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The University of Manchester

TransMaths Research Briefing

June 2011

Teaching and teacher identity in Higher Education

Summary findings

In order for students to have the necessary mathematics to pursue science, engineering or technology courses at university, they are very often taught mathematics as a separate subject with little reference to the way in which the mathematics is applied in their chosen areas of study. This is not unproblematic and requires sensitivity in teaching/pedagogic practices. However universities/academics may not see teaching as their core business/identity, especially they may not see mathematics as their core business/identity.

- University academe may not always see teaching – or responsiveness to students' learning – as its principal business. As a result, lecturers' development of knowledge and know-how in teaching can sometimes be rudimentary and the development of a pedagogical culture under-valued e.g. those positioned as teachers rather than researchers may be marginalised. Indeed academics' knowledge of teaching and learning may be largely based on their experiences of formal lecturing and their own experiences of school.
- There are academics that do have a 'teacherly' identity and there are also schoolteachers who are employed in Higher Education for their expertise, especially in mathematics education. Very often these individuals are employed in support centres or learning centres which are to be found on the fringes of academia, especially in elite universities. Students who struggle with mathematics very often find these staff extremely beneficial to their mathematical transition and development.
- Due to economies of scale, students are often taught in large lectures in ways that are not responsive to their diverse needs, especially those that emerge from their prior attainment and the difficulties they might have with new mathematical concepts. Students have mainly been 'taught to the test' in schools and colleges, with a narrow focus on a narrow range of techniques and procedures. This previous experience of mathematics learning can present obstacles for lecturers to overcome, especially when dealing with diverse groups and large numbers of students.
- An issue which concerned many of our case study students is that their tutors lack the teaching skills (or even sometimes the necessary English language) to be able to take them through difficulties 'step-by-step'. It seems from our survey data, however, that the key problem is mainly transmissionist practices that fail to identify learners' difficulties and so are unresponsive to their needs.
- On occasions, in our case study work, we observed doctoral students and novice academics engaging with students' learning difficulties by marking their work and providing feedback, helping in workshops, etc. This seemed to offer potential for learner-centred teaching development, with possibilities for helping new academics develop dialogue with learners.

Mathematics learning, identity and educational practice: the transition into Higher Education

The Transmaths research projects investigated students' transitions from school through college into mathematically demanding degree programmes in Higher Education. The focus was on transitional practices and the projects investigated the effects on learner identities, choices and learning outcomes. Using a mixed methods approach, quantitative survey data were analysed alongside a longitudinal series of student interviews and case study data.

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Summary findings

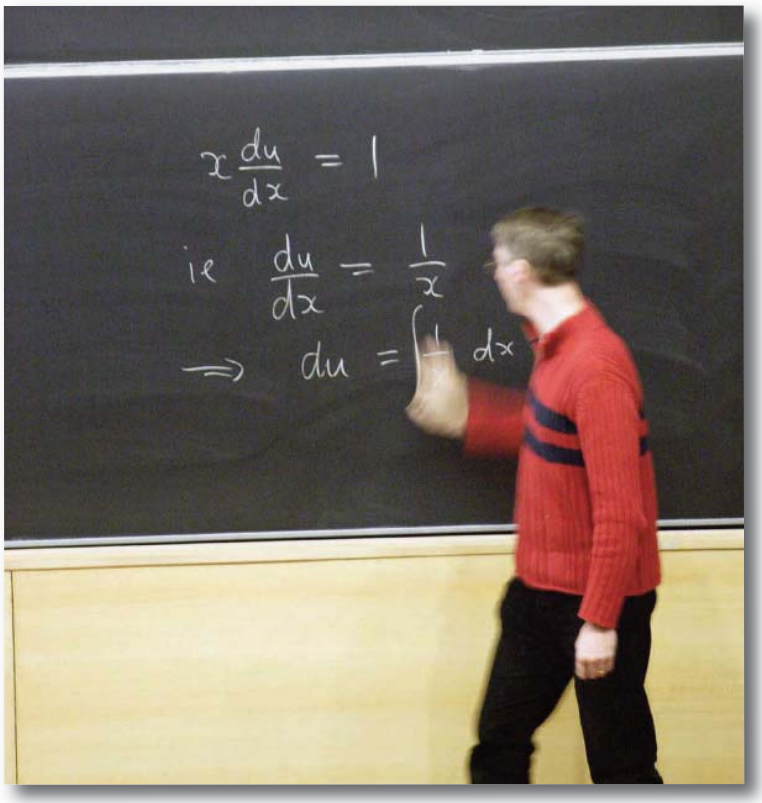
Teaching that connects with learners and learning

Lecturing remains the dominant mode of 'teaching' in universities, often even in tutorials/workshops. This form of teaching avoids engaging learners in mathematical activity or dialogue, and is mainly unresponsive to the varying needs of students, and in particular takes little account of their prior learning, difficulties encountered in learning new concepts, and indeed how students learn.

One lecturer we spoke to perceived 'teaching' as different from 'university teaching' but explained that he thought the former would benefit first year students:

Lecturer: That's not to say both groups wouldn't benefit from, shall we say teaching that is somewhat different to normal university teaching. That being said, I think what we hope to achieve is that the ones who come with weaker subject knowledge, get teaching in a manner that respects where they've come from, has some knowledge of the situation where they've come from, and attempts to teach them in a way, similar to what they might have been used to, so that there's an element of support, an element of confidence building etc. *Mathematics lecturer, Northern*

One lecturer was unaware about a problem his students were having with functions and their inverses until the tutorial following the lecture. This was because the lecturer did not have a firm understanding of the way schools work now, or the students' mathematical development prior to transition. So the tutorial proved to be a fortunate opportunity for both the students and the lecturer to learn from one other:



Lecturer: Well it was very, very clear wasn't it what I learnt in that particular class. One of the things I learnt was, that something has changed about the way students are taught to write functions at A-level and their inverses and I damn well better understand what that is, and why it is. I'm not, I don't, I just, don't know what the thinking behind that changes, but it's clear it's a change that's been some sort of national enforced, nationally enforced change, because they all, they said the same thing. Sometimes I learn some mathematics and try to explain to them that something daunts me that even after forty years of teaching this, I haven't quite understood some of the little aspects of it that are important, and I will sometimes myself have a 'aha!' experience in these classes. Even with stuff in the first year...And it's always in the back of my mind, 'what have they been exposed to at school or college and how are we, and in this case, am I going to help them get to a better place...? *Mathematics lecturer Riverside*

This single experience of dialogue arising for a lecturer seems as precious as it is rare. However, we did see doctoral students and novice academics engaged with students' learning difficulties by marking their work and providing feedback, helping out in workshops and learning centres, and even engaged in educational 'research and development'. This seemed to offer potential for learner-centred teaching development, with possibilities for helping new academics develop dialogues with learners. We suggest this kind of activity could provide the kind of professional development some teachers in universities need.

Teacher identity

Teaching is just one among many important aspects of a university academic's professional life. For many it is often not their first priority because it may be considered as being of lower status than other activity such as research, or even administration. In our case study work we found that staff employed specifically as teachers (sometimes part-time in school and part-time in university) were often recognised by students as being more aware of and sensitive to their needs.

Joanne teaches A-level mathematics in a sixth form college and also teaches mathematics in university. She uses the skills she has developed as a teacher to help the university students overcome the problems they are having with mathematics:

Joanne: I find, I treat, well, I was gonna say I treat the students differently, I treat the engineering students much more like college students than I think maybe other lecturers do, because I, I see them as being very similar to the, to the Year 13's that I have here, you know, they're a little bit more mature, but sometimes they just need that spoon-feeding. They need the, the teaching at step-by-step-by-step and trying not to assume they know anything, so taking them back and, and dividing it down

into the smallest parts sometimes is what you have to remember to do, I mean, like, with these today when you, when you're doing (integration) by parts, you can't just say, right, okay, the integral of cos 3x is this, the integral of sin 3x is that, the integral of e to the x is that and go through it, you've got to have that awareness that, that they're gonna struggle. So you've got to know to pause, you can't just go through it, because ultimately they will, they will still be looking at, well, why was the integral of cos 3x equal to 1/3 sin 3x, so they'll have mentally stopped at that point, stopped listening, switched off and they'll still be trying to rationalise step one, so the following six steps will have just past them by. *A-Level teacher andlLecturer in Mathematics, Northern*

Lectures

Lectures provide a focal point for student's concerns about the difficulties they meet in learning particularly in understanding mathematics. Equally students' experiences at A Level do not necessarily provide them with a solid foundation on which to build deep understanding: learning for A Level emphasises procedural fluency over conceptual understanding.

Lecturer: And it's a case of getting them to be able to work in sort of mental way, that if you possibly can, that they recognise structure, they recognise bits and pieces that join together, so it's not entirely - it's this segment of stuff, it's this segment of stuff, because a lot of their teaching modular seems to me, from what happens and from what a lot of them say, to be very segmented and the way that they work with it is: revise, do your module, next bit, forget what you've done, we're onto the next bit now, forget what you've done, we're onto the- and in a sense that sense of structure and building up and kind of carrying a lot of it in your head isn't, isn't there. So I don't know. I try. *Mathematics lecturer, Northern*

Some students in interview raised concerns that their tutors lack the teaching skills (or even the necessary English) to be able to take them through solutions to problems in a meaningful way to support their learning. This is supported by our survey data that suggests the universities offer mainly transmissionist practices on the mathematics courses.

One lecturer recalls a peer review of a colleague who seemed unable to engage the students due to the transmissionist approach he adopted in his lecture:

Lecturer: So I watched him, I watched him teach something I didn't understand. I have to be honest, I didn't understand. But his engagement with the students was zero. The students' engagement with what he was doing was almost zero. When he asked questions they clearly either avoided his eyes, looked elsewhere or the brightest kid in the class muttered the answer, just audibly enough for the embarrassment to sink so we can move on, you know we can get onto the next, the next chunk of it. *Mathematics lecturer, Northern*

The students reported teaching methodologies used 'most of the time' or 'almost always' (refer to Figure 1).

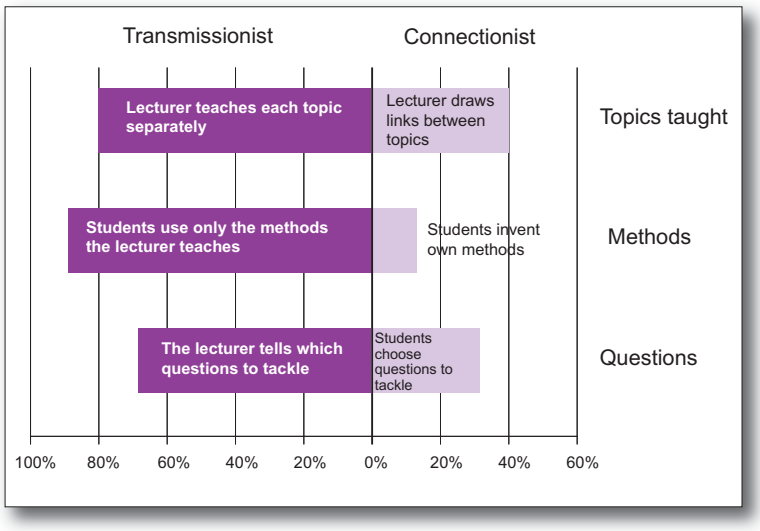


Figure 1: The reported use of transmissionist and connectionist teaching practices in mathematics courses

As a result of the interviews with our case study students, we were aware that they do not have time to ask questions during lectures, sometimes because they cannot understand the new concepts as they are too busy writing notes as the lecturer moves quickly through material. Also many, if not most, find asking questions in a lecture too daunting as they do not wish to expose their (lack of) understanding to a large group. Therefore any questions they may have are not raised until the lecture has finished. When asked whether students come to ask questions at the end of lectures, one lecturer replied:

Lecturer: Ooh yes, yeah. It tends to be the same ones come up every time - so the enthusiastic ones. Yeah, I mean they ask further things about what I've lectured and they told me that this seems different to hypothesis testing as we got it at school, they were saying, and they recognised why, and they felt at school they got given a recipe: you do this series of steps and get an answer and then write the standard comment. Whereas here they could see that I was trying to develop it, right through from the basic logic of the hypothesis testing, but they did say that makes it difficult, which is true. *Mathematics lecturer, City.*

Implications and recommendations

- We question whether academics appreciate the value of developing a pedagogical culture in universities, with the result that many lecturers make few efforts to develop their teaching beyond delivering transmissionist lectures. Teaching needs to be given higher priority in the professional practice and professional development of university lecturers.
- Much can be learnt from those positioned as mathematics teachers in Higher Education: they should be nurtured as models of good practice rather than being marginalised. Their understanding of the difficulties faced by some mathematically less competent students and their capacity to help students overcome difficulties should be given support (resource) and encouragement (status).
- Large numbers of students being taught in large lectures may seem cost effective but the situation makes it almost impossible to respond to diverse student learning needs in transition. Universities need to consider how to develop dialogue, and how to be more responsive to students' needs, for example, taking account of prior attainment and their ability to understand new mathematical concepts and connectionist practices.
- Case study students were concerned that their tutors often lacked the necessary teaching skills (or in some instances the necessary English) to take them step-by-step through problem solving examples in ways that support new conceptual understanding. In addition, our survey data highlighted the frequent use of transmissionist practices on mathematics courses. These are in stark contrast to the 'teacherly' approach that many students need/favour, especially in transition.
- Opportunities for lecturers to learn more about students' difficulties (and how they learn best, etc.) can be found in some workshop and learning-centre activities especially where genuine formative assessment occurs: such activity might be made central to the development of teaching, and of lecturers professional development.

Where next?

During 2011 the team, with ESRC Follow-on funding, will work with key partners, including the National HE STEM Programme, the National STEM Centre and the National centre for Excellence in Teaching mathematics (NCETM) to promote participation and engagement in post-compulsory mathematics education for STEM. This work will draw on and synthesise findings across all three research projects that investigated students' trajectories in and through mathematics programmes from compulsory school, through college to Higher Education.

Further details of our ongoing work can be found at the project website. Additionally the team are involved with further research that builds on previous work. The ERSC funded project (grant RES-061-25-0538) 'Mathematics teaching and learning in secondary schools: the impact of pedagogical practices on important learning outcomes' will explore issues of teaching and learning in the secondary years of compulsory school.

Further information

The mathematics education research team at the University of Manchester has undertaken three ESRC funded projects investigating students' trajectories in and across mathematics programmes from compulsory school, through college to Higher Education. These recognise the crucial role mathematics has to play in ensuring more young people are better prepared for, and more disposed towards, future study and careers in Science, Technology, Engineering and Mathematics (STEM).

The research draws attention to important issues in relation to programme design, institutional implementation practices, teachers' pedagogies and students' developing attitudes, dispositions and identities and hence their decisions and choices regarding their study (or otherwise) of mathematics.

Details of the projects' work and findings can be found at: www.transmaths.org

Publications of particular interest to the focus of this Research Briefing:

Jooganah, K. & Williams, J. S. (2010) The Transition to Advanced Mathematical Thinking: Socio-cultural and Cognitive perspectives. Paper presented at the British Congress of Mathematics Education (BCME7) Conference, University of Manchester, 6–9 April 2010.

Wake, G. (2010) Learning university mathematics: a case for expansive learning. Paper presented at the Psychology of Mathematics Education (PME34) Conference, Instituto de Ciências Exatas, Brazil, 18 –23 July 2010.

Williams, J. (under review) Mathematics teaching and learning across the boundary between school and university. Research in Mathematics Education.

Williams, J.S. 2011. Teachers telling tales: the narrative mediation of professional identity Research in Mathematics Education

Williams, J. S. & Hernandez-Martinez, P. (2010) Teaching mathematics in school and university: the case of a boundary crosser. Paper presented at the Psychology of Mathematics Education (PME34) Conference, Instituto de Ciências Exatas, Brazil, 18 –23 July 2010.

The warrant

One of the strengths of our project that investigated transitions into Higher Education is that it drew on a variety of methods. It used large- scale questionnaire surveys of students (n>1700) at the start of their university course and after the first semester, developed case studies of 13 university courses (mostly in STEM), and tracked a number of students in more depth through three longitudinal interviews (n>50). This provided a rich base of data for analysis.

In addition, we extended the conceptual framework already developed for our previous research project ESRC TLRP 'Keeping Open the Door To Mathematically Demanding Programmes in Further and Higher Education' which explored transition through college in much the same way.

Specially constructed instruments were developed and validated to measure important new affective learning outcomes in the transition into mathematically demanding (STEM) programmes in Higher Education.

The case studies were developed from mainly qualitative investigations and involved observations of lectures and tutorials with interviews of students and teachers. Triangulation was supported by the collection of other university degree course documents and data, and interviews with other stakeholders such as Heads of Departments. The series of longitudinal biographical style interviews about students' transitional experiences provided further deep description and insight into the transitional process.

Our methodological approach is imbued with the notion of generating practical knowledge in partnership with students and university teachers as informed and knowledgeable participants. This partnership approach also provides an ethical (and triangulating) basis for all the empirical, analytical and reporting work. A series of meetings with university teachers assisted in this respect. Finally, our warrant is also enriched by the project's advisory group, which consisted of academics and practitioners with relevant experience, and which met regularly with the project team.

Project website:
www.education.manchester.ac.uk/research/centres/lta/ltaresearch/transmaths/into-he/
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