaching and learning mathematics. At the beginning of their studies, the student teachers’ practice reflected their own school years as pupils and they were not willing to change their views. Investigational, collaborative or experiential approaches to teaching were not familiar to them, as these two examples indicate:

There was a time when I had an old-fashioned image of teaching and learning mathematics [...] In my mind the best methods of teaching were the teacher explaining and using the blackboard and the pupils calculating by themselves [...] I have no previous experiences of cooperative learning in mathematics [...] The classes

usually had the same formula: homework, new topic and practice. I think because of this I liked maths. (Reetta's essay, September, 2005)

Generally, secondary school teachers do not bother spending time talking about the tasks. If there was only one solution and you had done something differently, then the teacher invariably wiped off your writing on the blackboard and wrote it again himself. (Karoliina's interview, December, 2005)

One academic year later, while the participants were working in a teaching practice school as teacher trainees, their narratives echoed their mentors' voices:

Using illustrations requires of the teachers to delve into their teaching and make extra effort. Teachers may not have the time or interest to use visualizations. (Saara's essay, December, 2006)

Open tasks can be scary for a teacher because those tasks cannot be planned in advance in full. They can lead to situations in which even the teacher might not be able to solve them. (Reetta's essay, December, 2006)

In collaborative learning, when pupils are working and learning mathematics by themselves, there might be a danger that there will be gaps in their understanding. (Kaarlo's interview May, 2007)

In the third academic year of their courses, the prospective teachers developed into their own version of novice teachers. Many of them had worked as a substitute teacher in both primary and lower secondary school. They already had experiences of being a "real" teacher and these experiences were dominant in their views of teaching and learning mathematics:

Sometimes, depending on the subject, mathematics can be linked to pupils' everyday life and things that are close and familiar to them, and it will be more memorable for them. (Karoliina's interview, December, 2007)

Automatically I look for connections to concrete objects or what can be seen around us. (Kaarlo's interview, December, 2007)

When I was a substitute teacher, I suggested to my pupils that we could investigate the golden section. (Aada's interview, December, 2007)

These findings started to change my praxis as a mathematics teacher educator. Here is an example of how I now start our mathematics didactics course. The student teachers are asked to write memories from school and metaphors for mathematics. When we discuss these memories, I want to stop them to think how these experiences might reflect on their teaching in the future. Furthermore, I encourage them to see the classroom as teachers, not as pupils. They also have to interview a person who has not liked mathematics in school and reflect on what could have been done differently. I wish that in the future, our prospective teachers listen to their pupils' ideas, and plan their teaching accordingly.

Then we try out several activities to think about how to illustrate or visualize mathematics, how to change ordinary mathematical tasks into investigations or open-ended problems, and how to have more mathematical talk within your classes. All the time, the student teachers are working in pairs or small groups and I organize the groups differently by using varied methods: for example, "when you get your coordinates, find your group so, that altogether your coordinates form a square in a coordinate plane". By these methods, I hope our prospective teachers gain meaningful experiences of different learning environments, co-operation and investigational methods. Perhaps these experiences will also be realized in their future classrooms.

Theory and practice intertwine, but sometimes in surprising ways and modified by one's lived experiences. As a mathematics teacher educator, I believe I know what prospective teachers should know and perhaps I may even be able to convey these ideas. However, my praxis necessarily needs to respond to the students' lived experience. Their practice, and so mine, takes shape in relation to these experiences.

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## Being mathematics teacher educators in the praxis of living

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The phrase "praxis of living" (Maturana, 1988, pp. 26-27) captures, for us, a way of being in which we find out about what we think and believe through observing what we do (Bruner, 1990, pp. 16-17), developing new awarenesses that lead to new actions that lead to new awarenesses reflexively over time. However, as humans, it is possible to maintain beliefs that an observer would not recognise in what is done. We are not interested in getting prospective teachers talking in a philosophical manner about their hopes or ideals for their classroom. We do not want to set up too great a gap between what they are thinking about in relation to their teaching and what occurs in their classroom. Teaching and teacher education are complex and actions are generally required at a speed that does not allow for conscious

deliberation. However, ours is not an atheoretical position; as we hope to illustrate, reflecting (Brown & Coles, 2012) is an important part of what we do, both with our students and to develop our own practice. In some cases, evaluations of lessons or reflections have little impact on future action. Mason, Drury and Bills (2007) observed that “one thing we do not seem to learn from experience is that we rarely learn from experience alone” (p. 52). In this short piece, we hope to illustrate how reflecting that impacts future action can take place within the praxis of living.

In our praxis of living as mathematics teacher educators, we work with prospective teachers to support them in their praxis of living, learning to become teachers. As part of our praxis, we sit and discuss our experiences, particularly before and after teaching sessions. For us, doing, knowing, learning and being are equivalent. In reflecting, we engage in deliberate analysis (Varela, 1999, p. 32) staying with the detail of what we do to open ourselves to new awarenesses and to inform our future actions. We are reflecting in the here and now, present, not striving to fit into preformed patterns of behaviour but allowing ourselves to make new connections (Brown & Coles, 2012).

On a one-year course for prospective mathematics teachers of students aged 11-18 (Post Graduate Certificate in Education) in the UK, we are personal tutors to half the group each. We meet these smaller groups (usually around 15 students) on Fridays, for the first six weeks of the course, reflecting on experiences the prospective teachers have had in schools in the preceding days. We plan common prompts for discussion. We ask the prospective teachers to stay with the detail of their experiences of teaching so that we can, as a group reflecting together, uncover statements of awarenesses. Laurinda has written before (Brown, 2005) about how, with prospective teachers, if discussion is at too detailed a level (*e.g.*, ideas for specific lessons) then it cannot easily be generalised or applied elsewhere (“I can do that, but I wouldn’t know how to plan the next lesson”). If discussion is too abstract (*e.g.*, concerning the nature of mathematics or the kinds of understanding we should be aiming for) there is, again, no direct link to action. It is at a middle or “basic-level” (Varela, Thompson & Rosch, 1991, p. 177) that we can uncover “purposes” (Brown, 2005) that can accrue actions linked to awarenesses that are applicable to more than just the immediate circumstance. An example of a “purpose” (arising out of the detail of stories of difficulties faced in school) might be “how do I begin a lesson?” Having identified this label, the group will collect together a range of strategies, sharing their experiences of observing other teachers or of teaching themselves. Our experience tells us that for many of them, these strategies will be things they try out in future lessons. Some strategies may become routine and become a part of their praxis of living, allowing a more conscious focus on other purposes and related actions.

In what follows, we draw on data from one Friday group session and analyse the dialogue in relation to Rosch’s (1999, pp. 254-255) three layers of language, *i.e.*, abstract, basic-level (including “purposes”), and detail/behaviour. The interchanges are reconstructed from notes taken shortly after the small group meetings to offer an image of our own praxis (pseudonyms are used). The prospective teachers had

previously had to teach the rest of the small group something (non-mathematical) for ten minutes (called “mini-teachings”). The group were then reflecting on what they had learnt.

- 1 *Alf*: Okay, could we go round the room then, and I want everyone to say one thing, from their mini-teaching, that they know they want to work on as an issue in their teaching, as you go into school next week.
- 2 *Jo*: I want to be more confident.
- 3 *Alf*: You need to turn your ideas into an action, something you can actually do—anyone got an offer of something you can do to turn that into an action.
- 4 *Jay*: Practise talking to kids to get more confident.
- 5 *Alf*: That feels closer although I’m not sure you can know you will get more confident.
- 6 *Jim*: Take any opportunity for public speaking.
- 7 *Alf*: That’s again getting close, you can certainly do that. Jo, can you say more about what you meant by wanting to get more confident.
- 8 *Jo*: When I was giving the mini-teaching, there was one moment when I turned to you all and everyone was staring at me. I was floored by having all the attention.

Alf was aware at the time that “I want to be more confident” (line 2) was too abstract to be linked to action, hence his offer to the group for someone to turn the statement into something Jo could “do”. Alf was aware there was something that felt “wrong” about the responses, without being able to say why. It was in conversation afterwards with Laurinda, that Alf recognised that although he was trying to get the prospective teachers to make links to action (lines 3, 5), this can only be done meaningfully from a statement that is already in the middle (or basic) layer. “I want to be more confident” had to shift, before the prospective teachers could meaningfully engage in sharing strategies. Jo’s articulation (line 8), “I was floored by having all the attention” is a statement at this middle layer, a “purpose”, although Alf did not recognise it at the time. Following line 8 was the time when Alf could have usefully asked what he did in line 3, for example: “Anyone got an offer, then, how can I work as a teacher so that I don’t have attention on me?” Alf’s learning, in this story, is about extending his capacity to turn statements from prospective teachers into invitations to action that they can use to support their own development. Our praxis is about opening up possibilities for new action through awareness, both for ourselves and our students (the prospective teachers).

By focusing prospective teachers’ attention on issues (arising from their experience, such as “how can I work so that I don’t have attention on me?”), we side-step potential clashes in philosophical standpoints (both between members



of the group and, later, between prospective teachers and teachers in their schools). No matter what you think you believe about teaching, you can engage in finding strategies linked to purposes at the basic (middle) layer. No matter what your beliefs about teacher education, it is possible, as we observe Alf doing, to work on developing the sensitivity to notice when statements arise in discussion that are ones where a meaningful sharing of strategies can take place.

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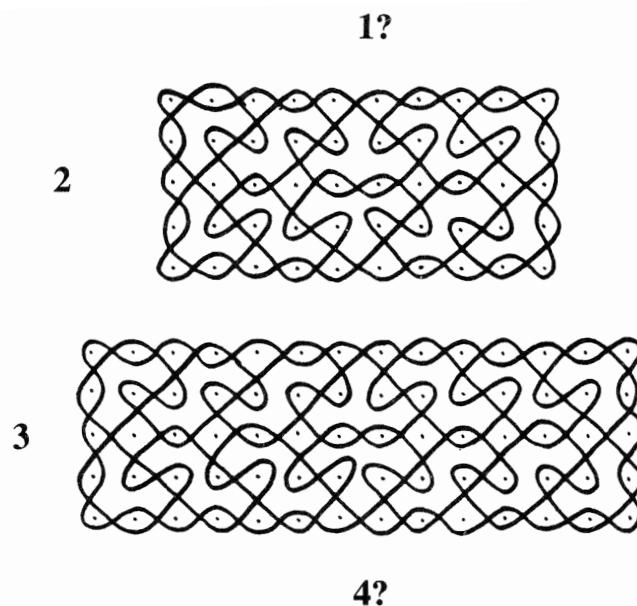
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