

Mathematics Education for the Mathematical and Physical sciences 2010-11

Induction

Mon 27th September 1700 **at QMUL** for prospective QMUL students

Tues 28th September 1530 **at UCL** for prospective UCL students

Course dates and location

Monday 4th October 1700-1830 course starts **at IOE**

and continues Monday evenings during term 1 and term 2 (until 14th March 2011)

room 802

Institute of Education (IOE), 20 Bedford Way, London WC1H 0AL

Course tutors

Course leader: Dr Melissa Rodd

for questions about the course please email t.jarvis@ioe.ac.uk

Other contributing tutors include: Prof Dave Pratt, Dr Candia Morgan, Richard Cowley
Mathematics Special Interest Group, Institute of Education, University of London

Administration

Tim Jarvis

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General character of the course

This H-level module is for undergraduates in mathematics or cognate disciplines who are interested in studying mathematics education. 'Mathematics education' is an umbrella term that encompasses all aspects of learning and teaching mathematics in schools and in other settings. During this course, you'll be introduced to these central themes in mathematics education:

What is mathematical thinking? Personal experiences and philosophical queries.

The mathematics curriculum Aspects of mathematics in various school curricula.

Needs and judgments On assessing learners of mathematics and special educational needs.

Theories of learning Perspectives on how people learn mathematics.

Communication Mathematical discourse and issues concerning 'how we take maths in'.

Teaching How mathematics is presented in/for teaching – pedagogical approaches.

Broad Learning Outcomes

- You'll have a better understanding of your own mathematics-learning strategies and capacities.
- You'll be able to explain how mathematical ideas can be represented in different ways with various tools or media.
- You'll have a coherent view on the content of the school maths curriculum and methods of teaching mathematics.

- You'll be able to discuss wider social and political issues related to mathematics education.
- You'll have developed your skills in presenting ideas about mathematics in writing; this includes expressing views and observations, synthesising readings and presenting arguments.

Teaching Methods

Most of the classes will involve a combination of short lectures or presentations, whole-group discussion and small group work. Students will work together to design or solve mathematics problems, to discuss readings, pull together ideas or put forward their point of view about a topic under consideration.



We shall be using the Bloomsbury Learning Environment, an electronic resource for communicating information about the course and accessing materials. You will use your Institute of Education registration details to access 'Bb'.

Learning expectations

Attendance, and participation, in the class sessions is essential – this is not the sort of course where you can copy up lecture notes and hope to achieve optimum learning/attainment. Most classes will be organised around a central theme for which there will have been some reading or a mathematical task (maths tasks will typically start at KS3 school level). This reading or task will either have been given out the previous week or posted on 'Bb' (see above); coming to class having done this 'homework' will be important in developing your perspectives on mathematics education

Special features

If you would like some school classroom experience too, you can apply to the Student Associate Scheme run by the Institute of Education, sas@ioe.ac.uk, that organises placements in London schools.

Assessment

Formative (on-going) assessment

You will receive formative assessment throughout the course in two ways:

- (i) in some classes, you'll be asked to write a paragraph or so about the topic under consideration and these writings will be read by the relevant lecturer who will give you some feedback about your ideas and their communication.
- (ii) during the January-March term you are entitled to an individual tutorial to discuss your essay planning and writing in depth.

Summative (final) assessment will be in two parts of equal weighting:

- 1) An essay (2000 words) to be submitted on Monday 21st March 2011
- 2) A 2 hr pre-disclosed exam in early May 2011 (*date to be confirmed*)

Session descriptions: dates, details, readings and references

4/10/2010 Mathematical thinking 1: your curriculum and biography

Welcome and introduction to the course. Starting from a review of your experiences, we shall characterise some of the philosophical, psychological, sociological, didactical, pedagogical and curricular issues that will be met during this course of 'mathematics education'.

Reference

Lakoff, G. & R. Núñez (2000) *Where Mathematics Comes From* New York: Basic Books

Melissa Rodd

Reading for week 2

Extracts from: Thurston, W^m (1994) 'On proof and progress in mathematics' *For the Learning of Mathematics* Vol. 15 (1) pp29-37

11/10/2010 Mathematical thinking 2: doing mathematics

Aspects of doing mathematics will be discussed including representation, processes and working with mathematical objects. In this session, you'll work together in groups on a selection of mathematical problems, starting points and tasks. We shall discuss and start to classify some of the mathematical concepts and processes that you have worked with.

Reference

Tall, David (2006) *The transition to formal thinking in mathematics* at davidtall.com (posted on Bb)

Task for week 3

A mathematical task will be given for you to work on and comment on during the week and to bring with you for session 3.

18/10/2010 Mathematical thinking 3: reasoning and proof

Devising a proof is often considered the pinnacle of mathematical reasoning, but where does the feeling that proof is important come from? how do pupils/students start to learn to prove and come to believe that the proving process is worthwhile? and are there pre-cursors to proving or alternative routes to 'being sure' about a mathematical proposition?

References

Rodd, M. (2000) 'On mathematical warrants: proof does not always warrant and a warrant may be other than a proof' *Mathematical Thinking and Learning*, 2 (3), 221-244

Melissa Rodd

Reading for week 4

Extract from Black,P., Harrison,C., Lee,C., Marshall,B. and Wiliam,D. (2002) *Working inside the black box: Assessment for learning in the classroom*. King's College, London: School of Education.

25/10/2010 Needs & judgments 1: assessment issues in mathematics education

In this session, the notion of assessment for learning will be introduced and discussed. Key findings from research in this area will be presented. We will spend some time looking at how questions and tasks within mathematics education can be framed in order to give open up students so that teachers can gain information about student thinking, and provide constructive feedback.

Reference

Lee, Clare (2006) *Assessment for Learning in Mathematics* Milton Keynes: Open University Press

Dave Pratt

Viewing for week 5

Before our meeting on Monday of week 5, please watch <http://www.teachers.tv/videos/secondary-maths-mathematics-for-all-playing-mathematically>

1/11/2010 Needs & judgments 2: school mathematics and 'special' needs

Different 'special' needs will be introduced and which aspects of mathematics offer particular challenges or particular opportunities for these different conditions will be discussed. We shall investigate strategies that are helpful in teaching learners with additional to typical needs, both in terms of personal development as teachers and those that employ suitable technologies.

Reference

Ann Dowker (2004) 'What works for children with mathematical difficulties' Research briefing www.dcsf.gov.uk/research/data/uploadfiles/RB554.pdf

Melissa Rodd

08/11/2009 reading week

Reading for week 6

Morgan, C.: 2005, 'Communicating mathematically', in S. Johnston-Wilder, P. Johnston-Wilder, D. Pimm and J. Westwell (Eds.), *Learning to Teach Mathematics in the Secondary School* (2nd ed.), Routledge, London, pp. 142-157.

15/11/2010 Communication 1: specialist mathematical discourse

It is impossible to separate doing, teaching and learning mathematics from the language through which it is communicated. While language and other modes of communication such as algebraic notation, graphs and diagrams make it possible to think and communicate mathematically, the specialist nature of mathematical discourse can also cause problems for learners and their teachers.

We will consider what characterises mathematical ways of communicating and how this may affect what happens in the classroom.

References

Barton, B. (2008). *The Language of Mathematics: Telling Mathematical Tales*. New York: Springer.

Pimm, D. (1987). *Speaking Mathematically: Communication in Mathematics Classrooms*. London: Routledge Kegan & Paul.

Candia Morgan

Reading for week 7

Extract from: BUXTON, L (1981) *Do You Panic about Maths? coping with maths anxiety* London: Heinemann Educational

22/11/2010 Communication 2: Affect, memory and mathematical performance

Despite the image of mathematics as rational and logical, learning mathematics involves 'affects' like feelings, emotions and moods, beliefs and values, as well as cognition. Indeed our abilities to think, cogitate, are intricately bound up with our affective states. This session will draw on our own experiences of learning and doing mathematics in order to understand better the wider set of personal resources learning mathematics involves.

Reference

Drodge, Edward N. and Reid, David A.(2009) 'Embodied Cognition and the Mathematical Emotional Orientation', *Mathematical Thinking and Learning*, 2: 4, 249 — 267

Melissa Rodd

Task for week 8

Download and try out *ChanceMaker* from the software section in http://people.ioe.ac.uk/dave_pratt (for PC only).

29/11/2010 Curriculum 1: Uncertainty

Using some problems that have non-intuitive solutions, we shall explore our own understanding and exemplify how intuitions can change as well as when they are resistant to change.

Reference

Pratt, D. (2002) Probability and Randomness in Haggarty, L. (ed.) (2002) *Aspects of Teaching Secondary Mathematics: Perspectives on Practice* London: RoutledgeFalmer, pp141-9

Dave Pratt

Task for week 9

Observe the instructional movie about *Tinkerplots* at <http://www.keypress.com/x4164.xml>

6/12/2010 Curriculum 2: Statistics

Exploratory data analysis is widely used in classrooms to enable student to carry out statistical investigations. We shall look at one example to see how specially designed tools can support such an approach and we shall compare this to classical treatments of statistics.

Reference

Graham, A. (2006) *Developing Thinking in Statistics* London: Paul Chapman

Dave Pratt

13/12/2010 Essay preparation and term review

The suggested essay titles will be discussed and advice give on how to plan, research and write your 2000 word paper. You'll have an opportunity to give an interim course evaluation.

Melissa Rodd

Winter holiday

Reading for week 11

Extract from: Margaret Donaldson (1971) *Piaget* Glasgow: Fontana.

14/12/2009 Theories of learning 1: 'Macro theories' of learning mathematics

We shall consider some of the principal theories about how people's knowledge develops and how mathematical knowledge might be assessed. We shall discuss some of the limitations of these theories and begin to understand what might be meant by a 'theory' in mathematics education.

Reference

Bryant P. (). Piaget, mathematics and Vygotsky. In *Piaget, Vygotsky & Beyond: Central Issues in Developmental Psychology and Education*, pp 131 – 144. Routledge.

Dave Pratt

Reading for week 12

Extract from Lave, J. (1988). *Cognition in Practice*. Cambridge: Cambridge University Press.

17/01/2011 Theories of learning 2: 'Micro theories' of learning mathematics

We shall consider some of the main theories about how thinking is influenced by contextual factors. We shall contrast this type of theory with those encountered in the previous week.

Reference

diSessa A. & Cobb, P. *Ontological Innovation and the Role of Theory in Design Experiments*

Dave Pratt

Reading for week 13

Thompson, I. (2004). To jot or not to jot? *Mathematics in School*, 33(3), 6-7.

24/01/2011 Communication 3: writing mathematics

Many students (at all levels) express a liking for mathematics because they do not have to do as much writing as they do in other subjects. Nevertheless, writing is an important part of the lives of both students and professional mathematicians. Not only is their work evaluated through their writing (for example, in examinations or in academic publications) but it can also serve a useful purpose in supporting their developing thinking about a problem. We shall consider the role of writing in mathematics and approaches to supporting learners in developing mathematical ways of writing.

References

Morgan, C.: 2001, 'The place of pupil writing in learning, teaching and assessing mathematics', in P. Gates (Ed.), *Issues in Mathematics Teaching*, RoutledgeFalmer, London, pp. 232-244.

Misfeldt, M. (2007). Idea Generation during mathematical writing: Hard work or a process of discovery? [Electronic Version]. *European Research in Mathematics Education V: Proceedings of the Fifth Congress of the European Society for Research in Mathematics Education, Working Group 8*, from <http://ermeweb.free.fr/CERME5b/>

Candia Morgan

Reading for week 14

Find 'algebra' in the Mathematics National Curriculum Programmes of Study Key Stages 3 and 4 <http://curriculum.qca.org.uk/key-stages-3-and-4/subjects/mathematics/index.aspx>

31/01/2011 Curriculum 3: School algebra

During this session, we shall think about what algebra is as first experienced at school. Is it 'sums with letters'? or 'reasoning structurally'? or something else. We shall look at tasks and at what teachers might do to help pupils start algebra. We may also discuss how school algebra articulates (or not) with university algebra.

Reference

FRENCH, D. (2002). *Teaching and learning algebra*. London, Continuum.

Richard Cowley

Reading for week 15

French, Doug (2003). Subject knowledge and pedagogical knowledge, *Mathematics Education Review* No. 16 (April).

01/02/2010 Teaching 1: Pedagogical content knowledge in mathematics

Part of the knowledge needed to be a teacher is knowledge of how to interpret the mathematical content of the curriculum for the particular students one is to teach. Pedagogy – the principled understanding of teaching – involves a secure grasp of mathematics, the students as people and representations of the mathematics suitable for those specific learners.

Reference

Rowland, T., Martyn, S., Barber, P., & Heal, C. (2000). Primary teacher trainees' mathematics subject knowledge and classroom performance. In T. Rowland & C. Morgan (Eds.) *Research in mathematics education* (Vol 2 pp. 3-18). London: British Society for Research into Learning Mathematics.

Dave Pratt

14/02/2010 reading week

Reading for week 16

Swan, M. The design of multiple representation tasks to foster conceptual development. *Topic Study Group 34*, ICME11 from <http://tsg.icme11.org/document/get/289>

08/02/2010 Teaching 2: task design

Teachers are designers; they need to create lesson plans, assessment methods and resources. A key aspect is the design of tasks. We shall consider some of the issues involved in designing good tasks.

Reference

Ainley, J., Pratt, D. and Hansen, A. (2006). Connecting engagement and focus in pedagogic task design, *British Educational Research Journal*. 32.1, 23-38

Dave Pratt

Reading for week 17

Goldstein, R., Povey, H. & Winbourne, P. (Eds) (1996). Mathematics and IT: A pupil's entitlement, from

28/02/2010 Teaching 3: technologies for teaching and learning

We shall 'taste' different types of software, ranging from a specific task, a broad tool and a microworld for exploration. We shall discuss how each might be used in the classroom.

Reference

Johnston-Wilder, S. & Pimm, D. (2004) *Teaching Mathematics with ICT* Milton Keynes: Open University press

Dave Pratt

Task for week 18

Try out the Bowland case study on *Highway Link Design*.

Go to <http://www.bowlandmaths.org.uk/index.htm>

Now choose 'Run the Bowland Player online'. Then choose 'The Case Studies' and finally 'Highway Link Design'.

07/03/2011 Teaching 4: Bowland maths

We shall work with and discuss materials from Bowlandmaths.org.uk: Bowland Maths offers materials for teaching for KS3 pupils by giving them purposeful 'case studies' that have resonance beyond the classroom. Pupils work together on open-ended problems over a sequence of lessons. The Bowland project aims to increase pupils' motivation and enjoyment, which should help increase their confidence and their competence.

Reference

Watson, A. & Mason, J. Extending example spaces as a learning/teaching strategy in mathematics.

from <http://www.education.ox.ac.uk/uploaded/annewatson/watsonmasonexemplextendspace.pdf>

Dave Pratt

Geometrical task for week 19

To be given

14/03/2011 Curriculum 4: geometry

We shall use different tools to develop various knowledge and ways of knowing about two-dimensional shapes in the plane. By using ruler and compasses, axioms and deduction and the software Cabri-géomètre we shall investigate different routes to exploring and to understanding familiar shapes. We shall then discuss geometry education from the perspectives of some of the theme introduced in the first term, for example: curriculum, pedagogy and language.

Reference

SCHUMANN, H. & GREEN, D. (1994) *Discovering Geometry with a Computer*. Bromley Chartwell-Bratt

Melissa Rodd

Essay hand-in Monday 21st March 2011

Summer term:

Date to be negotiated with students, April 2011 Course review

We shall review the course and help prepare for the examination in May.

Melissa Rodd

Books for further reading

BUXTON, L (1981) *Do You Panic about Maths? coping with maths anxiety* London: Heinemann Educational

DWECK, C. (2000) *Self-theories: their role in motivation, personality and development*. Hove, E. Sussex: Taylor & Francis

FRENCH, D. (2002). *Teaching and learning algebra*. London, Continuum.

FRENCH, D. (2004). *Teaching and learning geometry : issues and methods in mathematical education*. London, Continuum.

GATES, P. (ed.) (2001) *Issues in Mathematics Teaching*, London: RoutledgeFalmer

GIFFORD, S.: 2005, *Teaching Mathematics 3-5*, Maidenhead: Open University Press.

HAGGARTY, L. (ed.) (2002) *Aspects of Teaching Secondary Mathematics: Perspectives on Practice*, London: Routledge Falmer

HOPKINS, C., POPE, S. & PEPPERELL, S. (2003) *Understanding Primary Mathematics* London: David Fulton

HOUSSART, J.: 2004, *Low Attainers in Primary Mathematics: The whisperers and the maths fairy*, London: RoutledgeFalmer.

HOWSON, G. (1991) *National Curricula In Mathematics* Leicester: The Mathematical Association

JOHNSTON-WILDER, S. & MASON, J (Eds.) (2005) *Developing Thinking in Geometry* Maidenhead: Open University Press

JOHNSTON-WILDER, S. & PIMM, D. (Eds.)(2005) *Teaching Secondary Mathematics with ICT* Maidenhead: Open University Press

Lakoff, G. & R. Núñez (2000) *Where Mathematics Comes From* New York: Basic Books

MASON, J. et al (1985) *Thinking Mathematically*. Harlow: Addison-Wesley

MORGAN, C. R., A. WATSON, C. TIKLY. (2004). *Teaching school subjects 11-19. Mathematics*. London: Routledge- Falmer.

NELSON, D., JOSEPH, G.G. & WILLIAMS, J. (1993) *Multicultural Mathematics: teaching mathematics from a global perspective* Oxford: Oxford University Press

NICKSON, M (2004) *Teaching and Learning Mathematics* 2nd Edition: A Teachers Guide to Recent Research and its Application London: Continuum

NUNES, T. & BRYANT, P (1996) *Children Doing Mathematics* Oxford: Blackwell

OLLERTON, M. & WATSON, A. (2001) *Inclusive Mathematics 11-18* London: Continuum

POLYA, G.(1945) *How to Solve it* London: Penguin

PRESTAGE, S. & P. PERKS (2001). *Adapting and extending secondary mathematics activities: new tasks for old*. London, David Fulton.

THOMPSON, I. (Ed): 2003, *Enhancing Primary Mathematics Teaching*, Maidenhead: Open University Press.

TIKLY, C. and WOLF, A. (2000) *The Maths We Need Now: Demands, Deficits and Remedies*, London: University of London Institute of Education.

all available from the IOE library