

***What other people think and why it matters?
An investigation of key influences on mathematical identity***

Patricia Eaton and Maurice O'Reilly

p.eaton@stran.ac.uk

m.oreilly@spd.dcu.ie

*Stranmillis University College, Belfast Northern Ireland and
St Patrick's College Drumcondra, Dublin, Ireland*

Abstract

Mathematical identity is an overarching idea used to describe the multi-faceted relationship that an individual has with mathematics, including knowledge and experiences, perceptions of oneself and others. This paper reports on a study using narrative, of mathematical identity among pre-service teachers and focuses on the role played by teachers, family and peers in influencing this identity. An analysis of this role can provide insight into societal mathematical engagement, reveal the influences on those choosing to continue to study the subject to a higher level and help students to identify key formative critical factors for their own pupils.

Key Words

Mathematical Identity, Pre-service teachers

Abstract

This paper examines aspects of the findings from a study of mathematical identity among pre-service teachers. The participants were drawn from two colleges of education, one in Dublin (Republic of Ireland) and one in Belfast (Northern Ireland) and all were pre-service primary school teachers in the third year of their Bachelor of Education programme, having chosen to specialise in mathematics. Data was gathered using a questionnaire (with, mainly, open-ended questions) followed by focus groups, involving the same participants, on each campus

The aim of the SCoTENS funded project is to explore the mathematical identities of primary school student teachers. *Mathematical identity* is an overarching idea used to describe the multi-faceted relationship that an individual has with mathematics, including knowledge and experiences, perceptions of oneself and others. Narrative has been an emerging tool in recent years in to access complex multi-layer identities it is used here as a tool to access mathematical identity. It is anticipated that, by analysing the resulting data, some insight will be gained into the formation of mathematical identity amongst such a select well-motivated group. Moreover, by providing an opportunity for students to tell a story about their own relationship with mathematics, identity will be articulated and themes will come to the fore that give insight into their thinking.

One such key theme arising from an initial study of the findings is the role played by key figures such as teachers, family and peers in the mathematical life of the students. Through self-reflection on how influential particular teachers were in their own formation, it was envisaged that the students would engage in a meta-analysis of the impact of their own behaviours on their pupils. An analysis of the role played by other significant figures can provide insight into societal mathematical engagement and reveal the influences on those choosing to continue to study the subject to a higher level. An understanding of this can help the students to identify key formative critical factors for their own pupils, in particular the importance of peer pressure both inside and outside the classroom.

These findings will have resonance with those seeking to attract more adherents to mathematics, as the role played by the attitudes of society to what is traditionally thought of as a difficult and challenging subject is uncovered. The impact of societal dispositions on participants, as expressed and experienced through family and peers, illuminates the power that attitudes have to shape decisions about future study of mathematics.

Introduction

As the international view of teaching has shifted from didactic to constructivist with its image of learner as participatory, so research on teacher education has moved from a focus on the transfer of a body of knowledge to a more dynamic view of the classroom, with teachers being facilitators of learners' knowledge construction. In this view of teaching, teacher beliefs and attitudes play an important role in shaping classroom practice (Bolhuis and Voeten 2004) and there is a substantial body of evidence examining this supposed link between teachers' attitudes to and beliefs about mathematics and teaching, and classroom practice (Ernest 1988, Bishop and Nickson 1983, Fang 1996, Macnab and Payne 2003, Dunphy 2007, Horgan and O'Loughlin 2007).

In particular, the experiences that a student has during their own formative years in the classroom as a pupil have been shown to have a major impact on their behaviour as a teacher (Ernest 1988, Ball 1988, Hill 2000). It seems to be the case that student teachers revert to models of teaching that they themselves have experienced rather than try the often new and unfamiliar models that they study during their teacher education programmes (Borko et al. 1992).

It is thus important, at the beginning of any teacher education programme, to explore the previous experiences of the student teachers in their learning of mathematics, as these will be the major influence for many students on their teaching style. Often, when teacher education courses are designed, little consideration is given to the "baggage" with which students are already burdened and it is perhaps for this reason that student teachers are more likely to teach mathematics in ways in which they themselves were taught (Ball 1988, Meredith 1993).

The fact that this "baggage" carried by student teachers is multi-dimensional, in that it includes cognitive, affective and indeed meta-affective domains, makes it elude accurate identification. One way of attempting to unpack this "baggage" is through the consideration of mathematical identity, an overarching phrase used to describe the multi-faceted relationship that an individual has with mathematics, including knowledge and experiences, perceptions of oneself and others (Wenger 1998).

One emerging tool in recent years to help access identity has been that of narrative (Clandinin & Connelly 2000, Kaasila 2007). It is hoped that by allowing students to tell a story about their own relationship with mathematics, identity will emerge and themes will come to the fore that give insight into their thinking. In the study under consideration, the researchers intend to investigate the mathematical identity of two groups of student teachers self-selected to study mathematics in some depth as part of their undergraduate programme.

One such key theme arising from an initial study of the findings is the role played by key figures such as teachers, family and peers in the mathematical formation of the students. Through self-reflection on how influential particular teachers were in their own formation, it was envisaged that the students would engage in a meta-analysis of the impact of their own behaviours on their pupils. An analysis of the role played by other significant figures can provide insight into societal mathematical engagement and reveal the influences on those choosing to continue to study the subject to a higher level. An understanding of this can help the students to identify key formative critical factors for their own pupils, in particular the importance of peer pressure both

inside and outside the classroom. Such understanding acknowledges implicitly the social contexts or 'ecologies' of learning mathematics (Esmonde 2009).

These findings will have resonance with those seeking to attract more adherents to mathematics, as the role played by the attitudes of society to what is traditionally thought of as a difficult and challenging subject is uncovered. The impact of societal dispositions on participants, as expressed and experienced through family and peers, illuminates the power that attitudes have to shape decisions about future study of mathematics.

Methodology

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 specialise 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. Moreover their mathematical sophistication was significantly higher than is typical amongst pre-service primary school teachers in Ireland. These two factors 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. An overview of the study will appear shortly (Eaton & O'Reilly, 2009b). Here the focus will be on the influence that key figures had in creating the student teachers' mathematical identity.

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." The aim of these initial sentences was to allow the most prominent recollections to emerge without giving students explicit directions as to which recollections *should* be most prominent. It was felt that had this starter contained explicit reference to events or individuals or stages of study this would suggest that respondents should focus on these. Instead, by having an open-ended initiator, it was anticipated that the most dominant feature would emerge first and that the nature of this initial response would in itself be indicative of powerful influences on mathematical identity. After completion of this initial section, lasting approximately ten minutes but allowing all respondents to complete as fully as they desired, a second page was distributed, this time with more direction to encourage students to reflect on a wider range of features:

"Now think carefully about all stages of your mathematical journey from primary school (or earlier) to university mathematics. Consider:

- Why you chose to study mathematics at third level
- Influential people
- Critical incidents or events
- Your feelings or attitudes to mathematics
- How mathematics compares to other subjects
- Mathematical content/topics

With these and other thoughts in mind, describe some further features of your relationship with mathematics over time.”

It was expected that these prompts would encourage respondents to consider areas that may have been influential but which did not spring immediately to mind, rather than act as list of questions each of which was to be answered in turn.

The texts from the questionnaire were analysed for recurring themes and seven clusters of issues were identified to give the subsequent focus group discussions some direction:

- Reflections on the questionnaire
- The changing nature of maths as experienced from early childhood to now
- The balance between challenge and interest
- Critical events
- Attitudes of other people
- Ways of studying maths
- Persistence/perseverance with maths

The discussion in the two focus groups (one on each campus facilitated by the researcher from the other institution) was directed largely by these issues, while maintaining an informal conversational atmosphere.

Results

The complete set of field texts consisting of questionnaire responses and transcripts of focus groups was analysed to identify common threads and themes (Clandinin and Connelly, 2000). One strongly emerging theme was that of the influence of key people on the mathematical identity of the students. Perhaps unsurprisingly, teachers were seen to be critical with family also playing a key role. The views and attitudes of peers appeared to be significant at particular stages of the mathematical journey.

Teachers

The students reflected on the significant role played by teachers in influencing their own attitude to the subject:

My A-level maths teacher was a great influence on me as she made her lessons practical, with a point in mind and she was always there to help. I have gained a positive attitude to maths as all maths teachers I have had experience with have been positive and encouraging.

My fifth year teacher showed me a different side to maths a side where learning off by heart was not necessary and you could take your time and work things out.

Some students identified the impact that teachers had in setting their attitudes at an early stage:

My Junior Certificate teacher was very influential. I feel that the maths teacher that you have within school especially primary school greatly determines how I feel/felt about maths.... I felt that she had a great love for maths which I would like to transfer to my teaching kids.

It is apparent here that in engaging in the reflection on previous experiences, this student is already thinking about what impact her own attitude to mathematics will have on the pupils she will teach.

When pressed to articulate why particular teachers had been so influential, students expressed views more about the contagious love and enthusiasm for the subject rather than any particular teaching style or technique:

Observing their enthusiasm and enjoyment for maths like my own, has encouraged and influenced me greatly in wanting to also share my own interests in it with other people.

My secondary school teacher was quite a big influence for me, but I think it's more to do with them having the interest... in maths, and them wanting to sort of make you interested in it as well.

However some did identify particular approaches to teaching that were memorable:

That's what I loved about her, that she helped you at the stage that you were at, instead of just coming out and giving you the answer.

It's if they can get, if they can put across the understanding, that's when they become a good teacher, I think.

Not all had experienced positive teaching throughout their careers:

She was very, very old-fashioned and was not very friendly towards people and put an awful lot of people off maths.

One student separated the ability to teach from the enjoyment of the subject and commented:

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 student in the following quotation identifies characteristics of what she classifies as poor teaching in her background and consciously chooses to change her style of teaching so as to avoid inflicting her own experience on pupils:

In secondary school especially, it was all very blackboard and copy. There was no practical element to it whatsoever. I would never dream of going in and teaching a maths lesson and not having practical things to do.

Attention was drawn to the role that teachers played in determining whether or not the students continued the study of mathematics to a higher level:

The reasons for choosing maths and for choosing to teach it also has been to the teachers and tutors that have taught me.

Family

The role that family played in shaping the views of the students was also reflected in the comments of a number of students, although some had the good fortune to have family members who were also maths teachers:

The people who possibly influenced me were my mother and my aunt, who is a mathematics teacher.

My mother is a Maths teacher and so is my uncle so I suppose Maths always was viewed in a positive light in my household.

My father was consistent in helping us with maths problems and showed a great love for the subject himself.

Seeing him (Dad) work with numbers and you know, that encouraged me to want to work with numbers.

A number of students suggested that it was the fact that their parents were not interested or not good at maths that actually made the parents push their own children harder in that subject as if to somehow make up for their own lack of interest or ability:

My mum hates maths, is terrible at it and she's had a very bad experience at school, but then that encouraged her to push me into maths because she has had a block when it came to maths. Her fear of maths... she used that to encourage me to be good at maths because you know, she couldn't help me.

My mum and dad are awful at maths, and it was just a kind of a thing that you were kind of looked upon as being different doing maths.

However some parents had more pragmatic reasons for encouraging their children to pursue the study of mathematics:

Both my parents were quite encouraging, pushing me to do/be good at maths, you know, because they see that it's useful to everyone in everyday life in some form, you know.

Peers

The students were asked about how, as maths specialists, they were viewed by their peers. Undoubtedly students were aware of the negative views often associated with mathematics:

Or you sometimes get 'How can you do maths?' ... like it's the worst thing ever. I think maths has a stigma. You get used to it. But at the start, you're like, 'What's wrong with my subject? I like it.'

However there was almost a sense of pride or achievement in studying a subject that many view as very difficult:

Influential people would have included people around me in college. As people saw this subject as difficult, I saw it as a greater challenge.

They sort of take a step back, 'Oh, you're doing maths. Oh, you must be really smart.' I think if you say to somebody that you're doing maths in college, it's looked higher upon than if you'd said you're studying English.

And another reason (for keeping it on) because it's so much approved by other people that you're doing it as well, I suppose.

A few principals have said it to me that it looks very impressive, to have maths.

As well as being impressed by the difficulty of the subject there is also a stereotypical view of mathematics expressed by peers that the students were aware of:

But first impressions from people you don't know is usually, 'Oh no.'

People more are, are more impressed when you say that you do maths, but they're also more critical in a way of your social abilities, I think. Like 'you big nerd. You're doing maths'. And it's so normal to be doing maths, it seems to me. And I don't think it affects any of our social abilities at all, yet they would presume and label you as having lower social abilities or they're not great to go out with because you do maths.

While this peer pressure may have been important to them at an earlier stage it seems that by now the prestige and enjoyment of studying maths more than compensate for the slur on social abilities.

They (opinions) used to [matter]. But not any more.

Conclusion

The students surveyed have all chosen to study mathematics at a higher level as part of a bachelor of education programme and the journey undertaken to reach that point of decision is a complex and personal one. However an analysis of the findings from this group suggests that one of the common themes to emerge is the importance of other people in shaping identity in relation to mathematics. The role of the teacher was highlighted as being very influential although less in the details of the teaching and more in the attitudes and enthusiasm displayed for the subject. As the students reflected on the importance of their own teachers they explicitly made links between these reflections and their own classroom practice as future teachers. This theme of how student teachers' mathematical identity can be harnessed as a tool for self-reflection thus impacting on practice is further explored in a recent study (Eaton & O'Reilly, 2009a).

Family also played a part in influencing the study of mathematics although there were various motives suggested for parents in so doing. Some students were inspired by parents who demonstrated a great love of the subject or who used mathematics in their own careers, others by parents whose abhorrence of or weakness in mathematics caused them to encourage their children all the more. Some parents took a more pragmatic view of the usefulness of mathematics to future careers echoing the commonly held notion that maths is an important and difficult subject and those who study it worthy of praise.

The perception of peers was that mathematics is a hard and challenging subject and that those who study it are simultaneously worthy of praise for being intelligent yet are stigmatised as socially inadequate. The students acknowledged the powerful effect of such attitudes while noting that their importance had diminished substantially by this stage of their career.

It is clear that people have been very influential in shaping the mathematical identity of these students. The experience of reflecting on this has given students the opportunity to think about their own teaching at a deeper level and will have direct consequences for the recollections of future generations about the role played by these teachers-to-be. They have become more aware of the importance of their own attitudes as teachers and of the powerful impact of the opinions of family and peers on their own future students.

References

- Ball, D. L.: 1988, 'Unlearning to Teach Mathematics', *For the Learning of Mathematics*, 10 (2), 10-16.
- Bishop, A.J. & Nickson, M.: 1983, *A Review of Research in Mathematical Education, Part B*, NFER-Nelson, Windsor.
- Bolhuis, S. & Voeten, J.M.: 2004, 'Teachers' Conceptions of Student Learning and Own Learning', *Teachers and Teaching: theory and practice*, 10 (1), 77-98.
- Borko, H., Eisenhart, M., Brown, C., Underhill, R., Jones, D. & Agard, P.: 1992, 'Learning to Teach Hard Mathematics: do novice teachers and their instructors give up too easily?', *Journal for Research in Mathematics Education*, 23(3), 194-222.
- Clandinin, D.J & Connelly, M.: 2000, *Narrative Enquiry: Experience and Story in Qualitative Research*, Wiley, San Francisco.
- Dunphy, E.: 2007, 'Exploring pedagogy in early years mathematics for children in the first year of primary school in Ireland: A survey of teachers' views', *Procs. Second national conference on research in mathematics education, MEI 2*, Eds Close et al., (pp 290-307) Dublin.
- Eaton, P. and O'Reilly, M.: 2009a, 'What other people think and why it matters? An investigation of key influences on mathematical identity', submitted to 10th International Mathematics Education into the 21st Century Conference *Models in Developing Mathematics Education*, Dresden.
- Eaton, P. and O'Reilly, M.: 2009b, 'Who am I, and how did I get here? Exploring the Mathematical Identity of Student Teachers', submitted to the 3rd National Conference on Research in Mathematics Education (MEI), Dublin.
- Ernest, P.: 1988, 'The Attitudes and Practices of Student Teachers of Primary School Mathematics', *Proceedings of 12th International Conference on the Psychology of Mathematics Education, Hungary*, 1988, Vol. 1, A. Borbas (ed).
- Esmonde, I.: 2009, Ideas and Identities: Supporting Equity in Cooperative Mathematics Learning *Review of Educational Research* 79(2) 1008-1043
- Fang, Z.: 1996, 'A review of research on teacher beliefs and practices', *Educational Research*, 38, 47-65.
- Hill, L.: 2000, 'Theory, Practice and Reflection: a Pre-Service Mathematics Education Programme' *Teachers and Teaching: Theory and Practice*, 6 (1), 23-39.
- Horgan, K. and O'Loughlin, N.: 2007 'Here we go again!: Researching the role of teacher attitudes toward maths as they embark on a theoretically based early numeracy intervention programme', *Procs. Second national conference on research in mathematics education, MEI 2*, Eds Close et al., (pp 308-324) Dublin.
- Kaasila, R.: 2007, 'Using Narrative Inquiry for Investigating the Becoming of a Mathematics Teacher', *ZDM-International Journal of mathematics Education*, 39 (3), 205-213.
- Macnab, D. S. & Payne, F.: 2003, 'Beliefs, Attitudes and Practices in Mathematics Teaching: perceptions of Scottish primary school student teachers', *Journal of Education for Teaching*, 29 (1), 55-68.
- Meredith, A.: 1993, 'Knowledge for Teaching Mathematics: some student teachers' views' *Journal of Education for Teaching*, 19 (3), 325-338.
- Wenger, E.: 1998, *Communities of Practice: Learning, meaning and identity* Cambridge: Cambridge University Press.