Exploring mathematical identity as a tool for self-reflection amongst pre-service primary school teachers: “I think you have to be able to explain something in about 100 different ways”

Patricia Eaton, Stranmillis University College, Stranmillis Road, Belfast, BT9 5DY, Northern Ireland  p.eaton@stran.ac.uk

Maurice OReilly, CASTeL (Centre for the Advancement of Science Teaching and Learning), St Patrick’s College, Drumcondra, Dublin 9, Ireland  maurice.oreilly@spd.dcu.ie

Abstract
A study of students’ mathematical identity was carried out in February 2009 involving participants from two colleges of education, one in Dublin (Republic of Ireland) and one in Belfast (Northern Ireland). All participants were pre-service primary school teachers in the third year of their B.Ed. programme, having chosen to specialize in mathematics. Data was gathered using a questionnaire (with, mainly, open-ended questions) followed by focus groups, involving the same participants, on each campus. This paper considers how students’ exploration of their mathematical identity led them to deepen their insight into learning and teaching mathematics. Recommendations are made for how the methods used in this research might be beneficial on a larger scale, in different environments.

Introduction
Much has been written for over a decade on the links between the beliefs about, attitudes towards and self-efficacy in mathematics, on the one hand, and classroom practice, on the other. This discourse has flourished as understandings of the shift from a didactic to a constructivist approach to teaching mathematics have deepened. In this context, how is it possible to value the diversity of student teachers’ own experience in learning mathematics as they prepare for their teaching careers?

It has been suggested that student teachers are more likely to teach mathematics in ways in which they were taught (Meredith 1993). To gain insight of this in the case of a particular cohort of students would in itself be sufficient reason to explore their previous experiences of learning mathematics. In the study about to be described, a broader view is taken. Instead of considering only their previous experiences in learning mathematics, student teachers’ mathematical identity was examined in some detail. Moreover, participants were encouraged to reflect on how their mathematical identity evolved over time and on how they might draw on it throughout their teaching careers. By ‘mathematical identity’ is understood the relationship an individual has with mathematics, including knowledge and experiences as well as perceptions of oneself and others (Wenger 1998).

The study and the focus of this paper
The study was carried out in February 2009 involving participants from two colleges of education, one in Dublin (Republic of Ireland) and one in Belfast (Northern Ireland). All participants were pre-service primary school teachers in the third year of their B.Ed. programme, having chosen to specialize in mathematics. Data was gathered using a questionnaire (with, mainly, open-ended questions) followed by focus groups, involving the same participants on each campus, five in Dublin (but only four of whom participated in the focus group) and four in Belfast. The participants’ mathematical sophistication was significantly higher than is typical amongst pre-service primary school teachers in Ireland. This afforded the opportunity to explore two mathematically motivated sub-populations in some detail, although, in this paper, no attempt will be made to distinguish between the characteristics of the two groups. Here the focus will be on how student teachers’ mathematical identity can be harnessed as a tool for self-reflection and, in particular, how participants re-evaluated the teaching they themselves experienced.

On the questionnaire (which took about thirty minutes to complete), participants were prompted into revealing their mathematical identity by being asked: ‘Think about your total experience of mathematics. Tell us about the dominant features that come to mind.’ And later: ‘Describe some further features of your relationship with mathematics over time.’ The discussion in the focus
groups (each lasting almost an hour) explored aspects of mathematical identity drawing on the responses to the questionnaires.

**How participants re-evaluated the teaching they themselves experienced**

In examining their responses, we note that participants are drawn into the interacting narratives of their mathematical identities. Of particular relevance to the current discussion are their own experiences as learners of mathematics and their emerging practice as teachers either in the classroom or as tutors to individuals. We can perceive moments of re-evaluation of these experiences as well as speculation on how participants might teach in future. In this section, participants’ contributions (which are indented) are grouped around key ideas, highlighted in bold.

Participants engaged enthusiastically in the discussion exploring mathematical identity, expressing surprise at being stopped in their tracks to think about it; such exploration was new to them.

I’ve never traced back before why I was ever interested in maths and where it actually came from, but I felt when I was doing out the questionnaire that it came from my family and it came from my teachers up through the years, their interest and their like of maths brought me to like maths. Yeah, and also the questionnaire kind of had, make you stop and think to say that, ‘Oh, certain things did really influence me and other things didn’t, I don’t really pay much attention to.’ But it does, like the questionnaire did kind of, made me think. But it’s when you look back, you realize like, ‘Well, that’s why we did that certain thing’ or ‘That’s when we …’ It’s kind of I had never really thought about it before.

They readily acknowledged that **satisfaction in mathematics does not arise without effort**.

Speaking of her experience of giving private tuition to a student preparing for examinations at the end of secondary school, one participant recalled: And she, I’ve heard her saying, I don’t know whether she knows herself, but I’ve heard her saying, ‘Yeah, it took me ages, and then I finally got it.’ And you can hear the enjoyment in a person’s voice when they say that.

Her colleague emphasized the importance of **perseverance**: Just encouraging them to try it out, basically. Like instead of focusing on whether it’s right and wrong all the time, get them to try it at least. And just keep trying it.

**High expectations** of a teacher in the mathematical ability of his/her student are very likely to contribute significantly to the student’s appreciation of the subject, as one participant wrote: I think that my most influential teacher in maths was my secondary school teacher. Admittedly he wasn’t the best maths teacher in the world, but his love of maths was clear and obvious to the class. Perhaps it was his love that rubbed off on me, I’m not sure, but one thing I know is that he always had high expectations for me. He always pushed me to do my best and I felt compelled to live up to these expectations.

Another explained that she came to appreciate later how one of her teachers **supported individual learning**: I had two different Maths teachers at second level and one in particular I think really helped my enjoyment & understanding of Maths. I didn’t think so at the time as he was a hard taskmaster who gave great importance to his subject and for whom you could never do enough. Looking back on it, I admire how he placed great emphasis on individual learning and individual responsibility. Our Maths lessons were more ‘workshop style’ than other lessons. We worked independently until a common problem was encountered which he would then explain. If you required personal attention he would sometimes get another pupil to explain to you or do it himself. This meant that you could work at your own pace and level though he gave you a push when required!

The effectiveness of **working cooperatively** at mathematics in their university studies was discussed in both focus groups. Drawing on her experience, one participant is eager to incorporate it in her own teaching:

And you can encourage them to work together more, now that you know that it works, as opposed to individual working on your own.

Amongst those in the Dublin focus group a discussion arose on the importance of relating mathematics to **practical applications**. This was absent from their experience in secondary school.
Like if you’re doing the practical thing in primary school, it should continue to secondary school because that’s the kind of thing that they’re used to.

People think that bringing in a practical aspect into secondary school would dumb it down, or people say that all the time. But I don’t think it would. … I think that if the practical aspect was in it, that they would be able to bring maths to a higher standard, rather than a lower standard.

This last participant criticized the apparent disconnected nature of topics in school mathematics in the light of her third level studies:

And I found in secondary school that everything was not linked. Nothing was linked in maths, you know. The algebra and the geometry weren’t linked, and where there’s such a close, a big link between them or the algebra and the complex numbers were two totally different things that you’d never put together like ... But in college, we do. You do put them together then, yeah ... It’s so linked, it should be linked.

The Belfast focus group also articulated the absence of context in their secondary school mathematics, in contrast to their experience in primary school.

I remember when we sat there in the class, every day, we’d be like, ‘What do you need this for?’ And our teacher sort of wouldn’t be able to turn round and actually tell us what we needed it for, you know. ... It was part of the syllabus. Had to learn it. In the primary school there was always a, like a relevant context. ... Then you get to secondary school, it’s more forget the context, just do the question.

Out of this awareness emerges a conviction that teaching can improve. When understanding mathematics is fostered amongst pre-service teachers at third level, it can be imparted to the children they will teach in future.

I think in third level when we’re learning why there’s certain proofs and why certain things is the way it is, make us much better teachers because we can actually show the kids why there’s a certain formula instead of just, ‘Here, learn it off.’ So I think it’s our understanding of maths has really improved. And I really think it’ll benefit the kids we teach.

If they can put across the understanding, that’s when they become a good teacher, I think. I think you have to be able to explain something in about 100 different ways. I think you have to give enough information for the kids to start a question themselves so that you don’t give too much information to make it easy, but you give enough information that they can make a start.

And then after that, deal with individual problems as they arise because you can’t treat everyone the same because they all learn and will grasp ideas at different paces.

Discussion and recommendations

So, what is noteworthy from these narratives? In the study conducted in a period of less than three hours (across the two campuses), we have witnessed pre-service teachers’ thoughtful reflections on aspects of their own learning. Their reflections gave rise to recommendations in areas such as the importance of individual learning, emphasis on the practical applications of mathematics, linking topics in the mathematics curriculum that are traditionally kept separate, and the enrichment of the context of mathematics lessons. Participants indicated how their experiences might orientate their own approach to teaching by valuing perseverance, encouraging cooperative study and fostering understanding.

Situating these reflections in a broader setting, we note that Papert (2009, p. 134) makes a strong case for doing and creating to happen in tandem with thinking and understanding, while Egan (2009, p. 150) argues that children make sense of the concrete better when it is tied to underlying abstractions. The general disposition of participants in our study is consonant with the thinking of these two authors. In considering Irish teachers’ perspectives on mathematics, a high emphasis on memorising of formulae and procedures as opposed to understanding how mathematics is used in the real world has been reported (Lyons et al., 2003, chap. 9). Our participants appear to challenge this prevailing orthodoxy.

There are many factors that have a potential bearing on the future mathematics teaching of pre-service teachers. The authors consider the importance of the influence of others, such as teachers and family members, elsewhere (Eaton and OReilly, 2009a). Here we are making a case for exploring mathematical identity through narrative for re-evaluating pre-service teachers’ own
experience of being taught mathematics. We believe the approach adopted in this study can be gainfully applied to other groups, for example, to larger groups of pre-service primary teachers who do not necessarily specialize in mathematics, to pre-service post-primary (secondary) school teachers and to practicing teachers, at both levels, as part of continuing professional development (CPD). It would be fruitful to spend sixty to ninety minutes, in two sessions, the first prompting participants to focus on their mathematical identity by completing a questionnaire, the second exploring, through discussion, issues which arise from the questionnaire including re-evaluating the teaching they experienced. Depending on the group of teachers or students involved, the questionnaire might be informed by appropriate existing research such as Smith (2006) or Kaasila (2007) for pre-service teachers, and Back et al. (2008) for CPD.

**Conclusion**

So the process of using narrative to draw students’ attention to their own mathematical identity is a very valuable one. From the experience of this study, we maintain it is an efficient method for drawing attention to the bigger picture of teaching mathematics. Such reflection is not the norm amongst pre-service teachers in (either part of) Ireland. To remember how they were taught, to discuss the memories and in doing so to tease out and distil important issues in the complex process of how they learned mathematics, will bring greater awareness to the professional practice which lies ahead of them. This exercise is also of value to lecturers in getting to know more intimately the formative context of students, and so lead students more effectively to a deeper understanding of mathematics, its learning and its teaching.

**Acknowledgement**

This paper arises from a study entitled “A cross-border comparison of Student Teachers’ Identities relating to Mathematics” (MIST) and supported by the Standing Committee on Teacher Education, North and South (SCoTENS). The authors are grateful for this support. An overview of the study will appear shortly (Eaton and OReilly, 2009b).

**References**