MATHEMATICAL BORDERS? COMPARING STUDENT TEACHERS' MATHEMATICAL IDENTITY IN IRELAND NORTH AND SOUTH

Patricia Eaton, Aisling McCluskey & Maurice OReilly

Stranmillis University College, NUI Galway & CASTeL, St Patrick's College

Mathematical identity is considered as the multi-faceted relationship that an individual has with mathematics, including knowledge and experiences, perceptions of oneself and others. The SCoTENS funded project, named MIST, examined the mathematical identity of student teachers who had chosen to specialise in mathematics in their B.Ed. programme. Students were drawn from two institutions, one in Northern Ireland, one in the Republic and narrative was used as a tool to access mathematical identity. This paper reports on the analysis of similarities and differences between the mathematical identity of these students teachers in each part of the island of Ireland and discusses how this informs our reflections on the mathematical education experienced.

INTRODUCTION

Two of the authors, Eaton and OReilly, have been exploring mathematical identity of student teachers for the past two years based on data gathered in Belfast and Dublin in February 2009. Mathematical identity is considered as the multi-faceted relationship that an individual has with mathematics, including knowledge and experiences, perceptions of oneself and others (Wenger, 1998). The SCoTENS funded project, named MIST (Mathematical Identity of Student Teachers), examined the mathematical identity of student teachers who had chosen to specialise in mathematics in their B.Ed. programme. Students were drawn from two institutions, one in Northern Ireland, one in the Republic. Narrative (Clandinin & Connelly, 2000; Kaasila, 2007) was used as a tool to access mathematical identity. The narrative material was gathered in two stages. The first stage involved a questionnaire with open-ended prompts giving respondents the opportunity for their mathematical story to flow freely. This was followed by use of focus groups, one in each institution, to elicit further narrative development.

Several aspects of their work have been reported (Eaton & OReilly, 2009a, b, 2010a, b), yet until now no explicit attention was paid to the similarities and differences between students in the Republic of Ireland and in Northern Ireland with respect to mathematical identity. McCluskey, the third author, is an academic mathematician originating from and educated in Northern Ireland. Her background together with a long-standing academic position in a university in the Republic underlines a keen interest in mathematics education and an informed sensitivity to mathematical and other cultural nuances in both jurisdictions of Ireland. She joined the research team

at a time when it was considered desirable to review the data with a fresh lens, at some distance from the subjects of the investigation and from the previous analysis.

Recent consultative and policy documents from both Teaching Councils and Government Departments, North and South, have drawn urgent attention to the importance of improving mathematics teaching and learning (GTCNI, 2007; DELNI, 2009; DES, 2010a; Teaching Council, 2010). The urgency arises for both economic and social reasons, and has generated much debate and discussion not just amongst policy-makers and educational specialists, but also amongst the public at large. In this context, understanding student teachers' mathematical identity is of critical importance because, as is widely indicated in the literature, it is likely to have a major impact on their agency and behaviour as teachers (Esmonde, 2009).

In this paper we explore the similarities and differences between two well-motivated groups of student teachers, one group in Belfast and the other in Dublin. Preliminary exploration indicates a notable disparity in terms of mathematical identity, fostered by two quite different educational systems. These findings will inform the understanding of mathematics teaching and learning, North and South, which will in turn contribute to the wider discourse around the STEM agenda.

BACKGROUND

The education systems in place in the North and South of Ireland differ considerably in their structure. Primary education in the North begins at age 4 and lasts for 7 years while in the South it begins at about the same age (4 or 5) but lasts for 8 years. The mathematical curriculum in primary schools across the island is however broadly similar throughout these years. In each jurisdiction, schooling is compulsory until age 16. Discussion of selection procedures (including examinations) for admission to post-primary schooling is beyond the scope of this paper. In Northern Ireland, end of Key Stage exams involving formal assessment in mathematics take place at the end of Key Stage 1 (age 7), Key Stage 2 (age 11) and, until recently, Key Stage 3 (age 14). At the age of 14, students then choose which subjects to continue to pursue for General Certificate in Secondary Education (GCSE) examinations. These examinations are usually completed at the age of 16 following two years of study. Schooling, and the study of mathematics therein, is compulsory until the age of 16 but it is not compulsory for every child to undertake the GCSE examination. In the Republic, by the age of 16, children have taken one formal examination, the Junior Certificate (typically at age 15). Otherwise, pupils will have experienced standardised testing throughout their primary school years with 95% of teachers administering standardised tests in maths to pupils in 2nd class (age 7-8) at least once in 2008-09 and 90% doing likewise for 6th class (age 11-12) in the same year (DES, 2010b). Both the GCSE and the Junior Certificate examinations allow candidates to sit mathematics at one of three different levels.

In Northern Ireland, the usual route for entry into higher education is to take Advanced level examinations (A-levels), a two year course of study with final examinations at age 18. Most students taking A-levels choose three subjects although some do take four and a very small number may take more. A-level Mathematics remains a popular choice with 2157 students in Northern Ireland taking the final examination in this subject in June 2010. This placed mathematics third behind Biology (2715) and History (2309).

In the Republic of Ireland, post-primary schooling starts a year (or two) later and is compressed into five or six years: three years of the Junior Cycle leading to the Junior Certificate Examination and two (or three, if the transition year is taken after the Junior Certificate) years of the Senior Cycle culminating for most pupils in the Leaving Certificate Examination. Mathematics is compulsory at Junior Certificate level and it is effectively compulsory at Leaving Certificate, as it is requirement for most further or higher education courses. As in Junior Certificate, Leaving Certificate mathematics is offered at three levels: foundation, ordinary (pass) or higher (honours). In 2010, 52290 students took mathematics (5997 at foundation level, 37903 at ordinary level and 8390 at higher level) in the Leaving Certificate, or 96.0% of all those taking that exam. Most students take seven subjects at Leaving Certificate, at levels according to their ability or inclination. Mathematics is exceptional not only because it is taken by more students than any other subject, but because it is taken at higher level by the smallest proportion (only 16% in 2010) of students taking the subject than any other subject (SEC, 2010).

It is of interest to compare the numbers taking mathematics at the highest available level at school in each jurisdiction: 8390 in the Republic and 2157 in Northern Ireland. The population of the typical-age cohort in the South is about 2.3 times that in the North – the number of 18-year olds in 2009 was estimated at about 57900 compared to 25100 (CSO; NISRA). Although 8390 is 3.9 times 2157, the uptake of higher level mathematics in the Leaving Certificate in the South is considered low (by far the lowest uptake at higher level across all subjects), while that of A-level mathematics in the North is considered high (the third most popular across all subjects).

A recent curricular innovation in the Republic has been the introduction of Project Maths which has impacted on the delivery and assessment of mathematics at post-primary level and encourages a more problem-based approach to mathematics. Students in the data set underpinning this article would however not have had experience of these changes.

METHODOLOGY

The study was carried out in February 2009 involving participants from two colleges of education, one in Dublin and one in Belfast. 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 (cf. Corcoran, 2005). In particular, 2.8% of the B.Ed. cohort in Dublin and 15% of the Belfast cohort chose to take mathematics to degree level. These two factors afforded the opportunity to explore two mathematically motivated sub-populations in some detail.

Particular attention was paid to the challenge of gaining access to students' mathematical identities through narrative by stimulating recollections but without being directive in doing so. In designing the questionnaire, the aim was to balance the need for some direction with the need to allow respondents to make open-ended responses that were indicative of their personal mathematical identity. A draft questionnaire for participants was prepared some ten weeks in advance of gathering data. This timing enabled it to be piloted amongst research colleagues from five institutions at a meeting in NUI Maynooth. In addition to some fine changes to the text of the questionnaire to avoid ambiguities, this group made the recommendation that the data might be collected without direct involvement of either of the researchers with his/her own students. The researchers acknowledge with appreciation the attention to detail of these colleagues. In due course, the questionnaire was administered on each campus by the researcher from the other institution.

The questionnaire began with two questions on participants' backgrounds followed by some questions on their attitudes to mathematics (using Likert scales). This paper does not address the quantitative data gathered in that section. Participants were then 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 provide an opportunity for 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 intended 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. There was no attempt at any stage to distinguish between the two groups in the questions asked or the issues probed – indeed every effort was made to ensure that the initial prompt questions in the focus groups were identical although obviously the flow of conversation inevitably allowed differences to emerge. At no stage were the participants explicitly asked to reflect on education systems or structures.

Seven main themes emerged from the MIST study (Eaton & OReilly, 2009b). We outline each of these in turn:

1. **Harnessing student teachers' mathematical identity as a tool for self-reflection** relates to how students' exploration of their mathematical identity leads them to deepen their insight into learning and teaching mathematics.

2. **The role played by key figures in the formation of mathematical identity** focuses not only on teachers and family members, but also on peers and society at large.
3. **Ways of working in mathematics** explores what students find effective in learning mathematics and why, either through individual endeavour or through collaboration.
4. **How learning mathematics compares with learning in other subjects** considers the particular characteristics of learning mathematics, usually at school, that distinguish the process from learning in other subject areas.
5. **The nature of mathematics** draws from a broad range of students' perceptions touching on the philosophy of mathematics and on what doing mathematics is about.
6. **'Right' and 'wrong' in mathematics** concerns students' perception that what is important in mathematics is to find the correct answer, and also a more general notion around the unambiguous nature of mathematical truth.
7. **Mathematics as a rewarding subject** examines the extent to which students enjoy the subject, often relating to how they persist with it or to significant moments of insight.

The themes themselves are not always sharply distinguished one from another. For example, **'right' and 'wrong' in mathematics** often appeared as a sub-theme of **the nature of mathematics**; this latter theme was often intertwined with the theme **how learning mathematics compares with learning in other subjects** or **ways of working with mathematics**. Also, students' recollection of key figures (especially teachers) often gave rise to self-reflection on how mathematics might best be learnt or taught.

Once this analysis had been completed by two of the authors, the third author was invited to read the transcripts of the focus groups and the outcomes of the questionnaires. Our purpose was to identify striking similarities or differences in identity between those students from the Republic of Ireland and those from Northern Ireland. It should be noted that it is possible for students from either jurisdiction to study at either institution but in both these samples the students in the Northern Ireland sample were all educated in Northern Ireland and likewise in the Republic.

FINDINGS

In this section we compare the responses from the two cohorts by examining the responses to the open-ended initiator on the questionnaire and the transcripts of the two focus groups.

Considering the students' responses to the open-ended prompt, *"Think about your total experience of mathematics. Tell us about the dominant features that come to mind"*, it is evident that students from the South were more expansive in their answers than were those from the North. Here is the full response of the northern student who covered the broadest spectrum of issues:

> Enjoyed maths from an early age and was good at it throughout my time at school. Maths usually has a right or wrong answer and once you have learnt a particular method you can apply it to lots of questions. Boys seem to like maths better than girls. Dancers seem to be good at maths. Need to understand a mathematical concept fully at the time it is taught or I will not be able to remember it. Practice makes perfect. Maths is enjoyable when you understand it but not when you don't. Maths is the easiest subject to revise for. (B)[1]

Southern students covered a broad range of issues such as their appreciation of the challenge of mathematics, the importance of understanding the subject, the attitude of others to their choosing mathematics, and the perception that "all Maths linked up". Significantly for the discussion to follow, we note that two out of five of the southern students expressed a strong preoccupation with examinations:

> In secondary school, everything was focussed to the exams, therefore much was learned without really being understood. In Transition Year we did do some more practical mathematics e.g. survey taking. None of the areas for Leaving Cert seemed connected – it was more Q1 is this topic, Q2 is a totally separate topic… At 3rd level Mathematics has definitely become more practical for me. Though the rote learning and learning unknown things off by heart still exists. (D)

In reviewing the data from the focus groups, three key areas came to light in which notable differences were apparent between the two cohorts: preoccupation with examinations, streaming in the Republic, and the nature of mathematics. These are described in turn below.

It's all about examinations….

It is striking that the first mention of examinations in relation to the mathematical experience of students from Northern Ireland occurred eventually on page 41(of 46) of the focus group transcript, and even then it is a fleeting reference. This is in stark contrast to the conversation played out by the students in the Republic where the

[1] Quotations from the Belfast students are indicated by (B); those from Dublin are indicated by (D).

theme was relentlessly about the damaging role of the examination in their post-primary experience. All students began their focus group conversations in response to a probe about the questionnaire and about how they reflected on their life-long mathematical journey. This prompted little reaction from the northern students, in contrast to quite a strong response from those from the South. Students in the southern cohort described heavy examination focus, rote learning and disconnection as evidenced by the following flow of discussion:

> Because in school … you just learnt [rules] off without having a clue of what [they were] about … didn't understand where it came from at all. … I remember, though, in the beginning of secondary school … thinking the maths was totally different [from] primary school … maybe it was the whole kind of exam emphasis that you're getting … It's definitely the exam. I mean we just learned things off for the exams … in secondary school (D)

Streaming: The great Pass or Honours divide in the Republic of Ireland

Connected to the previous theme but worthy of note in itself is the emotive reaction to the division that takes place in the South when students elect to take mathematics at either ordinary level or higher level. While the words 'ordinary' and 'higher' are the official terms for the corresponding level of subject taken, the alternative and more divisive words of 'pass' and 'honours' are entrenched in Irish society and were reflected in the language used by the students to describe their experiences:

> Like you're streamed, like the first year in secondary school, you're into Honours and Pass. … And they start talking about it straight away in first year, about exams … and then you think Junior Cert is like this massive thing, for no reason. (D)

> I found that when you're doing your Junior Cert and your Leaving Cert, people would ask you like, 'What subjects are you doing?' And they're always constantly asking about maths. 'Well, are you doing honours maths? Well then, you're fine.' You know like, you're obviously good at college or at school or whatever. But I just thought that the focus was on maths all the time. I didn't realise, like no one asked me about what you're doing in English. It was always maths. (D)

The southern students are all of one voice when they describe the pressure of having to consider which stream of mathematics to take as they progress towards third year. Indeed, the situation appears to worsen for those who choose honours mathematics for Leaving Certificate. In particular, some of them recollect their class of only five presenting for honours mathematics at Leaving Certificate. Limited resources (for these students) typically required that such students be 'catered for' within a class of numerous others who were taking pass mathematics. It appears that for some, doing honours mathematics is akin to standing conspicuously out from the crowd.

> For my Leaving Cert … there [were] only a few of us doing honours and … [the teacher] … put us in a class with the Pass. So he left us to [our own] devices. (D)

> I remember when like in … Leaving Cert, when you … were doing Honours maths, people would be like, 'Oh look at you in the honours maths class like.' It was real kind of oh, like 'Yeah, you're just a big nerd, really.' … And [there] were groups of people who wanted to be in the ordinary level class because it was just a better place to be. … Sometimes people felt that it'd be easier to go down to ordinary level because the focus is off you. It's just that you had this, always this constant focus on you when you were doing honours. … I do think that the teachers as well, they kind of thought that, 'Oh, you're grand enough. You can work on your own. I'll go and I'll work with the Pass pupils.' (D)

Students in Northern Ireland are similarly separated into ability streams for GCSE mathematics but this does not seem to have the resonance years later that the pass/honours divide creates in the Republic. The northern students of course also need to make the decision concerning which subjects to study to A-level but there does not seem to be the same emotional reaction to such choice. In fact there is not a single mention of GCSE or A-level examinations throughout the focus group discussion with the Northern Ireland students.

The nature of mathematics

It is abundantly clear that the post-primary experience of mathematics for the students in the South created a view of mathematics as being a subject taught for the purpose of examination and duly measured by examination, and indeed whose very nature was specified according to the exam question, as discussed above. This seems to have led to a more procedural view of mathematics. Consider the following Republic of Ireland student's recollection of mathematics in transition year at her school:

> I remember in transition year … we did totally different kind of maths, like it was nothing to do with exams. They didn't mention [them] at all. And in that way, we did do kind of more practical maths, the kind of stuff we talk about now [in college] as well. We did kind of statistics and we did surveys and things like that. Do you know, it was more kind of practical maths, which was great. And I think people even, in a way … didn't realise they were doing maths that much at that stage because it was all about … practicalities and stuff like that. (D)

With the exception of work in transition year, any sense of a 'greater purpose', or indeed of a real connection between topics appears entirely absent at post-primary level for these southern students. Another southern student develops this theme in the direction of its consequences for her own teaching; she is certain that there is another and a better way:

> I think that in third level when we're learning why [there are] certain proofs… and why certain things [are] the way [they are], 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. (D)

The dichotomy between rote-learning and learning for understanding is articulated clearly in another quotation:

> Secondary school is just about learning off your formulas and just plugging in your answers and that was it. But now in college it's coming back to why you are using the formulas. So there is kind of a deeper meaning to it. (D)

The Northern Ireland students describe a continuum of learning that does not seem to be so distorted by examination pressure. Students convey an impression of mathematics as developing from primary school's focus on number, through to more problem-solving activity in post- primary, thence to reasoning and proving in third level:

> I personally find that when you were at primary school, you know, you were basically being introduced to numbers. What is a number? … And that's the very early stages. And then as you progress, it's more sort of into problem-solving then, sort of working out answers. You know, you're given a question and you have to work out an answer. And then once you get on through that, then it's more into proof. Proving how something, proving an equation, why it works. (B)

Mathematics, perhaps surprisingly, was described as relaxing by several students. A southern student's description of the transition from relaxed primary mathematics to tense secondary mathematics is telling and illustrates the themes described above of the stressful nature of examination driven curricula:

> It was definitely more relaxed in [primary] school for me and then more tense [in secondary]. (D)

One of the northern students also describes mathematics as relaxing in a different context, in comparing it to other subjects:

> When you … can't think any more … I came back to my maths. And I maybe worked through like half a maths paper to sort of calm myself, relax myself, get myself back into focus again. Maths for me brings me back into focus. (B)

There was a number of areas where there was common ground among all the students. It is edifying to note students from both cohorts alluding to the need to make sense of the mathematics being studied, and also to the need for teachers to be able to explain a given concept or idea in potentially many ways. Such a realisation augurs well for their development as teachers. Another point of common ground is the reference to the vital influence of others and particularly teachers.

> [The teachers'] interest in maths more than anything else because they're so interested in it and so involved in it, then that makes you involved in it as well. (B)

> I've never traced back before why I was ever interested in maths and where it actually came from, but I felt … that it came from my family and it came from my teachers up through the years, their interest and their [liking for] maths. (D)

A further quantitative analysis was carried out on the data from the focus groups. Each transcript was divided into distinguishable items (140 for the Dublin focus group and 92 for Belfast) and each of these items, in turn, identified or 'tagged' with the seven themes as appropriate. It was noted that themes 4 and 6 occurred infrequently (less than 8% of the tags), so these two themes were omitted from consideration. The result of this process gave rise to 128 tags for the Dublin data and 94 for the Belfast data. Prevalence of each of the remaining five themes is summarised in Table 1.

Theme	**1**	**2**	**3**	**5**	**7**	**Total**
Dublin	**25 (20%)**	**32 (25%)**	**23 (18%)**	**32 (25%)**	**16 (13%)**	**128**
Belfast	**8 (9%)**	**37 (39%)**	**15 (16%)**	**18 (19%)**	**16 (17%)**	**94**
All students	**33 (15%)**	**69 (31%)**	**38 (17%)**	**50 (23%)**	**32 (14%)**	**222**

Table 1: Number of items from the focus group data identified with each of five of the themes for each cohort

It should be noted however that this coding by theme on such a small data set cannot be taken as a precise instrument. Moreover, this table does not take into account the nature of the responses nor the strength of feeling indicated, yet it does provide an overall comparison between the data from the two focus groups. Clearly there is a significant difference between the prevalence of themes 1 and 2. Students from the South were more likely to reflect on their experiences and discuss the implications for future teaching. This emphasis on how the past has influenced their development is consistent with the first major distinction drawn in our discussion, namely that of approach to examinations. It is apparent that the students from the South seem to have very strong feelings about the impact of the assessment at post-primary level and that this still strongly resonates through their whole mathematical identity. The second theme, relating to the influence of others, was detected more markedly in comments from the students from the North. This theme is discussed in more detail in a previous paper (Eaton & OReilly, 2009 b).

CONCLUSION

Exploring mathematical identity through the use of narrative allows a picture of a whole educational experience for these students to emerge and thus we gain a snapshot of the impact of each educational system, North and South, on the mathematical formation of these future student teachers. The most telling difference between the two cohorts of students was the strength of negative feeling apparent around the examination structure in the Republic of Ireland. While we are aware of the dangers of generalising from a small sample of students, their views are consistent with widespread criticism of the perceived overly procedural approach to post-primary mathematics. The existing structure – that the Project Maths initiative seeks to alleviate – seems to have produced students who, having now studied

mathematics at third level, have an awareness of how the nature of mathematics was perhaps incomplete at second level. Several expressed a desire to rectify this situation when they entered the classroom as teachers. Similarities between the cohorts were of course evident too, particularly in the descriptions of people who influenced the students' view of mathematics.

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