The University of Manchester

MANCHESTER 1824

TransMaths

Research Briefing

June 2010

Mathematics learning, identity and educational practice: the transition into post-compulsory education

Summary of findings

1. Students and teachers describe the School-College 'gap' as requiring:
   - a jump in mathematical abstraction and difficulty, especially regarding algebra; but also
   - a 'transfer' in the way GCSE mathematical content is used and understood, from School recipe following to new, more demanding College uses: this shift demands deeper conceptual understanding
   - students to be serious, more independent or self-directed learners (not 'spoon-fed')
2. Some teachers told us that school practices did not develop the conceptual understanding and independent learning because these were structured by the GCSE test and the imperative of teaching to the test;
3. Successful students from disadvantaged backgrounds are successful because of special help available to them, e.g. from an exceptional teacher or because of a supportive family member or group of classmates, and not because of personal qualities.

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The transitional mathematical gap between GCSE and AS-level

In many of our case studies, GCSE pedagogical practices focused on procedural understanding and preparing for the test rather than on conceptual understanding. However, we found that this latter is the type of understanding that is required of students during their transition into AS-Level: most of our teachers expected students to be able to adapt their previous knowledge effectively and in a very fast-paced learning environment.

Int *So can you explain me how that formula works or why it works?*

S *I don't know why it works but if you're given the two values, the radius and the angle, then you can find the length by multiplying.*

Int *Would you try to understand that in your work?*

S *I wouldn't think it would be necessary. I think what I'd need to know is how the formula works, what I have to do to get the answer.*

AS-level student

Int *Can you tell me why did you drop out of maths?*

S *Erm... I just thought it was too big of a difference between GCSE and couldn't deal with it. (...) I didn't really have trouble with maths at high school. I thought it was quite an easy subject and in the end I ended up getting an A, but the difference at A-level is just too big. The speed at which you go through topics, I think it's quite a lot as well.*

AS-level student

Almost all our teachers agreed that algebra is the key to progression into AS-level maths, and that it is this topic that becomes the "maths problem" during this transition. They explained that it is possible to avoid most of the algebra content on the GCSE exam and still get a good grade on it; we found that even students with a GCSE maths grade A/A* showed a limited understanding of algebra. Indeed, sometimes when students talked about "understanding" they referred to a procedural understanding rather than to a conceptual one.

Presumably they can get compensation and get good marks on other parts of the GCSE so they don't have to do very well on the algebra part, so it suggests that the GCSE is just not fit for purpose.

A-level teacher

I think you can be successful at GCSE maths without having to tackle a lot of the algebraic content, so you can still get a grade A, I mean you're not just... the one thing I think is the GCSE grade tells you nothing about their mathematical ability. It's a poor indicator full stop.

A-level teacher

Key algebraic concepts (e.g. surds, quadratic equations) may have different uses and meanings at either side of the transition, and the step up in formality and complexity can be quite significant.

Int *Did you find a big difference between Mathematics at college and Mathematics at school?*

S *A huge difference! Because firstly, the first module surds, we just did the basic surds which was surd 5, and then it was dividing and multiplying and then brackets were involved and if you forget one of them... (...) I came third and stuff like that in the higher paper and then came here and my first lesson was surds and I haven't, I didn't... for one I didn't re-do it over the summer so I didn't really know what was going on, and then I just struggled with the work and it sort of scared me in the first week, that maybe, 'cos it's your first week so you're thinking 'Oh this is going to continue straight away'.*

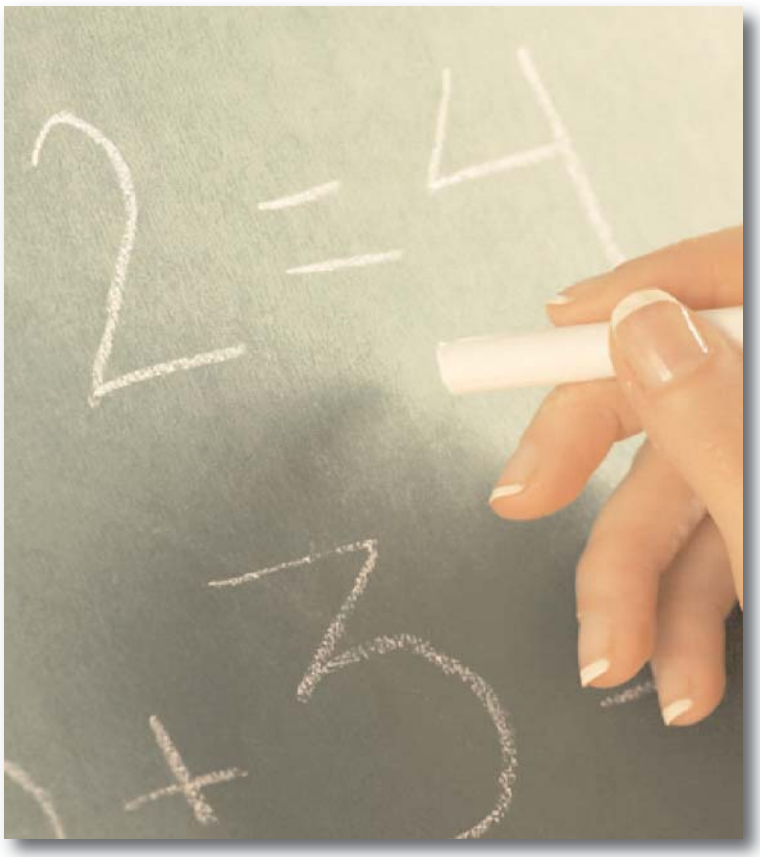
AS-Level student

Definition of a 'surd' in a GCSE textbook

A surd is a square root that does not have an exact value. For example, $\sqrt{2}$ and $\sqrt{3}$ are surds but $\sqrt{9}$ and $\sqrt{4}$ are not.

Definition of a 'surd' in an AS-Level textbook

Expressions with root signs involving irrational numbers such as $\sqrt{7}-2$ or $\sqrt[3]{5}$ are called surds.



There was also an expectation on the students to be more independent or self-directed, which in most cases meant that the help was available only to those who seek it. We found that not all of our students were prepared for this type of independence, especially in a subject like maths which is considered by many as "lonely".

Int *OK, you are at college now... how has been your experience of college until now?*

S *It's completely different from high school, it's just... I don't know you have to be responsible for yourself because it's basically like you decide what you want to do, there's no-one ... like in high school everything says to you learn, do that, do that, but in college if you don't do it no-one's going to like be on your tail like do that and if you don't do it again it affects you so it's like more responsibility and stuff like that.*

AS-Level student

S *Erm, well when we were in (maths) class there was not really chance to ask for help and I don't really like talking to the teachers because I'm shy. (...) I didn't know anyone in the class so I couldn't ask them for help either, cos there was all new people.*

Int *So why did you find it easier to talk to other people in your other subjects and not in the maths lesson?*

S *Erm, because, media and textiles are more practical so it's more discussing things, but in maths it's just work.*

AS-Level student

Transitional practices in Mathematics

The performativity system in which schools are managed plays a fundamental role in shaping the practices adopted to ensure a good place in the league tables. We found that some school practices did not develop the necessary conceptual/independence learning because these were structured by the GCSE test and the imperative of teaching to the test.

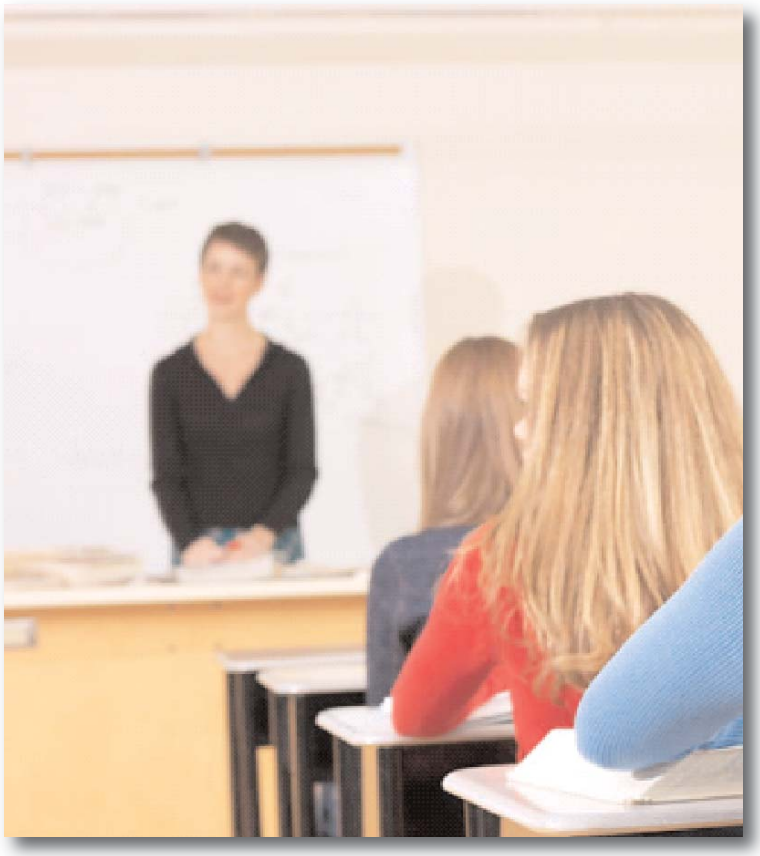
We are governed by the fact that it's an exam, to be honest. There is a GCSE for them to pass and that's what we aim for.

School Head of Maths

Success rates. Kids' success rates, that's what we're in that particular game. You play according to the rules really, you know, and my game is to get as many kids through GCSE maths as possible. That's this November. I can't see that a mentality of a maths teacher in school will be any different. You know with all the league tables and everything else.

A-level teacher

Colleges are under the same pressure to perform and therefore some of their practices that look to bridge the transition become inflexible and unresponsive to students' needs.



Some teachers said they can 'escape the system' by: (i) entering students into the GCSE test so they have a chance to re-sit and achieve the best grade they can and/or move on to teaching at AS level; or, (ii) teaching a bit beyond the syllabus in an attempt to give their students an advantage; or, (iii) creating a culture of independence in learning.

We developed a strategy of trying to take each concept, each subject topic area, a little bit further than you need to do for GCSE, essentially, and cover it in more depth(...) I think the main thing is we give them a lot of individual time. As a department, we're available every lunchtime and whenever they want us really. It's individualised learning I guess in many ways and it applies to the brighter students as much as the less able students.

School Head of Maths

What I don't think we've got right is the study skills in that some pupils are not used to having to work at things and they find GCSE easy and have never had to work at it and develop their own type of work skills. (Doing the A-level has made me) aware of how to extend my teaching; while still addressing the GCSE, but then if I take it that step further, not quite to sort of A and A/S level standard fully, but just sort of dipping into it . And I do try to find lots of different ways that I can link things together. There has to be some understanding there in the first place for them to get the most out of it.

School GCSE teacher

However, for some students these practices might not be as effective as teachers thought, particularly if these don't address the kind of skills and knowledge that students really require for a successful transition.

S *I'm sure the Use of Maths definitely gave me a little bit of a head start, but I think that was only at the beginning. Now I think I'd be more about the same.*

Int *So it was just a very little advantage, it was not something that was 'Wow, it prepared me for college'?*

S *No, just a little bit.*

AS-Level Student

In some cases, teachers agree that these practices do not really allow them to fully 'escape the system' and therefore fail to achieve their objectives in some students.

I've been teaching for so long and it's only been teaching up to GCSE, I'm good at what's on the GCSE. I kind of know and I have kept up to date with kind of what's the AS but I know I couldn't teach the AS, I know my own limitations, so I teach what I'm happy at, I'll get it to the A and I'll go through all of that but going into more detail it's too much preparation when there's so much other stuff to do.*

School Head of Maths

We could sit back and say 'Well if you haven't done your homework you haven't done your homework', but then we don't get so many grade Cs and we don't get so many grade As, so we're under pressure to produce those. So yes, we are going to chase them up.

School Head of Maths

Obviously they're not all like that and if you get those that are holding back a little bit they might have the desire but not the determination to make it happen, then we have to take responsibility for organising them. And if you give them responsibility for their own learning and allow them to fail as part of that process, then you've got to answer the question in terms of results.

School Head of Maths

Some of our students that come from disadvantaged backgrounds were able to succeed because of special help available to them, e.g. from an exceptional teacher or because of a supportive family member or group of classmates. In the past, one could explain this 'resilience' by personal qualities or habits, but we found that it is instead 'relational': resilience is to be found in the relation between students' 'habitus' and their cultural context, which includes classroom, school, home and community.

Int *Uhu. So what's the key to being successful at college?*

s *Probably working hard, but if the help's offered to you, take it, because you're only to get that help offered once so you might as well take it when it's offered to you. So if you're ever offered help you've got to take it, 'cos they're there to help you get the best grades you can.*

AS-Level Student

Implications

- A fresh look at the GCSE is needed to make it 'fit for purpose', so that students that will continue into mathematically-demanding subjects at post-compulsory level are really well prepared. This could include more effective algebra teaching, testing for conceptual understanding and encouraging self-directing skills through practices that are responsive to individual needs.
- There is also a need to provide institutional inducements for learning outcomes such as the ones already mentioned, including perhaps measures of students' subsequent progress beyond GCSE.
- The challenge for teachers is how to develop a practice based on conceptual understanding and 'learning to learn' skills within a system that privileges preparation for tests and procedural learning.
- 'Resilience' could be encouraged by providing and supporting a more social, relational view of learning.

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Project website: www.education.manchester.ac.uk/research/centres/lta/LTAResearch/TransMathsGCSE/

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