BSRLM Day Conference
University of Nottingham, 19 June, 2010

A. Janet Duffin Memorial Lecture

The Janet Duffin Memorial Lecture will take place at the day conference. The speaker is Andy Noyes of the University of Nottingham who will address: Exploring social patterns of participation in A-level mathematics.

B. Conference Sessions

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Development of prospective mathematics teachers with regard to technology integration to address student difficulties: the case of radian concept

This study investigates how two prospective mathematics teachers integrate technology into their lessons to address student difficulties. Prospective teachers took part in a teacher preparation program which aims to develop technological pedagogical content knowledge (TPCK). As part of this program, prospective teachers participated in workshops which aimed to develop TPCK of derivative and function concepts conducted by the presenter of this session. Following this workshop, prospective teachers conducted their own workshops during which they discussed student difficulties with various mathematical concepts such as function, limit, continuity, definite integral and radian with their peers. They also discussed how these difficulties could be addressed during a lesson using technological tools such as Graphic Calculus and Geogebra software. This session particularly focuses on radian concept. Prospective teachers prepared two lessons on radian: one before the workshop and one after the workshop. They taught the second lesson to their peers after the workshop. The data sources are two prospective teachers' lessons plans, teaching notes, semi-structured interviews on their lesson preparations and videos of their second lessons. This session discusses the development of prospective teachers' TPCK with regard to student difficulties with radian concept.

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The relationship between number sense and mathematics achievement in children and in adults

There is growing evidence that humans have an inbuilt 'number sense' system that supports approximate numerical operations. Findings suggest that when we learn to deal with symbolic numerals, they may be mapped onto the pre-existing non-symbolic system. Theorists have speculated that this non-symbolic system might be the cognitive basis of all higher mathematics. However, the relationship between 'number sense' and formal mathematics ability remains somewhat unclear. If symbolic arithmetic is aided by the use of a non-symbolic system, then children's understanding of number could be facilitated by improving mapping between systems. In the present study, seven- to nine-year old and adult participants were assessed for non-symbolic acuity, formal mathematics ability and IQ. In children, there was a positive relationship between formal mathematics ability and non-symbolic comparison accuracy when controlling for IQ. In adults, however, this relationship was not present. This pattern of findings suggests a developmental shift in the relationship between formal mathematics ability and non-symbolic acuity. In particular it seems that if 'number sense' is the cognitive basis of mathematical ability, it fulfils only a bootstrapping role.

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The Influence of a 'Teaching practice' course on Student Teachers' Perspectives on Mathematics Assesment

The main purpose of the study is to explore the assessment perspectives of mathematics student teachers within a framework of three categories of assessment which reflect assessment dilemmas faced during the practice of teaching. Turkish national education is in the middle of a radical curriculum reform based mainly on constructivist theories. We believe that the student teachers should be ready for the changing requirements of the new mathematics curriculum. Data was collected from 50 student teachers who just finished the mathematics teacher education program but not yet started to teach professionally. Data collection instruments are questionnaires, practice teaching portfolios and semi-structured interviews. The questionnaire data were analysed using descriptive and inferential statistics. Data from the interviews and student teachers' reports is used to explore reasons for the trends emerged. Data indicated tensions in perspectives between the psychometric paradigm which is influenced by the assessment practices in their pre-university school years and the 'assessment paradigm' which emphasised in the teacher education programme.

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Lesson Study as a form of professional development and action research

The Centre for Innovation in Mathematics Teaching has been engaged in working collaboratively with teachers to develop their professional practice using Japanese Lesson Study for some time. It has been suggested (Lewis, 2006) that in order to avoid a supeficial adoption of the strategy, research to gain a deeper understanding of lesson study is necessary. It is with this in mind that we have undertaken a pilot study exploring the nature of the lesson study initiatives with which we are working at CIMT. The session will describe the processes of lesson study groups, look at its impact on the classroom practice of the teachers and consider the wider research agenda.

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Working with visual representations of mathematical concepts

This session will present recent research that examined the impact of the properties of visual representations on students' ways of working with these representations. The study focused on multiplication and division, where 83 students (ages 11-13) were asked to identify symbolic expressions in different visual representations. Based on existing research, variations in performance between representations were explained by students' ability to recognize, and also the working memory load involved in reasoning with these representations. It was found that visual cues within the representations supported recognition and reasoning. However, it was found that supporting one process could hinder the other. Based on these findings, implications for classroom practice were put forward, specifically the need for different representations to be presented together in a coherent manner.

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Using an audience response system - what do the audience DO with the feedback?

This is work in progress looking at how to assess the assessments. The first year cohort of undergraduate mathematics students at Nottingham has experienced a range of assessment types in this academic year. They have been assessed using formative and summative coursework, in class tests and computer-based tests, and formative use of audience response systems. The use of an audience response system was new to them and the opportunity was taken to seek their views of their behaviour during the response system classes and afterwards. We also asked their view of the effect of the other assessment methods on various aspects of their learning experience. Views were sought on how the behaviour of students was affected by taking these assessment types, particularly in relation to reading notes, keeping up-to-date

with lecture material and encouraging students to seek support when needed. In this session we will present our initial findings of what kind of student behaviour seems to be encouraged by which type of assessment and thoughts as to how we might use that information. In particular in relation to the electronic system we looked at how students approach answering questions, what they do after answering a question correctly or incorrectly, and how that behaviour changed according to whether or not they had guessed their answer.

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The Construction of Mathematics Problem Solving Attitude Scale

Lack of scale measuring students' attitudes of mathematics problem solving (at grades 6, 7 and 8) has been observed in the relevant literature. The present research, which was motivated to remedy such deficiency, aims to develop a likert-type attitude scale (Mathematics Problem Solving Attitude Scale-MPSAS). A draft of the scale which contained 77 items was composed based on both review of the extant literature and the opinions of experts on this area of research. The draft scale was tested on a group of 638 students at 6th, 7th and 8th grades. As a result of factor and item analysis, 58 items were omitted, and the remaining 19 items have been divided into two dimensions called "Enjoyment" and "Teaching". Various techniques were used to ensure the content and construct validity of the scale. Test-retest and split-half test techniques were used to test the reliability. The Pearson correlation coefficient revealed by test-retest technique was 0.89. Cronbach alpha coefficient calculated to ensure the internal consistency was 0,848 for MPSAS, 0,869 and 0,777 for the sub scales MPSAS-E (Enjoyment) and MPSAS-T (Teaching) respectively. The research has produced a valid and reliable likert-type attitude scale as a research instrument.

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Using video for professional development: a case study of effective practice in one secondary mathematics department in the UK

The use of video recordings of lessons for teacher professional development has increased in prominence recently (e.g., see Clarke & Hollingsworth, 2000, LeFevre, 2004, Brophy, 2004, Sherin, 2004, Borko et al, 2008, van Es & Sherin, 2008). It has been reported that it takes time, within a group, to develop effective use of video (Sherin & Han, 2004) or that teachers do not necessarily gain insight into their practice from watching video recordings of their teaching (Brophy, 2004). This paper reports on evidence from the use of video recordings in one secondary school, where teachers commented on finding video watching in a group more useful than lesson observation, with no evidence of this taking time to develop. I report on the practice of using video in this school, where it has come from, and offer some speculations as to why it is effective.

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Long term impact of mental calculation sessions on primary PGCE students

In the summer of 2008, I worked with a small group of primary PGCE students and discovered that a brief taught session on mental calculation strategies had a significant impact on their final teaching placement. In order to evaluate whether there was any longer term impact, I have revisited some of those students who are now approaching the end of their second year of teaching. I will present my initial findings of this ongoing research.

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What role can workshops play in student learning?

Having previously been both Head of Mathematics at a secondary school and a university Lecturer in Mathematics, I have, over the last two years, run a number of contrasting workshops for students in the 16-21 age range. Some were hugely successful, whilst others appeared, on the face of it at least, not to have been so productive. Each workshop was based on some underlying problem or mathematical theme, usually one that I had either developed

myself or adapted from a simpler activity. Accounts of several of these workshops have been published as articles. In this session I would like briefly to talk about some of the workshops I have run, and to consider the following questions: How was the workshop conducted, and what were its aims? Was it successful? How do I know? For that, matter, what do we really mean by 'successful' in this context? Are such workshops worth the considerable time and effort spent preparing them? I would like eventually to open the session out into a discussion, so that we may learn from each other with regard to our experiences and ideas. It is not necessary to have run a workshop in order to attend this session. Nor is it necessary, despite the fact that some of the mathematical ideas in the workshops were relatively advanced, to have taught at A level or above.

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A socio-cultural approach to resilience in students' mathematical transition to College and University

In our Transmaths projects we are studying how different practices during transition from School to College and from College to University mediate students' mathematical learning and identities. Amongst our cohort of students we found that some, in spite of the difficulties faced during transition and, against the odds, persisted and completed the transition successfully. We look for a theory of resilience to try to explain what made these students persist against troubles. However, the vast majority of studies of resilience come from a psychological or psychosocial perspective, paying too much attention to the individual's characteristics (personal trait theories) or "environmental" factors that influence individual "personalities". In this presentation we will explore socio-cultural approaches to this concept to try to understand why some students persist while others don't. We will show the narratives of two "resilient" students and analyse them through socio-cultural approaches on identity and Bourdieu's concepts of capital, class, habitus and field.

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Mathematics education in high-performing countries: What does the research say?

In this session we will discuss the findings from our Nuffield Foundation funded review of the research literature on the features of mathematics education in those countries that perform well on international tests of mathematics attainment(Askew, Hodgen, Hossain, & Bretscher, 2010). Our focus will be on countries from the Pacific Rim together with Finland. We will discuss the factors underlying high performance in TIMSS and PISA. We will argue that that we should be careful not to 'cherry pick' findings that fit with what we believe might be key to success. However, we will argue that there are lessons to be learnt for England. Amongst these are findings relating to textbooks, shadow education and procedural teaching. We will also suggest that comparative research might be more usefully focused on culturally near-neighbours such as Massachusetts and Scotland.

Askew, M., Hodgen, J., Hossain, S., & Bretscher, N. (2010). Values and variables: A review of mathematics education in high-performing countries. London: The Nuffield Foundation. www.nuffieldfoundation.org

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How we Teach: Analysing University Teachers' Presentations of their Teaching

A series of seminars in the Mathematics Education Centre at Loughborough has focused on the teaching of mathematics in the university. In each seminar one individual has presented their personal view of teaching. This has led to a discussion and raising of issues, and is in the process of developing a teaching discourse. Most of the seminars have been video-recorded and we are in the process of analysing them as data to address the question of how we characterise mathematics teaching at this level. In the session we will discuss our data and the analysis that we have done so far, with emerging categories.

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Teacher Enquiries funded by the National Centre for Excellence in Teaching Mathematics : Understanding the initiatives and their impact

The NCETM funds teachers of mathematics, in all phases of education from Early Years to Further Education, to undertake small-scaleenquiry projects. Underpinning this strategy is the assumption thatinvolvement in teacher enquiry will have an influence on the practiceof individual teachers, of departments and of schools and colleges. This presentation reports on a study which a) provided a comprehensive overview of all NCETM-funded teacher enquiry projects completed between September 2006 and January 2010; b) evaluated the impact of NCETM teacher enquiry projects on teaching and learning mathematics; and c) assessed the experiences of teachers related to the processes of engaging with an enquiry project. The study found that the enquiry projects ranged in scope and focus, reflecting the wide interests and concerns of teachers and those involved with the CPD of teachers. There is clear evidence that taking part in the projects had a positive impact on teachers in terms of their own learning, changes in their classroom practice and improved student learning.

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Teaching and assessing algebra: Lessons from the ICCAMS Project

In this session we will discuss the teaching approaches that we are developing in the algebra strand of the ESRC-funded Increasing Competence and Confidence in Algebra and Multiplicative Structures (ICCAMS) project. In phase 1 of the project we tested representative samples of Y7, Y8 and Y9 students on several CSMS tests, including the Algebra test that was first used 30 years ago. In phase 2 we have worked closely with eight Y8 teachers and their classes, and have interviewed small groups of students on a variety of algebra tasks. The aim of this phase is to design and trial an intervention for dissemination to a wider group of teachers and schools. The presentation will focus on how we are integrating formative assessment and evidence about students' learning into teaching materials.

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It's good to talk! (EAL as a medium for teaching and learning in mathematics lessons)!

An analysis of Malaysian Primary ITE students' perceptions of learning and teaching mathematics in English; how the medium of EAL impacted on their practice in schools and how this might be relevant to teachers of mathematics in UK primary schools?

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How do learners parse and process mathematical constructs? The results from a preliminary eye tracking study

The aim of this presentation is to show the preliminary results from an investigation into how eye tracking equipment can be used to provide evidence has to what learners fixate upon and for how long when reading mathematical constructs. The preliminary study was carried out with an expert mathematician, a mathematics PhD student, a graduate mathematician, final year mathematics undergraduate and two final year psychology students. The initial findings show some similarities in the fixation times but also reveal some interesting differences. For example, the expert mathematician's fixation times commenced at 50ms whereas the others commenced around 110ms. The implication seems to be the expert has accessed an asemantic processing route and the others utilise deeper semantic processing. The eye tracking scans also reveal how the participants initially parsed the mathematics and regressed to the key points. This seems to imply that a first parse gives an overall sense of the question and also identifies key points associated with finding a resolution. Subsequent parsing focussed upon, what the participant considered, to be the key points. A bigger study should reveal if experts can identify the relevant key points quicker than a group of novice learners. It should also indicate the depth of semantic processing.

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Adaptation of the Finney-Schraw Statistics Self-Efficacy Scale for use by Turkish Mathematics Student Teachers

Belief of self efficacy is defined as someone's belief of his/her capacity in getting any kind of success (Bandura, 1986). Self-efficacy theory is rooted in a larger theoretical framework called social cognitive theory, founded by Albert Bandura. Social cognitive theory is based on a view of human agency characterized by intentionality, forethought, self-regulation, and self-reflection capabilities that place people in a position to act as both producers and products of their social systems (Bandura, 2001).The present study is concerned with the fact that students' belief of self-efficacy plays a critical role in statistics courses and their performance. However, there is insufficient research about the influence of service-learning on statistics-related beliefs.. The purpose of this study is to adapt the self efficacy beliefs scale developed by Finney & Schraw (2003) to Turkish and review its validity and reliability. There were 14 items in the scale wh1ch used a 5-point Likert scale (1=strongly disagree, 2=disagree, 3=neither disagree nor agree, 4=agree, 5=strongly agree). This was carried out with 144 mathematics student teachers and 10 instructors. After analyzing the linguistic equivalence of the scale, reliability and validity analyses were conducted. First, sampling adequacy and Barlett Sphericity results were checked. To be able to conclude that the data is appropriate to investigate with exploratory factor analysis, In this study, KMO sampling adequacy coefficient and Barlett Sphericity test value was found to be .84 and 569.167 ($p<.001$, $df=.91$), respectively. Since the original form of the scale is composed of two subscales, while conducting factor analysis with principle component analysis with oblique rotation technique, the results were limited to three factors. After varimax rotation of the common variance of substances between .37 and .86 , factor loading ranged between.51 and .89 were collected. Cronbach Alpha internal consistency quotient was .87 and the correlation coefficient for the split half method analysis was .84 and 0.76. According to these results, it can be concluded that the Turkish version of the scale is reliable and valid to measure self efficacy beliefs of students.

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The Influence of Teacher Candidates' Spatial Visualisation Ability on the use of Multiple Representations in Problem Solving of Definite Integrals: A qualitative analysis

Student's difficulties of understanding definite integral concept have been in the centre of the many researches. One of the principle reasons behind the difficulties is thought as the lack of the awareness of different representations. Some studies in mathematics education indicate that there is a relationship between the visual-spatial abilities and multiple representations. This study aims to investigate the influence of spatial visualization ability in representations used in definite integral subject. In this sense, a case study has been carried out on 45 mathematics teacher candidates. Multi- method approach was adopted by using more than one research techniques. Tests, Document analysis and semi-structured interviews are the research instruments and inferential & descriptive statistics are used for the data analysis. Findings showed that spatial visualization ability of the teacher candidates is low. In parallel to these findings, it was determined that the candidates, who have low spatial visualization ability, used predominantly algebraic representation. It is observed that the teacher candidates, who particularly used two representations as mixed representations in solving the definite integral problems, have high spatial representation abilities; the candidates with low spatial representation ability predominantly used algebraic representations even in problems which could be solved through different representations. The candidates, who did not use graphical representations, experienced difficulties in the process of solution were algebraic-based thinking, misuse of graphical data and interpretation. The development of spatial visualization ability, which may influence the relationship between graphical representations and the other representations, increases the performance of solving definite integral problems. Moreover, the candidates are advised to develop their spatial visualization abilities to improve their abilities of interpretation of visual information.

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Research Impact: the teacher and researcher interface

The NCETM HEI liaison group has been thinking about how to enhance the impact of research, for example through teachers access to research, through researchers engaging with teachers, and through teacher-research with HEI support. This is timely for researchers in view of the increased role impact will play in the REF. This discussion will involve sharing examples of practice in formulating research questions, preparing research bids, methods of dissemination, and other forms of joint activity. It is hoped that experienced researchers will contribute to this discussion, as well as new researchers, with the aim of preparing a statement of principles.

C. Working groups

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Ranking mathematical tasks by difficulty using paired-comparisons

The design of classroom and assessment materials for secondary mathematics typically involves developing sets of tasks for use with pupils of varied ages and abilities. The tasks then need sequencing in terms of content, processes and relative difficulty in order to develop a balanced and cumulative programme of learning. Determining the relative difficulty of a set of mathematical tasks can be a tricky and time-consuming process. It might involve trialling the tasks with large numbers of pupils (>30 per task) to produce a mean score for each task which can then be used to produce a rank order of relative difficulty. In this session we will explore an alternative method based on paired-comparisons (Pollitt, 2004), in which experts are presented with pairs of tasks (taken from the Bowland CPD materials) and asked to make a holistic judgement about which of the two they think would be the more mathematically demanding. Every task is compared with every other task until a final rank order is produced. This ranking will be compared to that produced by the traditional trial-and-score method which was recently carried out for the same tasks. Participants will play the role of expert judges in the session and require confidence with mathematical task design and assessment at Key Stages 3 and 4. Depending on outcomes and participant feedback it is hoped there will be further BSRLM sessions exploring methods for ranking tasks, as well as pupil scripts, in mathematics assessment.

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Geometry Working Group: the role of the teacher in teaching proof and proving in geometry

As Stylianou, Blanton, & Knuth (2009: 5-6) identity, “very few studies have focused on the teaching of proof in the context of teachers’ day-to-day instructional practice”. In recognising that more is currently known about the learning of proof, this working group session focuses on the role of the teacher in teaching proof and proving in geometry. The plan is to work with a a selction of theoretical positions, perhaps including the theories of teaching with variation, of socio-mathematical norms, and of instructional exchanges. The group is open to all; everyone is welcome!

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What maths do you need to get to university?

Analysis of UCAS data shows that students entering university to study subjects that need some maths knowledge separate into three blocks according to the maths and/or statistics needed in courses in these various subjects. One block comprises students entering degree courses in the traditional STEM subjects: maths, physics, and physics-based engineering that

demand full A-level maths for entry. A second block of subjects, containing other science, technology, and business courses, requires no more than GCSE maths for entry but there is likely to be maths "top-up" during the course. A third block comprises students entering courses in subjects, such as psychology, where there is statistics top-up only. These facts provoke a series of questions concerning post-16 maths. How well does the A-level content actually prepare students for their various courses, considering the variety of maths topics on offer at A-level? Do courses in block one simply need two years of general development of mathematical thinking after GCSE? Is it helpful to distinguish subject-specific from more general foundational maths? Courses in the second block of subjects typically top-up the students' knowledge with one or two units of maths in the first year. Could the maths needs of students in both blocks be met by reform of A-level content so that AS-level, by emphasising discrete maths, meets the needs of the large number of students in the second block, while A2 satisfies the additional needs of the smaller number of traditional STEM students? ACME has proposed reforming the post-16 maths curriculum from 2012. How consistent is this suggestion with their proposals? Is choice within maths A-level helpful or unhelpful? Could teachers cope with a significant shift of curriculum content? Could they cope with a big increase in AS-level numbers? And the big question- how likely is it that reform, aimed at making AS-level more relevant to the needs of more students, would actually lead to many more students entering block two courses having taken AS-level maths instead of giving up maths after GCSE? Block three students just get a unit of statistics top-up. Another big question- is there a case for *all* students getting a unit of statistics before entering university?

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History in the Mathematics Classroom

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'. Objectives for the Working Group are to examine claims 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.

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The future of subject specific Masters programmes in Mathematics

Since 1995, we have been offering Masters level credit as part of the PGCE programme at Swansea. In 2004, we established a dedicated Master of Research (MRes) degree in Mathematics Education funded by the Gatsby Charitable Trust. This was externally evaluated and we are convinced of the positive impact that such courses can have on mathematics teaching and learning. Moves towards a Masters level teaching profession and the development of the MTL are thought by some to have placed the future of subject specific Masters programmes in mathematics at risk in some parts of the UK. However, the recent change of government may result in a change of policy in this area. This working group would consider the future of subject specific Masters programmes in mathematics, with a view to considering the matter further at the BERA SIG in September. In particular, we should like to include, in the working group discussion, the ongoing need to collect data about the impact of such Masters programmes on teachers, teaching and learning.

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Trigonometry Working Group

The Trigonometry Working Group is open to all and takes the form of an informal discussion group about research and practice in trigonometry. In this session we shall discuss two research papers on teaching and learning trigonometry. It would be helpful, but not entirely necessary, to read these in advance. Copies will be available on the day:

Singh, S. (1986) 'Teaching trigonometry in the (micro)computer age' International Journal of Mathematical Education in Science and Technology,17:3,315 — 323 (available online).

Kendal, M. & Stacey, K. 'Teaching trigonometry'. Downloadable from http://staff.edfac.unimelb.edu.au/~kayecs/publications/1997/KendalStacey-Trig.pdf

Notes of past sessions can be found in the BSRLM conference proceedings. These two papers and other documents used by this group in the past can be obtained from anne.watson@education.ox.ac.uk.