BSRLM Day Conference
Newcastle University, 13 November, 2010

A. Annual General Meeting of the Society

The AGM of the Society will take place at the day conference. Executive Committee Vacancies: There will be four vacancies on the BSRLM executive committee from January, 2011. One is the key post of Chair (3 year term of office) and the others are the Publications Officer (3-year term of office), Day conference organiser (3-year term of office) and Secretary (one-year term of office to complete Kirsty Wilson's term). Elections will take place at the AGM.

B. Conference sessions

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Prospective mathematics teachers' use of multiple representations to introduce the function concept in technology-rich environments

This study investigates the development of prospective mathematics teachers' use of multiple representations during teaching in technology-rich environments. Forty prospective teachers took part in a teacher preparation programme which aims to develop technological pedagogical content knowledge (TPCK). As part of this programme, prospective teachers participated in workshops during which the TPCK framework was introduced focusing on function and derivative concepts. Various components of TPCK were considered. This study investigates one particular component of TPCK: knowledge of using multiple representations of a particular topic with technology. The content we focus on in this paper is "introduction to functions". Five out of forty prospective teachers introduced the function concept in the beginning and at the end of the programme as part of their micro-teaching activities. The data obtained from semi-structured interviews, videos of prospective teachers' lessons, their lessons plans and teaching notes was analysed to investigate prospective teachers' knowledge of representations and of connections established among representations using technological tools such as Geogebra and Graphic Calculus software. We discuss the educational implications of the study in designing and conducting teacher preparation programmes related to the successful integration of technology in teaching mathematics.

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Investigating the impact of a developmental research project: listening to mathematics teachers' reflections

In this session I present results from my current research concerning the impact of a developmental research project called TBM (Teaching Bettter Mathematics) on six primary - secondary schools. Three of these schools have been involved in a previous project (LCM project) while the three others started with the present TBM project. This project ran for the period 2007 - 2010 and the main focus was on researching teaching development as a means to enhance pupils' learning opportunities. The data base consists of focus group interviews conducted in 2009 within each school. Analysis brings evidence of change in the teachers' practice and, at the same time, emphasises the challenges they met. Systemic implications are also addressed. In addition, the differences between schools with previous experience in participating in a project and schools without such an experience are pointed out. Implications for collaborative work between teachers and didacticians are presented and discussed.

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Calculating: what can Year 5 children do?

In 2006 we collected and analysed answers from a Year 5 QCA test paper to explore the range of calculation strategies used by a sample of approximately 1000 children. Two years later in 2008, we repeated this research using the same questions with a new cohort of Y5 children from the same group of 22 schools. In 2010, we carried out a third set of similar research. This session explores the findings from the 2010 data and makes comparisons across the longitudinal study. It examines the range of strategies used by the children and how these have altered over time. We conclude by considering if and how the use of particular calculation strategies have impacted on the overall results and we ask if we are clearer about which strategies lead children to success. The session will include an opportunity to look at some of the children's work and to discuss the effectiveness of their strategies.

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Measuring students' persistence on unfamiliar mathematical tasks

As part of a wider study endeavouring to measure aspects of students' beliefs and behaviour in relation to learning mathematics, 182 students responded to a number of Likert-scale items regarding their persistence on mathematical tasks. Rasch analysis was then used to construct a measure of persistence from their responses and to assign persistence scores to each student. The same students, all of whom were enrolled in the first year of a third-level programme, also completed a 30-minute test involving mathematics items from PISA. The latter, although commensurate with the students' level of mathematical education, represented largely unfamiliar tasks to the students and required the transfer of previously learned mathematical knowledge and skills to a new context. The students' performance on these items was used to construct a second measure of persistence. Preliminary analysis indicates that the self-reporting measure correlates well with the evidence provided by the PISA-type test. While the wider study was undertaken in an effort to test Dweck's (1986) theory on the relationships between students' beliefs concerning the nature of intelligence, their goal orientation, their confidence, and their willingness to seek challenges and to persist when faced with difficulties during their learning of mathematics, this session will focus on the measurement of a student's persistence on mathematical tasks. An account of the results and the reliability of the self-reporting measure will be presented.

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Relentless consistency – analysing mathematics teacher education through four of Fullan's 'Six secrets of change'

In the leadership of change literature, Michael Fullan's work is influential. He has developed theories about the process of working rather than the content of that process. The work of a mathematics teacher educator could be seen as leading change for a group of prospective teachers. In this session, I aim to use four of Fullan's 'six secrets of change' to analyse the structure of the mathematics education aspects of the one-year University of Bristol Post-graduate Certificate of Education (PGCE) course, to gain insight both into practices that illustrate Fullan's 'secrets' and into possible developments to the course given aspects of the secrets not in evidence. Fullan's idea of 'relentless consistency' seems to fit with the way the prospective teachers evaluate strengths of the course.

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Pitch and pace: pedagogic strategy and dialogic engagement

Teachers' subject knowledge has been the focus of much commentary over the years at least since George Bernard Shaw made his dismissive comment. The development of Map, Narrative, Orientation (MNO) has sought to address issues of subject knowledge for teaching through foregrounding it in sequence planning (see session with Chris Olley). In planning a sequence of lessons the material to be learned is mapped out and a route determined through which students are to be taken. However, at this point, the desired rate of student acquisition of new knowledge is determined and this may carry "invisible social class assumptions"[Bernstein 1990]. This session looks at developing a description of pacing strategies with respect to the 'connectedness' of the curriculum and the maintenance of any particular approach through dialogic engagement. This in turn generates a question about 'formative' assessment strategies, which might also be considered as part of a teacher's 'knowledge'.

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Snapshots from a classroom: an analysis of patterns of interaction over an academic year in one year 7 mathematics class

This case study draws on data collected in one secondary mathematics department in the UK in the academic year 2007-8. I took six video recordings of Teacher X working with her year 7 class. In line with the enactivist methodology that informed the research, in this paper I look at the final recording of the year and trace the patterns that can be observed back through the rest of the data. The analysis of two patterns offers a partial lighting on how a particular way of working developed, and demonstrates how the patterns that can be seen at the end of the academic year are observable at the beginning of September.

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Sorry Sue, two staff off and we can't use the hall: the serendipity of a saturated teaching project

This session sets out to relate the learning experiences of an ITE tutor and their PGCE students resulting from a new saturated teaching experience and its subsequent evaluation using creative research methods. The saturated teaching project involved taking a group of twenty four students into a National Challenge school to work with two groups of pupils. The students worked on a one-to-one basis with twenty-four Year 11 pupils and in groups with around eighty Year 7 pupils. This session will share some of the positive outcomes from the project as well as some of the issues it raises. It will also consider the value of incorporating such activity into the PGCE programme. In addition, to evaluate the project, a creative hermeneutic approach was developed. The students created a communal art work or 'mandala' which was then collectively discussed by the students and tutor. A narrative based on the discussions and images was created by the tutor and fed back to the students to inform their further reflections and entries into their reflective journals. This proved a rich method of evaluation and the benefits of such an approach are explored. The images used to illustrate this session are those created by some of the students in the mandala. They are a subjective selection but represent the range of responses and engagements which resulted from the use of the arts based approach. The results from the reflections and the project itself were interesting for the tutor and provided some new insights into different way of working with PGCE students and schools.

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Benchmarking mentoring practices for effective mathematics and science teaching

This study investigates PGCE mathematics and science teachers' perceptions of their mentoring experiences using the five factor model of mentoring as a lens through which mentoring practices can be benchmarked for improvement. The research questions that the study addresses are: What mentoring practices do PGCE mathematics and science teachers perceive their mentors to exhibit during their school placement? Are there differences in the perceived mentoring practices between male and female pre-service teachers? Are there differences in the perceived mentoring practices between different age groups of mentees? Are there differences in the perceived mentoring practices between trainees on placement in urban, sub-urban and rural areas? Do mentors model effective use of ICT during school placement? To answer these questions, the Mentoring for Effective Teaching instrument was used to collect data from 68 pre-service mathematics and science teachers on school placements in two Local Authorities in the South East region of England. The results indicate that mentors in the two LAs overwhelmingly exhibit effective personal attributes for mentoring, provide adequate mentoring in pedagogical knowledge, model teaching effectively and provide effective feedback to pre-service teachers. Yet, the results also indicate mentors did not provide adequate mentoring on systems requirements in relation to the national curriculum and school policies. Mentoring the use of ICT was also found to be inadequate. The study concludes that the Mentoring for Effective Teaching instrument is transferable to the English initial teacher preparation context and that gender and location of school placement have no influence on mentoring practices within the two LAs. Finally, although ICT is perceived to be less effectively modelled, science mentors may benefit from the expertise of mathematics mentors through sharing of best practice at mentor training meetings.

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Perceptions of symmetry: a window into how 13 year old students appear to understand symmetry

For a doctoral research project, which uses the Design Based methodology (Cobb et al, 2003), I have designed a task for Year 8 students (aged 12-13) using Dynamic Geometry Software (DGS). Students are asked to investigate triangles and quadrilaterals which can be generated by dragging two rigid perpendicular lines within a shape in DGS (ie the diagonals of a quadrilateral, or base and height of a triangle). When they have generated a specific shape the students typically use the Measures menu to check properties of equal sides and angles. The dragging strategies employed by the students during the task will be described with reference to Hollebrands (2007) and a newly observed strategy which I call 'dragging to adjust measures'. Excerpts from the dialogue and the on-screen activity recorded during a session with two particular students will be analysed. One issue which became apparent was that the students viewed shapes through the lens of symmetry, using symmetry to identify congruent objects (and thus properties) within the shape. On being questioned about the meaning of symmetry their notions of it were process based rather than coming from an esoteric understanding of the meaning of symmetry.

The students also appeared to use mental rotations, to describe how two right angled triangles could make a rectangle. Battista (2008) has surmised that unconscious mental transformations such as rotations may be employed when visualising congruent objects such as opposite sides in a parallelogram. This idea will be discussed as a potential line of inquiry for the next iteration of the research project.

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A week with secondary mathematics through history and culture

In this session I discuss the mathematics lessons I delivered during the last week of the previous school year at a secondary school, years seven to ten. The lessons involved history of mathematics as well as cultural elements. What I look at is the material I chose to use and why. I also comment on the students' initial reactions to the idea and whether they engaged with the lesson. I also comment on what kind of questions students asked in class. Another area I discuss is students' answers as well as their interpretations of the issues raised in class. As each of the four classes was of different achievement (from bottom to top sets), I comment on whether achievement seemed to have any effect on students' reactions. Finally, I raise some teaching issues I encountered when attempting to teach with this approach and I make some suggestions on what a mathematics textbook could encompass. It is important to note that this series of lessons is 'the last cycle' of the action research project begun three years ago. In 2007-08, I taught a one-year course called cultural mathematics and recorded the results using action research. The lessons that are described in this session have been informed by this action research project and are also briefly discussed.

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A framework for analysing students' approaches to solving mathematical tasks

This paper looks at the development and implementation of a framework for analysing students' performance on tasks when using mathematical software. Through a literature review, three approaches and one affective factor were identified to analyse how students' make sense of solving tasks and how these affect students' performance. The three identified approaches were 1) processing level approach (deep or surface learning), 2) self-explanation approach (quality of explanations) and 3) explorations (extent of using software). The affective factor used was mathematics confidence. Using these approaches and affective factor a triangular framework based on the literature was developed which showed how all of these factors were related to performance and their inter-relationships. The literature indicated that confidence was related to the processing levels but there were not any studies that showed whether self-explanations were related to confidence, processing levels or software exploration.

Through observing 38 students solving conceptual and procedural tasks on a computer whilst thinking-aloud, the research aimed to determine whether there was a relationship between these approaches and the factors using both qualitative and quantitative data. An updated framework was developed based on the results from this study. Some evidence was found that quality of self explanations was related to the processing levels. Mathematics confidence was found to be related to software explorations and the quality of self explanations. Software explorations were also found to be related to the quality of self-explanations. The framework can be further implemented for testing theories on the relationship between performance and the approaches that students' take in making sense of solving tasks

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Expert and novice approaches to reading mathematics: where do the eyes go during proof validation?

Learning by reading mathematical proofs is central to the study of advanced mathematics. Indeed, some philosophers have argued that professional mathematicians learn the majority of their new mathematics by reading the proofs of others. However, many educational research studies have shown that students find mathematical proofs difficult to engage with. Here we report a study in which professional research mathematicians and first year undergraduate students were asked to read, and then determine the validity of, several purported mathematical proofs. Participants' eye-movements were recorded as they read. We analysed the order in which participants attended to different components of the purported proofs. Our findings suggest that a major difference between expert and novice behaviour when reading mathematics is related to the level of effort exerted when looking for logical links between different statements. In addition, we demonstrate that novice readers spend

proportionately longer studying formulae (compared to text) than experts. However, contrary to the predictions of earlier researchers, we found no evidence that experts read mathematics in a non-linear fashion.

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Affordances and constraints of turn-taking

In this session I will focus on turn-taking in whole class interactions in secondary mathematics classrooms. Building upon a thorough analysis of turn-taking in classrooms by McHoul (1978), we will explore of situations that arise in classrooms where the turn-taking deviates from the rules outlined by McHoul, such as pupils self-selecting as next speaker. The structure of turn-taking in the classroom raises some important questions about the teaching and learning of mathematics.

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ESUM -- Engineering students understanding mathematics

With a small amount of STEM money from the Royal Academy of Engineering, I am just starting an innovation project in teaching mathematics to first year undergraduate materials engineering students in the first semester. The innovation will follow two years of teaching in which I have tried to introduce inquiry-based tasks into regular tutorials, without feeling much success (Jaworski, 2009). The innovation will include use of specially designed "good" questions in a GeoGebra environment to stimulate conceptual understanding, and a project for students to undertake in groups of four involving inquiry in mathematics. Two colleagues are involved in the project and a PhD student and a part time research officer will collect and analyse data. Together we form a small inquiry community looking into the teaching of these students. As well as theory of inquiry communities, which I have reported on many times before, I am thinking about the possibility that French theory of "documentational genesis" (Gueudet and Trouche, in press) might be relevant to this project. I will report on our setting up of the project and reflect on the first weeks of teaching.

Jaworski, B (2010). Challenge and support in Undergraudate Mathematics for Engineers in a GeoGebra medium. MSOR Connections, 10, 1.

Gueudet, G. & Trouche, L. (in press). Communities, documents and professional geneses: interrelated stories. In,G. Gueudet, B. Pepin and L. Trouche, Mathematics Curriculum Material and Teacher Development: from text to 'lived' resources. N.Y.: Springer.

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Why do GCSE examination papers look like they do?

Examination papers for GCSE mathematics qualifications are produced by private awarding bodies working to government regulations. A given paper and its mark scheme is usually written by one individual, and then reviewed and revised by a Qualification Paper Evaluation Committee (QPEC). As such, QPEC meetings have a significant role in how the final published exam paper looks. Over the past year I have observed several QPEC meetings across the three awarding bodies that publish GCSE papers. I will describe how government regulations are interpreted and applied by QPECs, and so shed some light on why GCSE examination papers look like they do.

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Measurement: everywhere and nowhere in secondary mathematics

School mathematics is commonly structured into number, algebra, geometry and statistics. Measurement is a topic that occurs across such headings since some aspects of measurement (such as measuring length or area) have a geometrical component, while other aspects of measurement (such as time or money) are about number. Then there are compound measures such as speed, acceleration, fuel consumption, and so on, and issues such as precision in measurement. When actual measures are not known, a relationship between two measures can be expressed quantitatively – and this is one of the roots of algebra. Probability can be thought of as a form of measure (of uncertainty) and the various measures of data variation, such as standard deviation, can also be viewed as a type of measurement. All this means that the placing of measurement in the mathematics curriculum can be problematic for curriculum designers and policy makers and equally tricky for teachers to teach in the most effective way. The Nuffield-funded project on the research basis for teaching the key ideas of secondary school mathematics is reviewing what is known about pupils' prior understandings of measurement that secondary teachers might expect to be able to draw on, the possible routes of progression in measurement at the secondary school level, and what is known from research about different teaching approaches that might inform classroom choices. This session provides an opportunity to consider how measurement is everywhere and nowhere in secondary mathematics.

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Exploring the relationship between research and professional development for teachers of mathematics

There is a perception that the relevance of research to teachers is limited (for example see Hargreaves, 1996) and that research has little influence on what teachers do in the classroom and to the continuing formal and informal professional development of teachers (CPD). However, there are at least five ways in which research is related to CPD for teachers of mathematics: research is seen as a CPD activity (teachers do research as part of their CPD); research informs the design of CPD; reading research within CPD; teachers being the subject of research studies; and research about CPD. I argue that, given the multiple ways in which research is related to CPD, it is important to address the concerns above by exploring all these aspects of the relationship between research and CPD. In this presentation, I take each of the five aspects of the relationship between research and CPD outlined above and discuss the ways in which this relationship can be characterised, particularly focusing on the potential and limitations of the contribution of research to CPD. I look at evidence pointing to what seems to happen in practice, such as, for example, the influence of literature about 'lesson study' on the design of a CPD initiative or a tendency to follow the 'letter' of recommendations arising from research without becoming familiar with the 'spirit'. The presentation draws on the literature concerning CPD for teachers of mathematics, evidence gained from the RECME research project and an evaluation of NCETM-funded teacher enquiries, as well as from my experiences related to developing approaches to making research accessible to teachers. It is 'work in progress' and comments and suggestions are welcome.

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Does every child count? Some tensions around quality and equality

In this session, we look at the interlinked discourses through which quality and equality are constructed as objects within neoliberal education policy in England and at the consequences for teachers' practice. We will do this by analysing two sets of data: policy documentation and qualitative in-depth interviews with four prospective primary teachers. We will argue that the rational neoliberal discourses of policy conflict with hierachical discourses of mathematics. We will show how this conflict is exemplified in the practices of 'ability' grouping.

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Integrating technology into a mathematics degree
I report on an aspect of a case study at an English university where the mathematics department has integrated technology into its mathematics degree programme for many years. In this session I will be looking at codes that resulted from interviews with various people with a view to getting some audience input on how the various factors worked together to make 'technology work' at this maths department.

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Exploring opportunities for reification in cooperative learning situations
The notions of reification, encapsulation or 'procept' have provided a way of examining children's use of processes and construction of objects in arithmetic. As part of a project to promote cooperative learning situations in young children's arithmetic, this paper considers the construction of mathematical objects from a socio-cultural perspective. Theoretical perspectives are explored and illustrated through videos and transcripts of cooperative learning situations with children aged 6 years old. This is used to consider what opportunities are afforded by cooperative learning situations for reification and the construction of mathematical objects.

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Map: from content to pedagogic content, the work of recontextualisation
Effective teachers have a constructivist orientation (Askew et al. 1997) and these teachers themselves have connected mathematical knowledge. In secondary schools, the design and structuring of courses is frequently deferred to published resources or curriculum development projects. What we refer to as Narrative is clearly structured in published resources in the linear layout of text books. In detailed presentations of curriculum design, such as Realistic Mathematics Education, the narrative is clearly set out. These materials detail the activities designed to engage students with the mathematics, which we refer to as Orientation. However, we will argue, the element either missing or unarticulated is an overview of the mathematics to be taught, the Map. We will contrast this with the relationship between Shulman's content knowledge (CK) and pedagogic content knowledge (PCK). PCK is only orientation, it sets out the skills for getting students in to mathematical ideas. We will claim that without map and narrative, there cannot be connectionist teaching. However, from CK to PCK, we suggest there is a recontextualisation of academic mathematics to school mathematics. Schulman appears to mythologise teaching as the direct transmission of academic mathematics. We are replacing a stochastic view of prior knowledge with a process. So, we will suggest an approach to being a mathematics teacher as the incorporation of map, narrative and orientation. You have to work on the recontextualisation or you simply create procedure, this work is the creation of map and narrative. We have previously presented data from PhD mathematicians, who had trained to teach. Despite an evidently high level of academic mathematics, they generated procedural planning. They saw the recontexualisation as trivial and did not see the need to do this work. In this session we will draw on empirical instances of the use of map in a variety of teachers' plans.

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Level 3 mathematics: a model for the curriculum

ACME has published a proposed pathways structure for the post-16 maths curriculum to take effect from 2016. A model with a simpler highway structure is derived starting from a view of the purposes of level 3 maths. Preparation of students for quantitative university courses, not just STEM but courses of various kinds requiring different amounts and perhaps different kinds of maths, is assumed to be a main purpose of post-16 pure maths. The implications of this proposition have been explored previously and pointed to the conclusion that the foundational mathematics needs of non-STEM quantitative courses could be satisfied by AS-level pure maths and STEM courses by full A-level pure maths. The model builds on this position and offers enough pure maths for up to three years of full-time study as part of a balanced curriculum. Mathematics support for vocational courses is considered as a second purpose for level 3 maths, by analogy with its role as a foundation for university courses. However, pure maths support for vocational courses is excluded from the model on the grounds that what is required will generally be at level 2. The place in the curriculum for various kinds of applied maths is discussed, distinguishing what, like mechanics, is relevant foundation for a restricted range of university or vocational courses and what, like statistics, has generic relevance. The latter are covered by the model, the former are assumed to be the responsibility of the courses needing them and excluded from the model. The model offers students choices as to how far and how fast to travel down the highway and permits exits and later returns.

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Analysing secondary mathematics teaching with the Knowledge Quartet

The 'Knowledge Quartet' (KQ) is a theoretical framework for the analysis and development of mathematics teaching. It directs the attention of the analyst (and, potentially, the teacher) to situations when the teacher's knowledge of mathematics and of mathematics-related professional knowledge comes to the fore. This focus for analysis and reflection is a stimulus to the enhancement of teacher knowledge and the improvement of teaching. The KQ framework was developed in empirical research in 2002 (and subsequently) in the context of primary mathematics teaching, but it has also been applied, in an opportunistic way, to post-primary mathematics teaching. My current work with colleagues in Cambridge investigates the application of the KQ to secondary school mathematics contexts in a more systematic way. Much of this BSRLM session will focus on discussion/analysis of one videotaped mathematics lesson with a Year 9 class, taught by a trainee teacher.

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Conceptions of 'understanding mathematics in depth': what do teachers need to know and how do they need to know it?

In recent years there has been much debate and concern about the preparation and supply of mathematics teachers (eg Williams, 2008, Smith, 2004). In Britain this is linked to a perceived under-performance in mathematics of school students in comparison to their counterparts in other countries. With this debate there has been a growth in interest in what constitutes subject knowledge for mathematics teaching, and how it is developed. Much of the research has focused upon primary teachers. The nature of subject knowledge required by secondary mathematics teachers has been relatively under-researched. My own interest in this area has developed through my experience firstly as a PGCE tutor, and then as a tutor on two programmes specifically designed as subject enhancement courses for secondary mathematics teachers. This work has been a fascinating opportunity to develop 'bespoke' mathematics courses for teachers, and has challenged the course team to think deeply about the mathematics that teachers need to know, and how they need to hold that knowledge. I have thus become very interested in what constitutes subject knowledge for mathematics teaching, and what 'understanding mathematics in depth' might mean to teachers. In this session I will report on work in progress in an investigation into what characterises 'deep understanding of mathematics', as understood by two particular groups of secondary pre-

service and serving mathematics teachers. This part of the investigation is carried out by means of semi-structured interviews, drawing upon methods developed by Adler and Hossain (2009) in their ongoing work into 'understanding mathematics in depth'. Additionally, quantitative data on groups of pre-service Mathematics PGCE students is presented, to investigate the nature of the relationship (if any) between degree classification and effectiveness as a teacher, and whether the data suggest any differences in subject knowledge, between former Mathematics Enhancement Course (MEC) students and others.

C. Working Group

History in the mathematics curriculum

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The 2008 Programmes of Study for KS3 and 4 declare that one of the Applications and Implications of Mathematics is that pupils should be "Recognising the rich historical and cultural roots of mathematics" (Key Concepts 1.3 (c)). This session continues the earlier meetings of the group and will review the outcomes and material from the meeting on 'History of Mathematics in and for the Classroom' held at BCME, and also the publication in May of the special History Issue of 'Mathematics in School' together with more recent material. Objectives for the Working Group are to examine claims made for the benefits of introducing the history of mathematics in our teaching, and test these ideas in our current climate. From the experience gathered we are beginning to produce case studies and investigate possible theoretical foundations to inform both cognitive, affective and operative aspects of our teaching. By starting with our standard curriculum we continue to examine how we can offer historical information or short 'episodes' to support the rationale, learning and motivation of particular areas of mathematics at different levels. The Working Group aims to select, share, trial, evaluate and modify appropriate material in the light of teachers' experience so that together we may discover sensible ways of introducing the "rich historical and cultural roots of mathematics" to our pupils.