Research Update

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Mathematics Education Centre · Loughborough University www.lboro.ac.uk/mec

Research Update is a newsletter sent out three times a year to schools by Loughborough University. We hope you find this newsletter useful and we welcome feedback and suggestions.

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Informed Sixth-Formers.

On 22 April, Lara Alcock, author of *How to Study for a Mathematics Degree* and *How to Think about Analysis*, visited Bilborough Sixth Form College in Nottingham. She gave a talk for students considering undergraduate mathematics; about 20 students attended, and the session had three linked parts.

In the first part, the students engaged in exercises related to formal mathematical definitions, their relationships with intuitive conceptions, the importance of definitions in developing mathematical theories, and the consequent importance of focus on definitions for students of advanced mathematics.

In the second part, Lara talked about research conducted in the MEC. She explained the designs and results of a sequence of studies on ways in which self-explanation training (as discussed in a previous newsletter; see also setmath.lboro.ac.uk) helps students to read mathematical proofs more effectively. This research involved both experimental studies and eye-movement analyses, and the students were able to see this brought to life via animated output from the MEC's eye tracker.

In the final part, Lara discussed practical and emotional aspects of making the transition to undergraduate mathematics, summarising some of the advice that is offered in her books. After the talk she had a cup of tea and a nice chat with students who were interested in further informal advice. She directed one young man in particular to Loughborough University's (short) suggested reading list for incoming students. Readers of this newsletter might like to know that the books on this list were selected to be accessible via independent study, and would be appropriate for students who want to find out whether university mathematics is right for them. The list can be found at tinyurl.com/puh4oh9

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PGCE Partnership?

The new Loughborough Mathematics PGCE is one which is research-led as well as practically based within the classroom. If you are interested in being involved in the partnership with the university to take one or two trainee teachers during their teaching placements in 2015-2016, then do contact Dave Hewitt at the below address to discuss this further. There are two placements and you can be involved in just one or both of these. Phase 1 placement is 10 weeks in length starting from 2nd November and continuing through until 22nd January. Phase 2 placement is 11 weeks in length, starting 22nd February and finishing on 20th May.

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Progressing From Levels.

The Mathematics Education Centre has been working with No More Marking Ltd. and FFT to develop progress measures in Key Stage 3 mathematics. In the first year of the pilot ten schools signed up to administer tests to Year 7 pupils in September and again in May. The tests involve short conceptual questions such as "*Why do we need negative numbers? Give examples of how negative numbers can be useful.*" Pupils answer on a blank side of A4, and the results are assessed by mathematicians using the comparative judgement technique described previously in this newsletter. The May tests are still being assessed, and once complete this will enable the calculation of a predicted grade for every pupil, as well as a measure of relative progress over the year at the pupil, class and school level. The pilot will be rolled out to more schools and Year 8 in September. For more information see tinyurl.com/qab3vsh or contact Ian Jones at the above address.

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Teaching for mathematical thinking: *inquiry* in mathematics learning and teaching Professor Barbara Jaworski at the ATM 2015 conference

I was invited to give the closing talk at the conference of the Association of Teachers of Mathematics (ATM) this year on the theme of *Thinking Mathematically*. I chose to focus the talk on *teaching* and, in particular, the use of inquiry processes in enabling students to make sense of mathematical concepts. I started with some examples of starting points through which to promote mathematics through inquiry.

For example, consider this image of a 22-foot tall Sierpinski tetrahedron (reproduced with permission of Gwen Fisher). It reminded me of a fractal known as the Sierpinski Gasket. Starting from an equilateral triangle, imagine removing an equilateral triangle from the centre as shown. For each of the remaining triangles remove an equilateral triangle from the centre, and keep doing this. You can see a pattern starting to emerge, as shown above right. The above sculpture can be seen as a 3D version of the Sierpinski Gasket. I have always been struck by the coincidence of this pattern with a pattern which emerges from Pascal's Triangle if we write all numbers Mod 2.

I could imagine asking a class of students to work on these images at a range of levels, investigating the patterns and asking and exploring questions related to them. The big question concerns how the Pascal patterns are related to the Sierpinski patterns, if they are. Addressing such questions is an example of the use of inquiry to generate mathematical thinking in the classroom. The choice and exploration of such ideas to generate students' mathematical thinking is an example of inquiry in teaching.

Mathematics teachers are designers of classroom activity to motivate students in mathematics and enable their engagement with mathematics. The new national curriculum also supports this kind of activity, as in: "*reason mathematically by following a line of enquiry, conjecturing relationships and generalisations, and developing an argument, justification or proof using mathematical language*".

In my talk I provided other examples of tasks to support such mathematical inquiry. I have used these tasks with students of different ages from 9 to 19, and with student teachers. All these tasks are guaranteed to raise many mathematical questions and afford opportunities to address the NC aim. For any teacher, taking on board the use of such tasks can be seen as an inquiry approach to teaching. It has more chance of success if you do it together with other teacher colleagues so that you can share experiences, decide what you are trying to achieve and by which means and evaluate the outcomes in terms of students' success with the inquiry approach.

In my talk I provided examples of teachers with whom I have worked at different times who have taken up this challenge. It was never plain sailing, but the desire to do the best for the students motivated the teachers and kept them in inquiry mode. Working with researchers from a university was something they valued, and the university researchers also learned from the experience. You may find that a researcher at your local HE institution might be interested in engaging with you in some research into inquiry-based teaching.

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