**BSRLM Day Conference**
**University of Oxford, 19 November 2011**

## Conference Sessions

**Andrews,** Nick
University of Oxford
nicholas.andrews@education.ox.ac.uk
*The Tri-polar Attention Space*
Categorising pedagogical content knowledge risks failing to capture the dynamic nature of knowing-in-action (Schön, 1983). Instead, I propose a framework that might better represent knowing-to-act in the moment. The tri-polar attention space is a triad with the attractive forces of teacher–content, learner–content and teacher–learner interactions at the three poles. A point within the interior of the triad marks the location of a teacher's attention relative to the three poles.
In this session, I will introduce the framework and present a study that focused on centres of attention: the mean point of locations over a period of time. Data was collected from beginning teachers on the University of Oxford Mathematics PGCE Course so as to locate their centre of attention relative to the three poles at three time points. Analysis revealed that the movement of the cohort centre of attention over time was consistent with the findings of previous differently framed studies. However, the geometry of the tri-polar attention space offered alternative approaches to analysis and these revealed an interesting sub-trend not predicted by previous studies.

**Attridge,** Nina & **Inglis,** Matthew
Loughborough University
n.attridge@lboro.ac.uk
*The development of deductive reasoning skills in A level mathematics students*
For centuries it has been assumed that the study of advanced mathematics improves logical thinking skills. Even today, this argument (known as the 'Theory of Formal Discipline') is used in policy debates to prioritise mathematics in the UK's National Curriculum. So far, however, there has been no conclusive evidence that the claim is actually true (and some suggestive evidence that it may not be). The research that will be presented in this session aimed to test the Theory of Formal Discipline by tracking the development of three aspects of logical reasoning in A level students: conditional inference ability, syllogistic reasoning ability, and avoidance of belief bias. Mathematics students were compared to English Literature students at the beginning and end of their year of AS study. The mathematics students did improve more than the English Literature students in conditional inference and syllogistic reasoning, but not in avoidance of belief bias. This suggests that while there is some truth to the Theory of Formal Discipline, further research is needed to narrow down exactly which reasoning skills are improved by studying mathematics and which are not.

**Barmby,** Patrick
University of Durham
p.w.barmby@dur.ac.uk
*Assessing young children's understanding of multiplication*
This study is part of Nuffield Foundation-funded project aimed at developing primary children's understanding of mathematics. As part of this project, a test of primary children's understanding of multiplication was developed. Although there has been research on developing tests of understanding in other mathematical topics (e.g. fractions) and in particular for older (e.g. late primary or secondary) children, there has been little reported work on tests for multiplication for younger primary children. In this study therefore, a test of multiplication was constructed based on the range of contexts and representations associated with multiplication. The 19-item test was administered to a sample of mainly Year 3 pupils

(*n*=272) with a small sample of Year 4 pupils (*n*=18) in 10 primary schools. The age of the pupils meant that test questions were read out by the teacher, and most were multiple choice items. The data obtained from the test was analysed using Rasch analysis in order to examine the reliability of the overall measure, and the validity of individual items. Two items were shown to correlate poorly with the overall measure, possibly because of the difficulty of the contexts presented to children. Overall, the measure was show to have a good reliability indicated by a Cronbach α value of 0.79. The analysis of data was also used to examine the progression in difficulty of the different items, and related to the progression in children's thinking in multiplication. The children from one school in the sample were also found to have performed markedly better than those from the other schools, and the data is further explored as to why this difference may have occurred. Recommendations for further improvements in the test are put forward.

**Bellamy,** Elizabeth
Swansea Metropolitan University
ebellamy@klbschool.org.uk
*Exploring and Encouraging Metacognitive Behaviour in Problem Solving*
This session describes an exploratory study into the metacognitive behaviours displayed by Year 7 pupils, when solving novel problems. Theoretically, the study draws predominantly on the work of Schoenfeld and methodologically, studies by Artzt and Armour-Thomas, Kramarski and Mevarech and Garofalo and Lester. The study involved a high achieving group of 34 Year 7 pupils, consisting of 11 girls and 23 boys. Over the course of three lessons, pupils were required to solve novel problems in groups of three and their cognitive and metacognitive comments were observed. Within their groups, pupils were assigned roles as problem solver, actor, or observer. The restriction on the contributions of individual group members, imposed by their assigned roles, altered the form of interaction and social involvement and was intended to delay discussion. Metacognitive training was provided through reflection, both during and after pupils' attempts to solve novel problems that were within their mathematical range. The findings of the study are encouraging in that informal instruction and group and class reflection led to improvements in the quality of communication and greater awareness of metacognitive knowledge and processes.

**Breen,** Sinead; **McCluskey,** Aisling; **Meehan,** Maria; **O'Donovan,** Julie & **O'Shea**, Ann
St Patrick's College Drumcondra, National University of Ireland Galway, University College Dublin, Cork Institute of Technology, National University of Ireland Maynooth
ann.oshea at nuim.ie
*Reflection on Practice, in Practice: The Discipline of Noticing*
In the academic year 2010/11, a group of mathematicians in five third level institutions in Ireland conducted a study in which each reflected on her own teaching. There are many definitions of the term reflection but we endeavoured to employ the ideas of Mason (2002) as described in the book 'Researching your own Practice: The Discipline of Noticing'. Each lecturer wrote accounts of critical incidents that occurred in her classes, taking care to keep the accounts short and as free from opinion and value judgments as possible. The modules involved ranged from service Mathematics courses for first-year Civil Engineers to an Analytic Topology course for Masters students. At the end of the academic year, each of the project participants reflected on the experience of reflecting on her practice and of writing accounts. These final reflections provide the data for this talk. We describe the aims that motivated the study, the challenges we faced in using the Discipline of Noticing to reflect on our teaching, and the progress that we have made.
Reference:
Mason, J. 2002. Researching your own practice: The Discipline of Noticing. Oxon: Routledge.

**Campton,** Ian & **Edwards,** Julie Ann
University of Southampton
i.campton@soton.ac.uk, J.S.Edwards@soton.ac.uk
*Relationships between the influences of primary teachers' mathematics knowledge*
Teachers' subject knowledge remains the topic of much discussion. Recent reports have highlighted the view that strong subject knowledge is fundamental in enabling pupils to gain a comprehensive understanding in their mathematical learning. Although much research surrounds the development of different constructs of subject knowledge, less has been undertaken in order to identify what the mathematical subject knowledge of current primary school teachers consists of and how it is constructed. This session reports on the findings of a small scale project that aimed to identify areas for improvement within the continuing professional development of primary school mathematics teachers in two schools. The research involved interviewing 11

primary school teachers using questions adapted from the research of Ma (1999) designed to gain an understanding of their approaches to teaching a topic, how they dealt with pupils' misconceptions and the extent of their own subject knowledge in order to prepare for the unexpected when teaching. The emergent conceptual framework of the influences of primary school teachers' mathematical content knowledge will be discussed as will the relationship between these influences, which reveal a multi-layered belief system that is well-intended and well-informed at the top level but underpinned by less firmly established levels of subject knowledge and pedagogical approaches.

**Colloff,** Kate & **Tennant**, Geoff
University of Reading
*The 'algebra as object' analogy: a view from school*
Concern has previously been expressed about the use of the 'algebra as object' analogy to teach early simplification of algebraic terms (eg. Tennant, 2009). Drawing on research undertaken for a Masters dissertation, this paper examines this issue from a current classroom perspective, with a review of textbooks used, teacher interviews, year 7 interviews and the views of year 10 asked how they would explain the simplification of algebra to younger pupils. It was found that a number of textbooks in current usage continue to use the 'alegebra as object' analogy. Teachers often indicated that they knew that they were 'not supposed' to use it but were unclear as to why exactly. Year 7 pupils were, in the main, able to complete elementary simplification of algebra without reference to 'algebra as object', although approaches were very rule-based. Most year 10 pupils suggested an 'algebra as object' approach in explaining simplification of algebra. Implications for initial teacher education on the learning of algebra generally, and simplification specifically, are considered.
Tennant, G. D. (2009). 2a+3a=5a without apples: the algebra as object analogy. Mathematics in School, 38(1), pp. 4-6

**Corcoran,** Dolores & **Moffett,** Pamela
St Patrick's College, Drumcondra, Dublin & Stranmillis University College, Belfast
*Fractions in Context: the use of ratio tables to develop understanding of fractions in two different school systems*
This research is funded by a grant from the Standing Conference on Teacher Education, North & South (SCoTENS). The project seeks to investigate the implementation of a number of Realistic Mathematics Education lessons on fractions in two different educational systems (Northern Ireland (NI) and Southern Ireland (SI)).. Four teacher participants were invited to engage with trialling the RME lessons in their own classrooms. Teachers were involved in two joint meetings with the researchers to discuss and support the use of an agreed sequence of lessons from an RME textbook in one Primary 6 classroom in NI and in three fifth classes in SI. The teaching of lessons was observed by each researcher in her own school system. There were multiple data sources. Curriculum and text books from each system were examined and compared. All children participating did the same pre-test. See Moffett (2011) for a report on one aspect of the pre-test with children from NI. Nine of the lessons were video recorded and short video clips were made of children at work during other lessons. Children's mathematical workings from the lessons were collected and analysed. Researchers kept field notes of school visits and audio recordings of joint meetings with the teachers. Drawing primarily on the Transformation dimension of the Knowledge Quartet (Rowland, Huckstep & Thwaites, 2005) as an analytic framework, each researcher analysed the lessons she observed while adopting what we have called an 'RME gaze'. Similarities and differences in teaching approaches across contexts were examined with a view to identifying some of the supports and constraints experienced by teachers in the implementation of RME lessons. In this session we propose to report on the manner in which three RME contexts provided teachers and children with novel ways for thinking about and working with fractions.

**Crisan**, Cosette & **Rodd**, Melissa
Institute of Education, University of London
c.crisan@ioe.ac.uk, m.rodd@ioe.ac.uk
*Teachers of mathematics to mathematics teachers through a Mathematics Development Programme for Teachers*
Given the premise that there is a shortage of mathematics teachers in England, serving teachers, qualified in subjects other than mathematics yet teaching secondary mathematics, were eligible to participate in our Mathematics Development Programme for Teachers (MDPT) course commissioned and funded by the TDA. This paper reports on research designed to track our 2010-11 cohort of teachers' journeys towards becoming

mathematics teachers. Our course emphasised connections between different aspects of mathematics and involved doing a lot of mathematical work. The notion of 'participation' used in this research is developed from Wenger's (1998) notion of community of practice. The main findings are that engagement with the course facilitated their teaching of mathematics in non-transmission manner; they were able to articulate a wider view of what mathematics was about; their mathematical fluency and accuracy at the end of the course was not as good as a high achieving GCSE student. The course did add value in terms of their self-knowledge about their mathematics 'standard', knowledge of mathematics as a discipline, capacity to immerse themselves in learning mathematics, including overcoming some of the difficulties they had in the past, and knowledge of mathematics-specific pedagogical approaches.

**Darlington,** Ellie
University of Oxford
*Approaches to Learning of Undergraduate Mathematicians*
The approaches to learning adopted by undergraduate students is an area which has been heavily researched, particularly since Marton and Säljö (1984) first wrote of a deep/surface approach dichotomy. However, such research has generally focussed its attention on the techniques of the undergraduate population as a whole, rather than exploring those of students in particular degree streams. For this reason, a study was conducted which aimed to research the approaches to learning of first-year undergraduate mathematicians, specifically relating to what these are and the ways in which the students themselves perceived them to have evolved over time. This study revealed an overwhelming majority of undergraduate mathematicians at Oxford University to adopt strategic approaches to studying, which they claimed were due to the nature of university study. It was established that it was in fact the nature of their specific course that resulted in this approach, as the nature of the new mathematics being studied, assessment demands and question formats in their department contributed towards this. In order to be successful, students who had once adopted approaches synonymous with an – albeit successful – instrumental understanding (Skemp, 1976) of mathematical concepts had to adapt their styles in such a way that rote memorisation became a feature of their learning. This is not a desirable outcome, and cannot provide students with a sound basis to continue their studies and, therefore, further research is warranted into devising mechanisms which may detect students at risk and guide them into learning in a manner more appropriate to gaining a more conceptual mathematical understanding.

**Dickinson,** Paul; **Hough**, Sue, **Searle**, Jeff & **Barmby**, Patrick
Manchester Metropolitan University & University of Durham
P.Dickinson@mmu.ac.uk;S.Hough@mmu.ac.uk;Jeffrey.Searle@cem.dur.ac.uk;
p.w.barmby@dur.ac.uk
*Evaluating the impact of a Realistic Mathematics Education project in secondary schools*
Over the past 30 years researchers at the Freudenthal Institute in The Netherlands have developed a mathematics curriculum and a theory of pedagogy known as Realistic Mathematics Education (RME). This curriculum uses realisable contexts to help pupils to develop mathematically. In 1991, The University of Wisconsin, in collaboration with the Freudenthal Institute, started to develop a middle school curriculum based on RME. This curriculum was called 'Mathematics in Context', and was adopted by numerous schools and districts across the US, with research suggesting significant gains in pupil achievement. A related Mathematics in Context (MiC) project was carried out in England in 2004 to 2007 at Manchester Metropolitan University (MMU) with Key Stage 3 pupils. This initial pilot project was evaluated by Anghileri (2006). In 2007, the ideas behind the project were extended to include Key Stage 4 pupils, particularly those studying towards Foundation GCSE Mathematics, and given the project title Making Sense of Mathematics (MSM). MSM has been running as a pilot project in some Manchester schools since 2007. Both these projects were recently evaluated by Durham University, with revaluation of test data from the original MiC project using Rasch analysis, interviews with teachers from both projects, and observations of the RME approach in lessons. Teachers and researchers found that RME offers a very different account of how pupils develop mathematically. This presentation summarises these differences, presents the findings from the Durham University evaluation, and discusses the impact of RME on both pupils and teachers.

**Dooley,** Thérèse
St. Patrick's College, Drumcondra, Dublin
therese.dooley@spd.dcu.ie

*The affordances of ethical constraints: Brenda's 'voice' in research on the construction of mathematical insight by primary pupils*
In this paper I address the role played by 'informed consent' in framing the design and analysis of a teaching experiment in which I, as researcher-teacher, taught a series of mathematics lessons to primary pupils aged 9 - 10 years. My research aimed to examine the role played by whole-class discussion in the construction of mathematical insight. On the basis of Roschelle's (2000) advice that progressive levels of consent be sought from children and their parents/carers I initially received consent to gather data using audio tape-recorders and written artefacts. When I later asked for consent to use video-recorders, one pupil, Brenda, and her parents refused to give it. I examine the dilemma posed by this - whether to exclude her from the lessons or to 'compromise' the data collected. My decision not to use the video-recorder was opportune. Brenda, who was perceived to be a low attainer in mathematics, made significant contributions to many mathematics lessons and facilitated the collaborative construction of knowledge. The decision also led to new directions in the analysis of my data - in particular, a focus on the role played by 'vague language' (Rowland, 2000) in the development of new understandings in mathematics.

**Dowker,** Ann & **Holmes,** Wayne
University of Oxford
ann.dowker@psy.ox.ac.uk; wayne.holmes@education.ox.ac.uk
*Catch Up Numeracy: An Intervention for Children Who Struggle With Mathematics*
This paper describes an intervention developed to support the needs of children with mathematical difficultis, Catch Up Numeracy, which involves two 15-minute sessions a week of individualized intervention targeted at individual children's pre-assessed specific strengths and weaknesses. We then report data 440 children. The 348 children, who received Catch Up Numeracy intervention, achieved average Mathematics Age gains on the Number Screening Test of more than twice that expected from the passage of time alone, and significantly more than with controls who received non-targeted intervention (50 children) or none (42 children). The evidence reported here indicatesd that Catch Up Numeracy is an effective intervention. More generally it strongly supports the view that children's arithmetical difficulties are highly susceptible to intervention, and that the amount of time given to individualized interventions does not need to be large to be effective.

**Farsani,** Danyal
University of Birmingham
Dxf950@bham.ac.uk
*What are the factors that influence the frequency of mathematics register in one linguistic code than in another?*
This study is to draw attention to some of the significant factors that have increased the frequency of English mathematics register by both classroom teacher and learners in a bilingual Farsi/English mathematics lesson. Throughout my classroom observation in a bilingual mathematics lesson in a weekend school there appeared to be a high degree of code-borrowing in Farsi from the English mathematics register. Mathematical operations and technical terms such as 'times', 'to the power of", 'squared' as well as both cardinal and ordinal numbers were highly likely to be in English. In other words, the English mathematics register seems to take over from the Farsi mathematics register on these occasions. The English language seemed to pervade the technical terms and expressions within a mathematical domain and Farsi was left to encompass the vernacular form of communication.
Overall, the extent to which code-switching occurred depended upon the speaker's linguistic proficiency. This study reveals not only being communicative competent in a particular language can dominate the conversation in that specific language, but also how the written mode can influence the verbal counterpart.

**Finesilver,** Carla
Institute of Education, University of London
carla@finesilver.info
*Pulling out the layers: non-routine counting strategies and recognition of multiplicative structure by students with difficulties in mathematics*
This paper explores students' varied responses to a set of simple enumeration tasks involving three-dimensional arrays constructed from multilink cubes. The participants were all in KS3 or KS4 mainstream education, but had been identified by their mathematics teachers as the lowest-attaining in their respective year groups (all NC Level 3 or below) and as displaying significant difficulties with mathematics. The

majority of participants were initially unable to enumerate the constituent cubes of a presented cuboid, but with the aid of a sequence of minimal teacher prompts, developed some successful strategies. A framework is proposed for categorising enumeration strategies used for multiplicative structures of three dimensions, and for the analysis of individuals' progression from unitary counting towards multiplication. Particular consideration is given to the emergence of structure in counting, and its implications regarding the development of students' mental representations of multiplication.

**Gomes,** Alexandra
Institute of Education/ University of Minho
magomes@ie.uminho.pt
*Portuguese pre-service elementary teachers knowledge of geometric transformations: An exploratory study*
It seems almost evident that every teacher who has to teach mathematics needs adequate mathematics knowledge.
*"After all, if teaching entails helping others learn, then, understanding what is to be taught is a central requirement of teaching."* (Ball & McDiarmid, 1990, p.437)
For elementary school teachers this knowledge is critical since they play a crucial role in introducing children to basic but fundamental mathematical ideas and initiating a process of mathematical learning, with every stage highly dependent on the previous.
However, there is plenty of evidence that teachers, in particular elementary teachers, don't possess the necessary knowledge to teach mathematics effectively.
The case of geometry is particularly worrying. Even though there are some findings from research that revealed many deficiencies and errors in teachers' geometric content (Sarama & Clements, 2009; Gomes, 2004), the fact is that the teaching and learning of geometry has deserved little attention from research when compared with other fields of research. Teacher knowledge literature has focused mainly on elementary teachers' knowledge of number and proportional reasoning.
In Portugal, new programmes for elementary school mathematics (DGIDC, 2007) are just starting to be implemented. In these new programmes, an important role is assigned to geometry and especially to geometric transformations. Since this is a rather new topic in the elementary curriculum, it seems important to understand what knowledge do (future) teachers have on the topic.
In this paper we present findings from a pilot study, conducted with future elementary teachers designed to evaluate their knowledge on geometric transformations.

**Hall,** Graham
Newport University
graham.hall@llandrillo.ac.uk
*Investigations of Motivation and Engagement in Mathematics amongst Post-16 Vocational Students and Adults*
Munns and Martin (2005) propose a model of motivation and engagement in which students are drawn into the study of a subject by the presentation of exciting, challenging and personally relevant activities. A key feature is a top-down approach, in which an interesting problem is presented and methods of solution are sought through experiment and discussion, rather than a bottom-up approach in which basic techniques are first taught and mastered before being applied to specific real world problems in a standard manner.
Case studies have been carried out with two groups at a Further Education College in North Wales:

- students of the BTEC National Diploma in Engineering studying the module 'Mathematics for Engineering Technicians',
- teaching staff of the Construction Department undertaking the course 'AS-level Use of Mathematics' as professional development.

A range of mathematical topics, including: algebra, trigonometry, solid geometry, and calculus, were introduced entirely through the investigation of real world problems, rather than the conventional approach of first learning standard mathematical relations and algorithms. The techniques required to solve the problems were identified by the students themselves, and researched with the assistance of the tutor in an advisory role. The objective was to develop both a deeper understanding of the significance of the mathematical techniques used, and a confidence to work independently.
Students' views of mathematics and accounts of personal study activity were collected through interviews as the courses progressed, so that levels of motivation and engagement might be assessed.

Reference
Munns, G. & Martin, A. (2005), 'It's all about MeE: A motivation and engagement framework', paper presented at the Annual Conference of the Australian Association for Research in Education. Sydney, December 2005.

**Hewitt,** David
University of Birmingham
d.p.hewitt@bham.ac.uk
*Movement, language and mathematics: an interplay on the journey towards solving linear equations*
A group of 21 Year 5 students worked over three lessons with the software Grid Algebra and activities related to the software. The software offers a visual and dynamic environment where movement within a grid creates formal expressions. This session will look at the way in which the focus of students' attention changed between language, movement and mathematics, and how each of these supported the others at different times during the lessons. A theoretical model will be offered for how existing meaning within one of these areas can support the meaning making in others.

**Hickman**, Mike
York St. John University
*Talk Framework for Primary Problem Solving*
Part time postgraduate primary student teachers are currently taking part in a pilot project to inform doctoral work on the way in which the analysis of digital audio recordings may be utilised to support problem solving. The project considers how thinking aloud, supported by digital audio recording (or other technologies that allow playback/recall of material) may support student teachers' learning and levels of confidence in teaching primary problem solving. Having produced digital recordings of one or two problem-solving activities within taught sessions, participants are given their digital recordings to listen to and analyse using a 'talk framework' in a stimulated recall situation. While the pilot project attempts to determine the usefulness of the digital audio recordings, and additionally test the technology, the mechanisms for analysis (inspired in part by the work of Neil Mercer) will also be tested; alongside this, confidence ratings will be taken both before and after undertaking the process. This session will present pilot work undertaken to date and discuss the categories of talk identified, including categories such as Exploratory Transformative and Exploratory Encoding.

**Hodgen,** Jeremy & **Kuchemann,** Dietmar
King's College, London
jeremy.hodgen@kcl.ac.uk
*The ICCAMS project: Designing lessons to facilitate formative assessment*
This is the second session of the **Mini-Symposium on Research-informed pedagogy in early-secondary mathematics**.
The ICCAMS project has focused on examining how to support teachers to implement formative assessment. The focus is on algebra and multiplicative reasoning. Over the past decade, formative assessment has had a phenomenally "successful" reach with both policy-makers and the teaching profession, but evidence suggests that teachers and schools have considerable difficulties in implementing the approach, particularly in mathematics. The distinctive features of ICCAMS include a strong connection to understanding students' difficulties, a strong encouragement for teachers to adapt lessons and the use of conceptual models such as the Cartesian graph, double number lines and ratio tables. We will describe the principles underlying the ICCAMS approach and illustrate this with examples from lesson materials, classroom observation data and student interviews. We will contrast the ICCAMS approach with those of episteme and REALMS. Finally, we will consider the issue of scaling-up ICCAMS and related intervention.

**Huntley**, Ray
University of Gloucestershire
rhuntley@glos.ac.uk
*Lower Attaining Primary Trainee Teachers' Choice of Examples: The Cases of Naomi and Victor*
Following doctoral research into the choice of mathematical examples by primary trainee teachers in one UK institution, this session looks at the cases of Naomi and Victor. Each of these trainees was identified as having lower than average attainment in mathematics, measured both prior to them starting a training course in primary teacher education by their results in GCSE exams and interview tests, and throughout the course

as measured by mathematics tests and mathematics education assignments. The session presents data relating to their choices of examples from lesson plans and semi-structured interviews and considers the different pedagogical approaches they demonstrated. Concerns will be raised about the level of mathematical attainment in lower-attaining trainees and discussion will be invited as to how to improve this for the benefit of pupil learning.

**Hunter,** Jodie
Plymouth University
jodie.hunter@plymouth.ac.uk
*Developing teacher understanding of early algebraic concepts using lesson study*
This presentation reports on the use of lesson study as a professional development tool to facilitate a group of primary teachers enhanced development of their algebraic 'eyes and ears' (Blanton & Kaput, 2003). A specific focus is on how the teachers increased their understanding of how tasks, classroom activity and teacher actions scaffolded students to construct early algebraic reasoning in two areas of early algebra; equivalence (equality) and the commutative principle. Teacher voice is used to illustrate how lesson study cycles caused the teachers to reflect on and review their own understandings of early algebraic concepts. The opportunities to closely observe student responses provided a foundation for them to build understandings of how their students approached tasks which challenged their understandings of the commutative principle, and the equals sign. The teachers recognised the pivotal role they held in making links between the early arithmetical and algebraic reasoning and pressing the students towards situations of generality.

**Hyde,** Rosalyn & **Edwards,** Julie Ann
University of Southampton
R.M.Hyde@soton.ac.uk; J.S.Edwards@soton.ac.uk
*Pre-service teachers' understandings of learning to use digital technologies in secondary mathematics teaching*
One of the biggest challenges facing pre-service mathematics teachers is that of learning how to make effective use of digital technologies in the classroom in order to enhance the learning of their students. For initial teacher educators the challenge is to enable the development of teachers who have the capability to respond flexibly to new technologies and who are able to evaluate and reflect on the impact of such technologies on learning. This session reports on data collected as part of a research project examining ways in which pre-service mathematics teachers can more effectively develop skills in using digital technologies to enhance teaching and learning in the classroom. The opportunities and the evidence for the development of this learning by pre-service teachers collected during the project is examined using Mishra & Koehler's (2006) model of Technological Pedagogical Content Knowledge (TPCK). The emerging understandings of pre-service teachers' learning are considered in the context of their learning experiences during their initial teacher training course and in terms of charting the learning journeys they undertake on the course. The project outcomes point towards ways forward in enabling more effective learning by pre-service teachers in the use of technologies for mathematics teaching.

**Inglis,** Matthew; **Crisp,** Rebecca; **Mason,** John & **Watson,** Anne
Loughborough University, Open University, University of Oxford
anne.watson@education.ox.ac.uk
*Eye gaze in generalising sequences*
We have been using eye-gaze tracking equipment with people with varied mathematical backgrounds who are asked to give a formula for a function, given the table of values. Our hypothesis is that the relative use they make of sequential (term-to-term) and functional information (sometimes called position-to-term) will depend on their experience and the particular function. Our aim in the longer term is to learn more about how people coordinate different sources of information when generalising - but for now we are focusing on linear and quadratic sequences. We shall present preliminary findings.

**Johnson,** Tracy
University of Cambridge
tracywestonjohnson@gmail.com
*Developing Mathematical Knowledge for Teaching (MKT) in Teacher Education*
This study examined pre-service teachers' development of MKT over their final year in a university based teacher education program. This was done through analyzing written reflections, focus group interviews,

individual interviews, teaching observations, and post-observation interviews as well as through the use of a quantitative measure, the MKT test (Learning Mathematics for Teaching, 2005). The study design employed situated case studies, in which tiered participation resulted in extensive data for three focal pre-service teachers as well as a comparison to larger groups of their peers through interviews (n=8), focus groups (n=11), and written reflections and the MKT test (n=35). A new protocol for coding elementary pre-service teachers' mathematics lessons was developed to extend Rowland et al.'s (2009) work on the Knowledge Quartet (KQ) model.
The study investigated pre-service teachers' definitions of MKT, demonstrations of MKT in their teaching, and educative experiences that contributed to their development of MKT. Insights were gained into pre-service teachers' definitions of MKT, the development of which was dynamic, non-linear, individual, and shared similarities to the aggregate definition only at the end of the year. The KQ category of foundation tended to dominate the pre-service teachers' definitions of MKT, the transformation category remained vague, connection was an inconsistent category in their definition, and contingency arose late in the year and at a relatively small proportion.
Insights were also gained into pre-service teachers' demonstration of MKT in their teaching of mathematics. Dimensions of MKT were most often demonstrated at a minimum level, growth on a dimension as indicated by scores that improved over time was extremely rare, scores were more variable than predicted across the four observed lessons, and the connection category was particularly challenging.

**Jones,** Martin
Havant Sixth Form College
martin56jones@hotmail.com
*Exploring algebraic thinking at AS level: the interpretation of letters*
In the 1970s, Dietmar Küchemann identified six interpretations of letter that secondary school students used when thinking through algebraic problems. He also developed a number of test items to assess how they used these interpretations. I compiled a number of the higher order questions into a written test which I gave to 145 sixth form students who were studying the Core 1 (C1) module of AS mathematics and their responses were classified according to the category of letter they appeared to be using. All categories of letter were seen, suggesting in many cases a limited view of how to interpret letters. The written solutions suggest that students' ability to think algebraically is strongly influenced by the interpretations that are available to them, the context in which they see the question, and the ability to shift between interpretations. I also suggest that 'letter as object' is an interpretation used at different levels of algebraic thinking and perhaps used simultaneously with other interpretations. Some resources were then developed and used to help communicate these findings to fellow teachers.

**Kay,** Julie
University of Bristol
julieykay@msn.com
*Does training in finger gnosis and other non-symbolic representation of number improve symbolic number skills?*
Evidence from previous research has demonstrated that babies are born with a biologically determined area of the brain for recognising numerosity. A neurofunctional link between this area used for approximation and the area responsible for finger recognition has been also been determined. It is suggested that many children find learning mathematics very difficult because their symbolic learning does not underpin their understanding of number magnitude. The aim of this study therefore is to demonstrate that by improving the mapping between non-symbolic representation of number using visual stimuli and the verbal counting sequence to their fingers that it is possible to improve children's symbolic mathematical skills by reinforcing the connections between different areas of the brain. Accordingly a pre-test, intervention, post-test experimental model was used with 51 Key Stage 2 pupils. Tests on finger gnosis, estimation and symbolic mathematical skills were performed before and after eight half hour intervention sessions. Initial results showed functional links between finger gnosis and estimation skills and between estimation skills and symbolic mathematics. Following intervention finger gnosis, estimation and symbolic mathematics skills all showed improvements with the correlation between estimation and symbolic skills becoming more significant. This indicates that the intervention had led to greater mapping between the non-symbolic and symbolic areas of the brain. The study also showed that a group intervention program could be delivered in a classroom setting and could provide positive effects for students of differing mathematical abilities.

**Kent,** Phillip; **Altendorff,** Lori & **Kent,** Geoffrey
University of Sussex
P.Kent@ioe.ac.uk
*An Evaluation of Complex Instruction in Secondary Mathematics Classrooms*
This is the third session of the **Mini-Symposium on Research-informed pedagogy in early-secondary mathematics**.
The recently-completed project 'Raising Expectations and Achievement Levels for All Mathematics Students' (REALMS) explored the potential of Complex Instruction (CI), a pedagogical approach that involves collaborative problem-solving in 'mixed ability' classrooms, and has been advocated as a particular means for increasing all students' engagement and achievement in mathematics. The research set out to assess the efficacy of the use of CI in English mathematics classrooms, which previously has had limited attention from UK researchers. We will summarise the research findings, and the implications for supporting mathematics teachers to work with pedagogical innovations.

**Kul,** Umit
University of Leicester
uk13@le.ac.uk
*Professional development of Turkish mathematics teachers within a computer-supported learning environment: changes in beliefs*
The purpose of this study is to investigate the degree to which a professional development (PD) course based on the use of Geogebra affects the beliefs of primary school teachers with regard to three aspects: the nature of mathematics, teaching mathematics and learning mathematics. The PD course was designed to provide six teachers with a better theoretical and practical understanding of mathematics teaching and learning that is consistent with the constructivist paradigm, thereby allowing them to interact with computer-based mathematical activities. The primary intention was to find out how participants in such a learning environment shape their beliefs. The potential shifts in beliefs of the participants were identified using a pre- and post-mathematical beliefs questionnaire. Overall, the results indicate that, such efforts transformed teachers' beliefs to some extent in favour of the constructivist view.

**Lacefield,** William
Mercer University, USA
lacefield_wo@mercer.edu
*Standards for Mathematical Practice: Research and Insight into Characteristics of Effective Problem Solvers*
A vital component of the United States Common Core State Standards Initiative, the Standards for Mathematical Practice describe powerfully the characteristics of effective problem solvers that teachers should embrace and strive to develop in their pupils. Strongly supported by research focusing on how people best learn mathematics, the Standards for Mathematical Practice focus on reasoning, problem solving, persistence, creativity, mathematical modeling, and use of a variety of tools for exploring math constructs. In this session, participants will examine supporting research, critique the Standards for Mathematical Practice, and brainstorm methods of infusing the Standards into mathematics teaching/learning opportunities. Additionally, session participants will discuss future directions for research endeavours pertaining to Standards for Mathematical Practice.

**Lewis,** Gareth
University of Leicester
gl78@le.ac.uk
*Mixed methods in studying the voice of disaffection with school mathematics*
Disaffection with school mathematics is a complex phenomenon. Indeed, the relation of the field of affect to the learning of mathematics, and to mathematics attainment is problematic (Gorard,S.See, B.Davies,P, 2011). (Schorr & Goldin, 2008) argue for 'the need to study affect more deeply than the study of attitude permits.' (p132) And further ' it is increasingly clear that the functioning of affect is far more complex than is suggested by considerations of positive versus negative emotions and attitudes.' (p133). Arguing along similar lines, the working group on affect in Cerme has suggested that new methods are needed to study multi-level phenomena, and we hold that there needs to be a focus on more qualitative research and a variety of methods to access the complexity of motivational and emotional phenomena. Whilst quantitative studies have proved helpful in quantifying attitude and other aspects of affect, there is also a need to examine the

subjective reality beyond attitude in order to better understand how motivation, emotion and other affective constructs impact students relationship with school mathematics.
At the same time and in order to do this, it is necessary to widen the methods used beyond questionnaires and interviews. In order to study complex issues such as disaffection, involving as it does, aspects of identity, motivation and emotion, newer approaches need to be developed and tested. This presentation outlines a range of quantitative and qualitative methods used to elicit the subjective reality of disaffected students in relation to mathematics. It provides an opportunity to evaluate these methods, and their efficacy in capturing the dynamic nature of the motivational and emotional reality behind the phenomenon of disaffection.

**Mason,** John
Open University
j.h.mason@open.ac.uk
*Explicit & Implicit Variation Theory*
Variation theory, promoted by Ference Marton (2006) but with roots going back to Aristotle, proposes that learners must experience variation in the critical aspects of a concept, within a limited space and time, in order for the concept to be learnable. But the presence of variation does not guarantee that that variation will be experienced, much less learned from. 'Implicit Variation' theory assumes or is called upon to justify the mere presentation of variation in order for learners to learn. This constitutes a subtlety to pedagogical intervention in which appropriate conditions will lead to learning. By contrast, 'explicit variation' theory includes the pedagogic assumption that teachers or materials will draw attention explicitly to the aspects that have been varied, and the range over which that variation is permissible, in order to enhance the possibilities for learning to take place.
Drawing on literature and experience, this tension is amplified and analysed in the context of variation theory. The conjecture is proposed that the tension between explicitness and implicitness is present in all attempts either to implement theories in pedagogy, or to justify pedgaogical choices by reference to theories, of whatever kind.

**Morgan,** Candia; **Tang,** Sarah & **Sfard,** Anna
Institute of Education, London; University of Haifa
c.morgan@ioe.ac.uk
*Grammatical structure and mathematical activity: comparing examination questions*
The project “Evolution of the Discourse of School Mathematics through the Lens of GCSE examinations” is studying the ways in which the mathematical activity expected of students has changed over the last few decades. We are doing this by analysing the discourse of examination papers, using linguistic tools. In this session we will present one aspect of this analysis, comparing the grammatical complexity of sentences in questions from 1987 (the last pre-GCSE examinations) and 2011. We will discuss the implications of differences in grammatical structure, not only for readability but also for the nature of the mathematical activity demanded of students.

**Morgan**, Debbie
University of Northampton
debbie.morgan@northampton.ac.uk
*The Mathematics Specialist Teacher Programme (MaST)*
The MaST programme is a two year national programme, part funded by the Department for Education to raise standards in Mathematics in Primary Schools in England. This session will explain the approach taken by one of the eight providers of the programme where a strong feature is exploration of a connectionist approach to teaching and learning mathematics as highlighted by Askew et al (1997) whose research identified that the most effective teachers were teachers of a "connectionist orientation" who emphasised the importance of making links between different parts of the curriculum. Data has been collected from participants through survey responses. The session will look at some of the data collected from teachers on the programme at the end of the first year, regarding the impact of the programme on their own development and children's learning. The theme of making connections in mathematics features strongly within the data.
Reference
Askew, M, Brown, M, Rhodes, V, Wiliam, D & Johnson, D (1997) The Contribution of Professional Development to Effectiveness in the Teaching of Numeracy. Teacher Development, 1, 335-356.

**Newton,** Richard & **de Abreu,** Guida
Oxford Brookes University
richard.newton@brookes.ac.uk
*"We don't do it like that": parents´ experiences of supporting their children's school mathematical learning at home*
Parental support of children's learning in mathematics has long been an aim of policy makers (Cockcroft 1982, Williams, 2008). However, a number of studies have suggested that factors exist which inhibit parents from playing an active role in their children's mathematical education at home (Abreu and Cline, 2005; McMullen and Abreu, 2011; Remillard and Jackson, 2006; Street, Baker and Tomlin, 2008). Using a sociocultural perspective we report findings from a PhD project investigating how parents support their primary school children's mathematics. Here we draw on narrative-episodic interviews (Flick, 2000) undertaken with 27 parents of primary school-aged children. The parents were asked to recount their experiences of learning mathematics and of doing school mathematics with their children. This data was thematically analysed (Braun & Clarke, 2006) in order to develop an understanding of parents' personal mathematical histories, their perceptions and representation of primary school mathematics, and their experiences of completing school work at home with their children. From this it became clear that the majority of parents in the sample faced a number of problems and impediments to supporting their children's conceptual development in mathematics. Examples of these experiences, such as divergent understandings, curriculum changes, time and motivation are discussed. It was also found that parents appeared to utilise a wide-range of strategies and approaches to overcoming these barriers. Illustrations of these strategies, for instance parental guidance and evaluating understanding are presented.

**NicMhuirí,** Siún
CASTeL, St Patrick's College, Dublin City University
*Teacher, do you know the answer? Initial attempts at the facillitation of a mathematical discourse community*
My research involves a teaching experiment I undertook in my own primary classroom. The aim of the research was to facilitate a mathematical discourse community where students would explain and justify their mathematical thinking and question the reasoning of others. It was envisaged that students would regularly engage in cognitively demanding tasks and take responsibility for determining what was mathematically correct by discussing different possible solutions. The lesson presented here was the first recording of the experiment and focussed on initial attempts at exploring equivalent fractions in the context of sharing pizzas between people. The contributions of students show different levels of mathematical understanding and engagement with the task. The whole class discourse is analysed with reference to the four components of the Math-Talk Learning Community (MTLC) framework (Hufferd- Ackles, Fuson & Sherin, 2004). These components are questioning, explaining mathematical thinking, source of mathematical ideas and responsibility for learning. Both teacher and student actions in these key areas are explored. Analysis of teacher questions was carried out using the question categories developed by Boaler & Brodie (2004).

**Osmon,** Peter
King's College, London
peter.osmon@kcl.ac.uk
*Applied mathematics = Modelling > Problem solving?*
The presentation is part of a series seeking to expose issues in mathematics education at Level-3, from the viewpoint of its role in preparation for education at Level-4. This viewpoint proved to be fruitful and resulted in criteria for determining appropriate coverage of pure mathematics in GCE AS and full A-level. Current work seeks to identify and explore similarly fruitful viewpoints relating to applied mathematics. Three have so far presented themselves: the role mathematical models have in relation to scientific knowledge, modelling as a teachable skill for putting the mathematics one knows to good use, and modelling as a motivator for learning mathematics.
The first of these raises the issue of the division of responsibility for teaching about this between mathematics and science. Also at issue is whether Level-3 mathematics should teach at least one model that underpins a branch of science. Traditionally this has been mechanics. Are there potentially more motivating 21st century alternatives accessible with Level-3 pure mathematics, Relational Databases for example?
As to the second- modelling is a process and hence seems to invite a procedural approach to problem solving and yet the most rewarding problems require insights- a skill which is apparently not teachable. Evidently

there are methodological issues to be explored.
The possibilities for learning modelling through projects and undertaking them in groups can potentially counter the image of mathematics as a solitary subject and attract more, and different, learners into Level-3 mathematical classrooms. This in turn opens the question of the extent encountering modelling problems may motivate further development of learners' pure mathematics knowledge: using a requirement to simulate in order to develop knowledge of probability distributions for example.

**Ragatz,** Andy
University of Oxford
andy.ragatz@education.ox.ac.uk
*Teachers' Use of Questioning in the Classroom*
Questioning can be a powerful instrument in a mathematics teacher's repertoire of teaching practices and can serve various purposes in defining the dynamics of the classroom and developing student learning. Teachers' use of questioning in Indonesia's 8th grade mathematics classrooms was studied through case studies of ten teachers. Multiple lessons were filmed, followed by stimulated recall interviews where teachers viewed their classroom activity and described their perspective of the situation, including explanations of the purpose in their questioning. Questions are examined in terms of the question type, how students respond, the mix of questioning used throughout the lesson and, most importantly, the teacher's explanations. Questions are looked at through a multi-layered contextual lens, starting with direct dimensions such as lesson segment purpose and classroom environment, but also extending out to system and policy influences and, perhaps most interestingly, culture. Teacher motivation is a focal point, with the goal of understanding why certain teaching strategies were chosen and how the teachers constructed their activities. For insights into this, interviews and scenario exercises related to teacher mathematical beliefs and mathematical knowledge in teaching (MKiT) were also conducted. The ten case study teachers were part of a larger video study by Indonesia's Ministry of Education and World Bank which included 100 teachers across Indonesia involved in Trends in International Mathematics and Science Study (TIMSS). The link to this larger study provides the opportunity to blend the strengths of each study together and provide a clearer picture on questioning.

**Ruthven,** Kenneth
University of Cambridge
kr18@cam.ac.uk
*The epiSTEMe pedagogical approach: essentials, rationales and challenges*
This is the first session of the **Mini-Symposium on Research-informed pedagogy in early-secondary mathematics**.
The epiSTEMe project has been undertaking redesign research aimed at developing a pedagogical approach capable of strengthening student learning and engagement in the crucial first year of secondary education. Designed to be suited to implementation at scale in the English educational system, the material expression of the approach is a set of supporting classroom resources and accompanying professional development. Amongst the distinctive features of the epiSTEMe approach are its use of dialogic teaching methods and its building of stronger connections between mathematics and science. This presentation will explain the system of principles at the heart of the epiSTEMe teaching approach and the underlying rationales (which take account of research both on effective subject pedagogy and on the English systemic context). An example drawn from one of the lessons developed by the project will be used first to illustrate the approach in action, and then to highlight some challenges encountered in realising it in the classroom.

**Ruthven,** Kenneth; **Hodgen,** Jeremy; **Kuchemann,** Dietmar & **Kent,** Phillip
University of Cambridge; King's College, London; University of Sussex
kr18@cam.ac.uk
*Research-informed pedagogy in early-secondary mathematics: three innovative approaches*
This is the fourth and final session of the **Mini-Symposium on Research-informed pedagogy in early-secondary mathematics**.
This two-hour mini-symposium will examine the research-informed approaches to mathematics teaching at early-secondary level that have been developed in three current projects. The three projects are epiSTEMe, based at the University of Cambridge; ICCAMS, based at Kings' College London; and REALMS, based at the University of Sussex. Each project team has been collaborating with groups of school mathematics departments over the last couple of years to trial some form of innovative pedagogical approach.

The mini-symposium will be organised as four consecutive 30-minute sessions. In the first three of these, each project will, in turn, present the essentials of its approach, explaining the rationales behind it and identifying what has proved challenging in realising it in the classroom. Each of these presentations will last around 20 minutes, leaving 10 minutes for immediate questions and discussion.
This final session will be devoted to open discussion aimed at examining similarities and differences in the approaches developed in the three projects and the challenges identified by them.

**Sevimli,** Eyup & **Delice,** Ali
University of Marmara
yup.sevimli@marmara.edu.tr
*The investigation of the relationship between cognitive styles and preferences of the representation of definite integral problem*
One of the main problems at the level of higher education is the abstract nature of the concepts which students have trouble in understanding. It might be said that using different representations for conceptual learning is shaped by the nature of the concept as much as individuals' cognitive attributes.This study focused on the students' cognitive styles and preference of representation. We try to find an answer to the question "How do students' preferences of the multiple representation change in definite integral problems according to cognitive styles?".The participants of the study are 26 undergraduate students enrolled on a Calculus II course.The preferences of the student representation were determined by the Representation Preferences Test and their cognitive styles evaluated with the Mathematical Process Instrument.Results show that the participants generally prefer algebraic representation.The preferences of representation were affected by the students' cognitive styles.According to the results students who had an analytic cognitive style preferred algebraic representation.The students who had a harmonic congnitive style stated that graphic and algebraic representation could be useful for accurate and successful solution.

**Spencer,** Paul & **Edwards,** Julie Ann
University of Southampton
Pcs1v07@soton.ac.uk; J.S.Edwards@soton.ac.uk
*A data collection process for an embedded case study focusing on the teacher-teaching assistant partnership in the mathematics classroom*
The use of teaching assistants in secondary mathematics classrooms has been the focus of a number of studies in recent years, with varying conclusions as to whether the impact of additional adults in the classroom is positive or negative. The lack of practical guidance for teachers on how to work with teaching assistants has led to different ways of working in different schools. It is this partnership between mathematics teacher and teaching assistant that forms the basis for an NCETM-funded case studentship project which aims to identify the characteristics which contribute towards an effective mathematics teacher-teaching assistant partnership. A number of quantitative approaches have been used in previous studies to assess the impact of teaching assistants; this research project employs a multiple embedded case study methodology. The case studies focus on three mathematics teacher-teaching assistant partnerships working in different schools, with the intention of developing intervention strategies which encourage an effective working partnership. This session reports on the multiple methods used during the pilot study to gather data, which include interviews, observations and a system of tracking teacher and teaching assistant movements during lessons. We begin by focusing on the outcomes to date of this methodology leading to a discussion of the data collection process, the methods employed to analyse the data collected and the innovative use of images to represent qualitative data.

**Tanner,** Howard; **Jones,** Sonia; **Cooze,** Angella & **Lewis,** Ishmael
Swansea Metropolitan University
Howard.Tanner@smu.ac.uk
*Developing Mathematical Literacy*
Following poor performance in PISA, literacy and numeracy have been identified as national priorities for Wales. A Literacy and Numeracy Thinking Skills Project has been established in partnership with six secondary schools. Teachers are co-researchers in action research over the 2011/12 academic year focusing on Y9. The project is quasi-experimental in design with pre and post testing of all pupils using PISA-style assessments for comparison with control schools.
Mathematical literacy is defined as "an individual's capacity to identify and understand the role that mathematics plays in the world, to make well-founded judgments and to use and engage with mathematics in

ways that meet the needs of that individual's life as a constructive, concerned and reflective citizen" (OECD, 2009).
In PISA assessments, students are typically required to extrapolate from what they have learned in school to apply mathematical knowledge to authentic problems in a variety of contexts. These contexts sometimes make high demands of literacy and many are presented with no obvious mathematical structure – this must be imposed by the student.
In this session we will discuss what strategies might be employed to develop such high level skills.

**Tasova,** Halil Ibrahim & **Delice**, Ali
University of Marmara
alidelice@marmara.edu.tr
*An Analysis of Pre-Service Mathematics Teachers' Performance in Modelling Tasks in Terms of Spatial Visualization Ability*
This study aims to identify the pre-service teachers' spatial abilities and to explore the effects of these abilities on performance in mathematical modelling tasks.Following a case study research approach, mixed methods were used for data collection.Participants were 75 pre-service teachers studying an MA degree, without dissertation, at a state university in Turkey.In order to identify the pre-service teachers' spatial abilities, data was collected using a Mental Rotation and Spatial Visualisation Test.In order to investigate the effects of spatial abilities on performance during the solution process and on the visual process, pre-service teachers participated in modelling activities.Descriptive statistics were used to analyse the qualitative data.Results indicated that almost half of the pre-service teachers had high level spatial abilities.It also found that pre-service teachers' mathematical modelling abilities were not sufficiently developed and that their spatial visualisation abilities were weaker than their mental rotation abilities.Moreover, the result of pre-service teachers who have higher spatial ability had better performance in modelling tasks than the others.

**Valentin,** Justin
King's College, London
justin.valentin@kcl.ac.uk
*Impact of the Mathematics Lesson Structure reform in Seychelles on pupils' achievement*
Inspired by the three–part lesson from the National Numeracy Strategy in UK, a Mathematics Lesson Structure or MLS reform was implemented in Seychelles to revamp the teaching of mathematics. The reform, a mandatory teaching approach, prescribes how teachers should structure their daily mathematics lessons. This paper is based on my PhD research which looks at the impact of the reform five years into implementation. The Seychelles data from the latest two SACMEQ studies, and data from a local longitudinal mathematics project are being used to explore changes in pupils' achievement before and after the reform. SACMEQ stands for Southern African Consortium for Monitoring Educational Quality. The results suggest that whilst pupils' achievement has not improved per se, variations in the pupils' ability scores have decreased considerably. It could be possible that the approach to teaching mathematics adopted by the reform has normalized what goes on in classrooms but, has not been effective enough to raise the pupils' performance. Recommendations are being made to relook at the MLS approach to teaching mathematics and carry out more learning enhancement projects alongside MLS in schools.

**Watson**, Steve
University of Nottingham
steven.watson@nottingham.ac.uk
*The impact of teachers' career stages and self-efficacy on their engagement with professional development*
In this session, I consider the effects of professional development (PD) for secondary mathematics teachers. I consider in particular the relationship between teachers' levels of self-efficacy, their career stage and the extent to which they engage, implement and sustain the approaches suggested by the PD. This was a mixed-methods, case study lasting 16 months. It involved a single school, with a mathematics department staffed by seven teachers. Bowland PD was used and sessions led by HoD each half-term. Data were collected from lesson observations, observations of the PD sessions, interviews with teachers and a teaching efficacy instrument. Using a theoretical framework based on teachers' career stage, efficacy levels and motivation I identify possible patterns in teachers' levels of engagement with the PD. I conclude that this PD is most useful and likely to have long term impact on teachers who are in their fourth to fifteenth year of their career and with higher levels of self-efficacy. I suggest there is potential to use the career stage framework further, to inform the design and implementation of effective PD.

**Williams,** Helen
Roehampton University
info@helenjw.co.uk
*To what extent might role play be a useful tool for learning mathematics?*
"To what extent is role play a useful tool for learning mathematics?' is the title of my PhD proposal. I intend to share some of the data I have been collecting in a Y4 classroom and open up discussion around questions such as:

What is the level of involvement of the participants? (Pascal & Bertran, 1999)
How does what is happening relate to what else is going on in the classroom (mathematically)?
What might be some of the broader educational themes raised by these observations?

(Pascal, C., & Bertram, T. (1999) The Effective Early Learning Project: The quality of adult engagement in early childhood settings in the UK. University College Worcester Centre for Research in Early Childhood Education)

**Wright**, Pete
Institute of Education, University of London
p.wright@ioe.ac.uk
*The 'Math Wars': Tensions and power struggles in the development of school mathematics curricula in the USA and UK*
The 'Math Wars' are still raging in the USA, where the world of mathematics education remains polarised between two camps: the 'reformers' and the 'traditionalists'. Tensions and power struggles have characterised the development of the US school curriculum; between those advocating a more collaborative problem-solving approach to mathematics teaching and those claiming such reforms are a dilution of standards. The aggressive stance adopted, and strong language used, by the two camps towards each other is exemplified by one academic writing a paper devoted entirely to criticising the research findings of a colleague from the same institution.
This session will explore the background to the 'Math Wars' in the USA, with reference to differing epistemologies of mathematics and conflicting philosophies of mathematics education. It will look at the extent to which parallels can be drawn between the way school mathematics curricula have evolved in the USA and in the UK, where similar, albeit less public, tensions exist amongst policy makers and practitioners. It will consider what lessons can be learnt by those who believe the aims of mathematics education should include helping students develop a critical understanding of the subject.

**Yang,** Kai-Lin
National Taiwan Normal University
kailin@ntnu.edu.tw
*Mathematics teachers make statistical inference based on sample distributions*
The study presented in this paper illustrated part-characteristics underlying mathematics teachers' alternative understanding or misunderstanding of Confidence Interval (CI) - related concepts. We firstly developed assessment instruments to explore teachers' understanding of CI-related concepts. We found that mathematics teachers could recognise the characters of a random variable and relationships between "standard errors and confidence level", "sampling errors and the length of CIs", and "sample sizes and sampling errors (or CIs, confidence levels)". Moreover, they were able to calculate a CI for a proportion, and the sample size of a sample when the sample mean and the standard error of the sample mean were given. However, they did not integrate the characteristics of a random variable appropriately when estimating a parameter for a random variable, and did not transfer their understanding of CIs for a proportion to CIs for a mean. One critical characteristic underlying their alternative understanding or misunderstanding was that they made statistical inference mainly based on sample distributions even when they knew the population distribution and the sampling distribution for a proportion.

**Zagorianakos,** Andonis
Manchester Metropolitan University
Andonis.Zagorianakos@stu.mmu.ac.uk
*The construction of knowledge by prospective teachers of mathematics in a non instructional environment*
The main focus of the research is on students' mathematical constructions in a non-instructional environment. The research is based on data collected from a sample of students in the Institute of Education at the

Manchester Metropolitan University. The students are prospective teachers of mathematics and the observations took place during the last academic year. The 'Nature of Mathematics' course that the students followed was designed in order to let the students' understandings emerge, with a minimal intervention by the teacher. The data originate from the observations during the researcher's participation in the students' activities, the recordings of the activities with the students' consent, the students's coursework and the interviews that took place at the end of the sessions. Two cases were chosen and the different methods, motivations and interactions that led these students to different constructions are elucidated. A second pivotal point of the research pertains to the change of the researcher's stance towards his participation during the sessions, including his negotiation with the students as he was bartering his license to observe and collect evidence, using the teacher-of-mathematics passport to gain admission.

**C. Working Groups**

**Coles,** Alf & **Turner,** Fay
University of Bristol & University of Cambridge
alf.coles@bris.ac.uk; fat21@cam.ac.uk
*Mathematics education and the analysis of language*
The aim of this working group is to share and develop approaches to the analysis of classroom talk, drawing on traditions both within mathematics education and more broadly. In this session there will be a presentation (20 minutes) of one approach to data analysis, that draws on the field of linguistic ethnography. Participants will work on some transcript data using this approach (20 mins), leading to a wider discussion and the raising of issues for future work within the group (20 mins). This is the second meeting of the working group (previously called 'Data Analysis Working Group') but attendance at that first meeting is not essential in order to join in, i.e., this group is open to all.

**Rogers**, Leo
University of Oxford
Leo.Rogers@education.ox.ac.uk
*History in the mathematics curriculum*
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.
This session continues the earlier meetings of the group and will review the outcomes and material from recent meetings and publicatons, a new European Community Project, and update on recent activities, and developments on the website for materials aimed at secondary pupils, teachers, and teacher trainers.
New colleagues are welcome!

**Wake**, Geoff & **Hernandez-Martinez,** Paul
University of Nottingham, Loughborough University
geoffrey.wake@nottingham.ac.uk;
*From research to practice: making an impact?*
This working group continues to explore ways in which our research might make an impact by informing practice at classroom, institutional and/or systemic level. The organisers are currently grappling with this issue as part of an ESRC funded follow-on project that aims to synthesise the results of three studies that have researched transitions of students through phases of education. Participants are invited to come ready to share ideas and examples of their own.
Part of the workshop will be devoted to more general discussion of how as a research community we might be strategic in ensuring that our evidence base informs both policy and practice. BSRLM itself plays a central role in our own community, but can it, or other key organisations, assist us in making an impact? These issues are of timely importance given (i) the performativity demands made of us as researchers at this time, and (ii) policy-making that currently seems to be informed more by anecdote than systematic and rigorous research.