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The University of Manchester

TransMaths

Research Briefing

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

TransMaths summary findings
(*drawn from cross case analyses*)

The new 'rules of the game' of learning at university can be problematic for many students. Furthermore, there is a special problem with first year students' engagement with mathematics: the motivation can be unclear and may involve alienation, even disengagement.

- The transitional link between school and university systems is structured as a market place where certificates such as A level/BTEC provide 'exchange value' as access to university rather than provide information/learning that is necessarily useful.
- Students' experience at A level does not prepare them well for university learning, eg how to autonomously manage the many resources available to them to learn. This subject is addressed sporadically in 1st year also, and not well integrated into the students' core courses.
- Particularly, students' experience at A level does not fit well with uses of mathematics in degree courses eg in other STEM subjects (modelling, use of technology) or even in mathematics (rigour and proof).
- University academe may not see teaching - or responsiveness to students' learning - as its core business/identity: as a result their development of knowledge and know-how in teaching can sometimes be rudimentary, and the development of a 'pedagogical culture' under-valued (eg 'teachers' may be marginalised).
- Productive/effective 'transitional practices' involve student-centred or student-led activity whereby the students' own mathematics become focal and teaching is responsive and dialogical.
- Apparent efficiencies of teaching scale (eg transmission in large lectures) can lack responsiveness to the diversity of student needs/prior experience and learners' capacity to 'connect': squaring this circle requires imaginative management and the fostering of a pedagogic culture.

In conclusion, these findings imply a need to re-think A level and the 6th form experience so as to align better with HE, but also the need for universities to be better informed, and to develop responsive, more dialogical 'pedagogical cultures' that engage with diverse student needs.

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Summary findings

The transitional link between school and university systems is structured as a market place where certificates such as A level/BTEC provide 'exchange value' as access to university rather than provide information/learning that is necessarily useful.

- The AS/A-level system – considered as an assessment-for-learning system rather than as a qualification for the university market – is not 'fit for purpose' (but then neither is GCSE for A level progression); A/AS level is a course primarily directed at achieving the grade needed for the University market, and teaching and learning in A/AS rarely reflects anything other than a focus on examination performances (typically at least 24 of these in 20 months).
- Misunderstandings of what contemporary students (transiting from A level or BTEC) know, understand and can do (i.e. their mathematics competence) when they arrive at university can make 'responsive' pedagogies/curricula difficult for university managers/teachers.
  - There is often a doubtful match/alignment between A-level/BTEC grades and relevant competence. The growth of 'diagnostic testing' (DT) on arrival at university in the last decade reflects this, but the DTs are only valuable to learning insofar as (i) the test is a valid assessment, and (ii) leads to 'responsively' adaptive teaching to learners' diverse needs.
  - In similar vein, tutors who mark the students' work themselves may gain an overview of students' problems. Yet this task is often given to others (being regarded perhaps as an unnecessary, low status activity (see below).
  - This finding seems particularly important for mathematics, because university teaching in mathematics has tended to build on what is assumed to have gone before whereas other teaching may begin 'from scratch'; and mathematics at quite a high level seems to be the key (difficulty) for some courses.

Students' experience at A level does not prepare them well for university learning, eg how to autonomously manage the many resources available to them to learn with; and this subject is addressed sporadically in 1st year, and not well integrated into teaching in core courses.

- There are important implications for schools as well as universities: the great 'grade rush' at A level encourages tranmissionist pedagogy and leaves little room for 'learning to learn' - or even to 'understand and use' - mathematics: becoming an independent learner, developing creativity, curiosity, interest, or even comprehension come a distant second to test-cramming, even though many students choose their degree subject because of interest developed during their A level, or when taught by an inspiring teacher at A/AS level or before.

- There is much talk of the need to be(come) an 'independent learner' at university, but this term is often/sometimes misunderstood by learners/lecturers as learning/working/surviving on their own, without support.
- Practices in lectures etc vary substantially, but there is often not enough explicit help for students to get to grips with these formats for learning: what is expected of them, and what is the point of the various resources on offer? Only the most savvy students 'know their way around' when they need help.
- The 'lecture' is a particular problem for students and teachers. Many students say they gradually realise that they can't/don't learn (much) in lectures. Many students find other learning formats, groups, and approaches to learning - formally or informally - but not all students access such informal networks when they need them.

Particularly, students' experience at A level does not fit well with uses of mathematics in degree courses eg in other STEM subjects (modelling, use of technology) or even in mathematics (rigour and proof).

Transfer from school to university mathematics is a classic 'transfer problem' for the learner, too, (eg a 'function' in A-level is not the same as a function in university mathematics) as is transfer from mathematics classes to science/engineering workshops/classes. This problem is exacerbated when the mathematics is taught 'purely' as mathematics, in A-level or in 'mathematics lectures', or by mathematics lecturers who have no/little grasp of the problems and field in which the mathematics will be used/applied.

University academe may not always see teaching - or responsiveness to students' learning - as its core business/identity: as a result their development of knowledge and know-how in teaching can sometimes be rudimentary, and the development of a 'pedagogical culture' under-valued (eg 'teachers' may be marginal).

- The 'base' line is that academics knowledge of teaching may be largely based on (i) their experience of lecturing-in-action, and (ii) their own experiences of schools some years ago. But professional learning in the face of change requires continual reflection on action within a culture that supports teaching.
- In an attempt to cope with large numbers of students, disparate groups who have varying problems with their mathematics learning (mathematical ability, lack of previous mathematical qualifications and those for whom English is a second language) may be taught together in large lectures on grounds of 'efficiency'.
- A further issue which concerns students is that students need tutors to take them through examples step-by-step – they say some tutors lack 'teaching skills' or even the necessary English fluency needed to explain mathematical problems to learners.
- There is a group of academics that have a 'teacherly' identity and expertise, however, and some school teachers are employed in HE for their expertise. They are often found 'on the fringes' in less academic, 'student support' or learning centre type positions, especially in the more elite universities. Students who struggle with mathematics often benefit considerably from these teachers, in support centres, remedial seminars, and classes. These people need support (resource) and encouragement (status).
- Student diversity has been increasing in many HE contexts. This change imposes new demands on teaching.
- Further, any Teaching and Learning innovation – to survive or succeed – needs to work at several levels at once: satisfying the needs of learners (eg responsive pedagogy/curricula), lecturers (eg making their teaching more efficacious to the fulfilment of their academic identities – but see above) and managers (eg making for economic benefits in the corporate culture).
- Something similar needs to be said about 6th form teachers also; there the problem is 'who is the client?' that the teacher has to account to/satisfy.

Productive/effective 'transitional practices' involved student-centred or student-led activity whereby the students' own mathematics became focal and teaching is responsive and dialogical.

- These take many forms (informal learning groups vs 'organised' classes) and may be organised in many different ways, (in support centre drop-ins/remedial classes, workshops/group-work, student-led informal or formal tutorials/working groups, and even relatively 'dialogical' classes/lectures, sometimes taught by 'teachers' who may not be 'academics').
- Drop-in support Centres may go beyond the 'sticking plaster to fix damage', to diagnose systemic weaknesses, and even CPD: as such they may provide institutional level pedagogic centres.
- Support classes/remedial catch-up classes etc are not just 'diagnostic testing', but can sometimes provide 'assessment for learning'.
- Setted, smaller, more personal or focussed classes, and/or use of 'teachers' even in larger groups, can allow more dialogic engagement with students' mathematics.
- Workshops for small group work (explicit or informal) can both support peer learning and allow teachers to become facilitators.
- Induction projects can helpfully also foster peer socialisation that may support some of the above.

In conclusion, these findings imply a need to re-think A level and the 6th form experience so as to align better with HE, but even more so the need for universities to be better informed, and to develop responsive, more dialogical 'pedagogical cultures' that respond to diverse student needs.

Implications

Apparent efficiencies of teaching scale (eg transmission in large lectures) can lack responsiveness to the diversity of student needs/prior experience and learners' capacity to 'connect'. Squaring this circle requires imaginative management and the fostering of 'dialogical' pedagogic cultures. Specifically:

- The '6th form curriculum'. A complete re-think of what A level Mathematics experience should involve to better prepare students for university is needed, especially as far as learning how to learn is concerned.
- For transitional systems, there is a need for better flows of information between school/college and university systems, and A level exam and feedback systems could help.
- For universities:
  - what are universities for? The challenge to the academic 'rationale' suggests a move towards a culture of (mathematics) education (including pedagogic R&D) as well as research;
  - this involves learning how students learn to learn, and how to develop dialogic T&L led by students activity;
  - use of 'teachers' in HE can help, but a cultural shift towards helping 'academics' to become 'teachers' is the real challenge.

Where next?

- 'Knowledge transfer' with School and HE STEM networks: our plan to 'develop' rather than disseminate research findings.
- A transitional joint Curriculum Development project: a new 'Mathematical science' at Further A/Foundation and 1st year university level: mathematical modelling, Learning to Learn, student led projects.

Further information

A resource providing information about the project, its members and an overview of our work is at:

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

Here you can find a selection of publications arising from this project:

Developing a leading identity across the transition to mathematically demanding programmes at university – Laura Black

Narratives of transition to university student – Pauline Davis

University transition and the semi-dependent youth – Pauline Davis

Using mathematics to solve engineering problems and mathematical subjectivities – Pauline Davis, Diane Harris, Kamilah Jooganah with the TransMaths team

Learning to Learn in STEM Subjects: Lessons Learned from Problem-Based Learning in Medical Education – Valerie Farnsworth

Using narrative analysis to explore the mediation of race, social class and gender in the transition to university in STEM subjects – Valerie Farnsworth

Mathematics as a 'tool': what does that mean for first year engineering students? – Diane Harris, Pauline Davis and Kamilah Jooganah with the TransMaths Team

The Transition to Advanced Mathematical Thinking: Socio-cultural and Cognitive perspectives – Kamilah Jooganah and Julian Williams

Measuring Mathematics Self Efficacy of students at the beginning of their Higher Education Studies – Maria Pampaka and Julian Williams with the TransMaths Team

A measure of students' perceived mathematical support during their first year at university – Maria Pampaka and Julian Williams

Developing an understanding of immigrant students transiting from college to university mathematics: who can successfully cross boundaries? – Birgit Pepin

Learning to learn mathematics: issues in transition – Geoff Wake, Valerie Farnsworth and the TransMaths Team

Teaching Mathematics in School and University: The case of a boundary crosser – Julian Williams and Paul Hernandez-Martinez, with the TransMaths team

Diagnostic testing in mathematics as a policy and in practice in the transition to HE – Julian Williams, Paul Hernandez-Martinez, Diane Harris

The warrant

One of the strengths of our project is that it draws on a variety of methods. It used a large-scale questionnaire survey (n>1700), case studies in 13 university courses (mostly STEM), and longitudinal interviews(N>50), providing a rich base of data for analysis.

In addition, it extends 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'.

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 findings reported here for policy and practice come mainly from cross case analysis. Our case studies take the form of mainly qualitative investigations and involve observations of lectures and tutorials with interviews of students and teachers. Triangulation is also 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 has assisted in this respect. Finally, our warrant is also enriched by the project's advisory group, which consists of academics and practitioners with relevant experience, and which meets regularly with the project team.

Project website:
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