## BSRLM – NoRME Abstracts, University of Cambridge, 16 & 17 November 2012

**Ruthven**, Kenneth
University of Cambridge
*What role can research play in practical innovations in mathematics education?*
I will start by identifying some significant ideals for the ways in which educational research can make distinctive contributions to practical innovation in mathematics teaching. I will then examine key reasons why such contributions may prove less fruitful than imagined. Such disappointment often originates in fundamental discontinuities between scholarly and professional practice, and the corresponding complexity of knowledge conversion and application between the two fields.
Then, after briefly introducing the English educational system as the largest of the four national systems within Britain, I will examine two significant initiatives in English school mathematics teaching: the National Numeracy Strategy, and "research-involved" continuing professional development for teachers. These initiatives exemplify quite different approaches to bringing research to bear on practical innovations in mathematics teaching, and both have benefited from some form of involvement by many BSRLM members. That should allow such participants to draw on direct personal experience in the ensuing discussions, prompted by the questions that I and my co-presenter will pose.

**Skott, Jeppe**
Aarhus University, DK, & the Linnaeus University, S.
*Revisiting theory-practice relationships: a cautionary note on the expectation of impact*
Mathematics education research is generally expected to serve the dual purposes of understanding and further developing the practices of mathematics teaching and learning. More often than not these two intentions are conceived as fully compatible and mutually supportive. Focusing on the increasing interest in research on and with mathematics teachers over the last few decades, I suggest that progress has been made with respect to both intentions, not least as a result of increasing attention to the social aspects of how mathematics classrooms function. However, I also suggest that the expectations of impact of research on practice are overly optimistic, and that mathematics should not be considered an applied field, or at least that we reconsider the ways in which this may be the case. The moral of the story is neither that we, as a research field, have had no influence in the past, nor that we should abandon attempts to make a difference in the future. Rather, it is that whatever influence we do have is necessarily modest and qualitatively different from what is often expected.

### 17 November Research presentations

**Ainley**, Janet
University of Leicester
janet.ainley@le.ac.uk
*Integrating inquiry in mathematics and science education: some insights and challenges from the Fibonacci Project*
Despite the casual way in which mathematics and science are linked in public rhetoric about education (e.g. STEM subjects), at school level there appear to be considerable barriers to integrating the teaching and learning of the two subjects. Within Fibonacci, a large scale European professional development project, the Leicester centre has focussed on integration through an inquiry-based approach which is built around 'big ideas'. In this session I will offer some examples of our work for discussion.

**Akkoç**, Hatice & **Ozmantar**, Mehmet Fatih
Marmara University, Turkey; Gaziantep University, Turkey
hakkoc@marmara.edu.tr
*A functional taxonomy of multiple representations: a tool for analysing TPCK*
This study investigates the development of prospective mathematics teachers' use of multiple representations during teaching in technology-rich environments. Forty prospective teachers took part in a teacher preparation programme which aims to develop technological pedagogical content knowledge (TPCK). As

part of this programme, prospective teachers participated in workshops during which the TPCK framework was introduced focusing on function and derivative concepts. Various components of TPCK were considered. This study investigates one particular component of TPCK: knowledge of using multiple representations of a particular topic with technology. The content we focus on in this paper is "radian concept". Two out of forty prospective teachers introduced the radian concept as part of their micro-teaching activities. The data obtained from semi-structured interviews, videos of prospective teachers' lessons, their lessons plans and teaching notes was analysed to investigate prospective teachers' knowledge of representations and of connections established among representations using technological tools such as Geogebra and Graphic Calculus software. We use the framework of "functional taxonomy of multiple representations" which differentiates three main functions that multiple representations serve in learning situations: to complement, constrain and construct. We discuss the educational implications of the study in designing and conducting teacher preparation programmes related to the successful integration of technology in teaching mathematics.

**Al Zahrani,** Yahya & **Jones**, Keith
University of Southampton
ymaz1g10@soton.ac.uk
*Coverage of school mathematics topics during a mathematics pedagogy module for undergraduate pre-service primary mathematics teachers*
For some time, research on teacher preparation has focused on the forms of knowledge that teachers need in order to teach most effectively, with such forms of knowledge commonly categorised into Subject Matter Knowledge and Pedagogical Content Knowledge. More recently, research has begun examining the opportunities to learn that pre-service teachers have of these different forms of knowledge. This paper reports on one component of a wider study of undergraduate pre-service primary mathematics teacher preparation: the pre-service teachers' opportunities to learn about the school mathematics curriculum during a final-year undergraduate module on mathematics pedagogy. Data is from observations of the complete teaching of this module at two university colleges in Saudi Arabia. The findings indicate that while the pre-service teachers have some opportunity to learn topics related to the primary school geometry curriculum, they have little or no opportunity to learn topics related to primary school algebra.

**Archer**, Rosa; **Morgan**, Siân & **Pope**, Sue
University of Manchester
sue.pope@manchester.ac.uk
*Rethinking partnership in initial teacher education – a case study in mathematics*
In a time of rapid and extensive change in initial teacher education policy, a new team of mathematics educators is establishing at the University of Manchester. How does a new team of mathematics educators (some with experience of other institutions) establish itself and ensure that previous strengths and successes are maintained and developed? One member of the team is a joint school-university appointment.
What are the affordances of a joint school-university appointment? What are the personal challenges for the appointee and colleagues working with the appointee – in school and in university?
Evidence for the paper is through personal reflective accounts, focus group discussions with school and university colleagues, an anonymous questionnaire of student teachers and their course outcomes.
The outcomes of this early experience have implications for the developing practice of the University of Manchester PGCE mathematics team and the way in which university and school based colleagues work together to optimise learning for beginning teachers, as new models of ITE are adopted within a well-established partnership. These implications may provide areas for consideration by institutions rethinking partnership in initial teacher education.

**Ayalon**, Michal & **Even**, Ruhama
Weizmann Institute of Science, Israel
University of Oxford, UK; Weizmann Institute of Science, Israel
michal.ayalon@weizmann.ac.il
*Factors shaping students' opportunities to engage in argumentative activity*
Research points to the importance of engaging students in argumentative activity in the mathematics classroom, and highlights the teacher as an influential factor in providing opportunities for such activity. The study presented in this meeting incorporates a focus on additional factors – the mathematical topic and the class – and examines how the argumentative activity is shaped by the teacher, the mathematical topic, and the class. Drawing on two case studies, we examine how the nature and extent of the argumentative activity vary across two topics in beginning algebra, and between two classes taught by the same teacher, using the same textbook.

**Barmby,** Patrick; **Bolden,** David & **Raine**, Stephanie
Durham University
p.w.barmby@durham.ac.uk

*Measuring pre-service teachers' attitudes to mathematics: A mixed methods approach*
Past research has highlighted the importance of teachers' attitudes concerning mathematics. Aiken (1970) stated that teacher attitudes towards mathematics were particularly important for students' attitudes towards the subject. Ernest (1989) emphasised the importance of teachers' attitudes towards teaching mathematics for student achievement. Elsewhere, Ball (1988), Philippou & Christou (1998) and Wilkins (2008) have linked teachers' attitudes with classroom practice in teaching mathematics. However, despite this importance of teachers' attitudes, researchers have also emphasised that many pre-service teachers come into the profession with negative feelings towards mathematics (Ball, 1988; Nisbet, 1991; Philippou & Christou, 1998). Furthermore, in the context of the England and Wales, school inspection evidence has suggested that teachers' lack of subject knowledge and confidence in mathematics contributes to low standards of pupils' mathematics attainment (Ofsted, 1994, cited in Rowland et al., 1998). In this paper, we examine the attitudes of pre-service primary teachers towards mathematics. In particular, we describe the results of a study which utilised a mixed methods approach to measuring pre-service teachers' attitudes towards the subject. We argue that this approach provides a more valid assessment of attitudes, whilst at the same time developing methods that can be applied across other subjects.

**Batchelor**, Sophie; **Gilmore**, Camilla & **Inglis**, Matthew
Loughborough University
s.m.batchelor@lboro.ac.uk
*Children's mathematics anxiety: how parental influence impacts on gender*
We investigated whether the mathematics anxiety of children is related to how anxious their parents are when encountering mathematical tasks. Thirty-eight child-parent pairs (with the children aged 6-9 years) were asked to complete standardised measures of mathematics anxiety. We found that the anxiety levels of parents strongly predicted sons' mathematics anxiety levels, but that there was no relationship between parents' and daughters' anxiety levels. During the session we aim to generate a discussion of possible accounts of this finding.

**Borthwick**, Alison & **Harcourt-Heath**, Micky
Norfolk Local Authority
alison.borthwick@norfolk.gov.uk; micky.harcourt-heath@norfolk.gov.uk
*Calculating: What can Year 5 children do now?*
In 2006, 2008 and 2010 we collected and analysed answers from a Year 5 QCA test paper to explore the range of calculation strategies used by a sample of approximately 1000 Year 5 children. Once again in 2012 we have repeated this research using the same group of 22 schools.
This session explores the findings from the 2012 data, including case studies, and makes comparisons across the longitudinal study. It examines the range of strategies used by the children. We conclude by considering if and how the use of particular calculation strategies has impacted on the overall results and we ask if this leads to greater clarity about which strategies lead children to success.
The session will include an opportunity to look at some of the children's work and to discuss the effectiveness of their strategies.

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

**Brown,** Tony
Manchester Metropolitan University
a.m.brown@mmu.ac.uk
*TIMSS mathematics has changed real mathematics forever*
School mathematics is socially constructed, but how does this change mathematics itself? The growth of mathematics depends on our priorities, whether that involves funding research in certain areas or deciding the contents of a course or curriculum. Mathematics is a reflection of who we are and mirrors our needs and practices. For example, international mathematics education has been transformed by the use of comparative

instruments. The way we think of mathematics and of ourselves as teachers and students have moved on as a result of mathematical activity being filtered through particular sorts of questions. These widespread adjustments to school mathematics have altered the demands made on teacher knowledge and practice. This paper considers a model of school-centred teacher education introduced to meet the new demands. For the student teachers involved mathematics comprises the administration of assessment. The model provides an example of how changing practices impact on the social construction of mathematics. The paper concludes by suggesting that our understandings of people and of mathematics are consequential to earlier needs, practices and assumptions. That is, psychology is built on the human's own self image, as is mathematics. Our work on them today will change what they are in the future.

**Crisan**, Cosette
Institute of Education, University of London
c.crisan@ioe.ac.uk
*I thought I knew all about square roots*
Following from my observations of the inconsistencies and misuse of the radical symbol amongst pupils, undergraduates, teachers and some authors of school textbooks, I became interested in those decisions that teachers take when confronted with inaccurate or ambiguous representations of the square root concept and its associated symbol notation. Moreover, I wanted to find out about teachers' sources of conviction when adopting a particular 'definition' of the concept and how they justify their choices.
In this session I will report on a small scale study which I carried out with eight PGCE secondary mathematics students. The participants were first given a piece of 'homework' consisting of questions where the concept of square root was likely to be employed, then invited to discuss with each other their solutions. This was followed by giving written feedback to four fictional pupils' responses characterised by a subtle mathematical error to a number of questions involving the square root, throwing further light on the choices they made.
The impact the lack of rigour in treating this mathematical concept and its associated symbol notation has on these PGCE students' conceptual understanding and pedagogical affinity will be discussed.

**Cronin**, Sue & **Hardwick**, Denise
Liverpool Hope Univeristy
cronins@hope.ac.uk
*Developing a pedagogy for working hybrid spaces in ITE*
We share an emerging pedagogy for Initial Teacher Education (ITE) mathematics tutors, who are seeking new ways to work with beginning teachers in what Zeichner (2010) defines as hybrid spaces. In terms of Initial Teacher Education hybrid spaces are those spaces which are created to "bring together school and university based teacher educators and practitioners and academic knowledge in new ways to enhance the learning of prospective teachers" (p.92). For several years the PGCE secondary mathematics programme in the authors' university has included a Saturated Learning Project, (SLP). This involves taking the secondary mathematics students into school one morning over ten weeks to work with groups of pupils in a shared communal space, supported by class teachers and university tutor. The project has been extended to the PGCE primary course with ten beginning teachers specialising in mathematics. They worked over a number of weeks with a Y6. The experiences in such hybrid spaces enrich and extend students' practical and pedagogical knowledge by facilitating understanding of theories about teaching and learning mathematics in a real, shared context. This new pedagogical approach is strengthening school-university partnership and improving learning experiences for both beginning teachers and their pupils.

**Dalby**, Diane
University of Nottingham
ttxdd4@nottingham.ac.uk
*From failure to functionality: A study of the experience of vocational students with functional mathematics in Further Education*
Many students who undertake vocational courses in Further Education colleges in England enter post-compulsory education as mathematical 'failures' at GCSE level but their experience in college has the potential to change not just their attainment, but also their future attitude and functionality with mathematics in employment and society. This study of the factors that affect the student experience aims to provide insight into the influences, inside and outside the classroom, that contribute to this transformation.

**Drageset,** Ove Gunnar
University of Tromsoe
ove.drageset@uit.no
*Redirecting, progressing and focusing actions – a framework for describing how teachers use students' comments to work with mathematics*

In order to describe and analyse teachers' orchestration of classroom discourse, detailed descriptions of teachers' comments and questions are critical. The purpose of this presentation is to suggest new concepts that enable us to describe in detail how teachers use or do not use students' comments to work with the mathematical content. Five teachers from upper primary school (grades five to seven, students aged ten to thirteen) were studied. Beginning with the analysis of a pattern where the teacher gives a confirmation followed by a question that indicates a rejection, their practices form the basis for the development of thirteen categories of teacher comments. These categories are then grouped into redirecting, progressing and focusing actions. The categories and their groupings shed light on tools and techniques which these teachers use to make student strategies visible, to make students justify, apply and assess, to ensure progress towards a conclusion, or to redirect the students into alternative approaches. These findings can help us develop a more profound understanding of how communication affects learning.

**Farsani**, Danyal
University of Birmingham
Dxf950@bham.ac.uk
*Cross-linguistic variation of the mathematical concept 'power' reflected through gestures*
I present findings of a study which investigated the role of language and gesture used to convey mathematical meaning in a bilingual (Farsi and English) mathematics classroom. The study specifically examined the gestural representation of the mathematical concept 'power' which varies between speakers of different languages because the lexical and syntactic resources of languages vary. The results show that different languages activate different conceptual understanding of the mathematical concept 'power' (exponentials) which is reflected through the students' and the teachers' gestures.

**Fernandez**, Ceneida; **Coles**, Alf & **Brown**, Laurinda
Universidad de Alicante; University of Bristol
alf.coles@bris.ac.uk
*Teacher Noticing as a Growth Indicator*
In this session, we will report on our analysis of four transcripts of teacher meetings that took place over the academic year 2011-12. These meetings took place in the context of a project looking into tackling underachievement in primary mathematics through a focus on creativity. We bring the idea of growth indicators (Jacobs, Lamb & Philipp, 2010) within the framework of noticing (Mason, 2002) in order to analyse shifts in teacher discourse in relation to a focus on groups or individuals. We use this analysis to illustrate teacher change.

**Fuglestad**, Anne Berit
University of Agder, Norway
anne.b.fuglestad@uia.no
*Teachers discussing inquiry-based teaching with digital tools*
In a developmental research project based on the key ideas of learning communities and inquiry approaches in teaching, the aim was to collaborate with teachers on the development of mathematics teaching with digital tools. A series of workshops were held in order to stimulate the collaborations and support teachers' competence development with digital tools (Fuglestad, 2008).
In spite of efforts from Norwegian educational authorities over several decades, use of digital tools in teaching subject content and stimulating pupils' investigations are scarce. Biannual reviews show that digital tools are less used in mathematics than other school subjects (ITU, 2010). Reasons, partly seem to be teachers lack of relevant competence and personal experiences with digital tools.
The project gave both the teachers and researchers opportunity for further development of their knowledge and teaching approaches with digital tools. In this presentation I will give some examples of teachers' work and discussions in workshops and team meetings to illuminate challenges, affordances and constraints provided by the digital tools.
The presentation will draw on theories of instrumental approach (Trouche, 2005) and documentational approach (Gueudet & Trouche, 2009) to highlight the complexity of the development necessary for teaching with digital tools.

**Gates**. Peter; **Clarke**, Nichola & **Dalby**, Diane
University of Nottingham
peter.gates@nottingham.ac.uk
*Is there a social justice element of visualisation in mathematics?*
There is a considerable and rich literature on visualisation in mathematics and cognition. However there has been less attention paid to the development of visualisation in children and the influence of their social and economic background. We know economically disadvantaged young people experience a restricted mathematics curriculum and pedagogy and are examining the place of visualisation in this. This study is

starting to look at the forms of visualisation that are used in teaching mathematics to young people from poorer economic and social class backgrounds.

**Grandi**, Clarissa
Thurston Community College, University of Cambridge
clarissa.grandi@thurstoncollege.suffolk.sch.uk
*Teacher-student dialogue during one-to-one interactions in a post-16 mathematics classroom*
Recent developments in mathematics education have redefined the teacher's role as 'facilitator of learning', giving rise to a 'to tell or not to tell' dilemma in mathematics teaching that I experienced in my own practice. This action research study investigated teacher-student dialogue during one-to-one interactions in my post-16 mathematics classroom in order to discover whether I did indeed 'tell' too much, why I made the scaffolding decisions that I did, and whether it was possible to develop this aspect of my practice. The study was carried out with four A-level mathematics students in an English 13 – 18 comprehensive school. Data sources included clinical interviews, student feedback interviews and an analytical and reflective evaluation log, and the data were coded using a framework of scaffolding categories drawn largely from current research literature. The findings suggest that my 'telling' interventions often served useful and necessary functions, and that the process of critical analysis did enable me to develop my scaffolding skills. They also reveal that my students themselves valued those scaffolding strategies that they felt best promoted their independence. The study concludes by suggesting that context is a crucially important factor in addressing the dilemma of whether or not to tell.

**Griffiths**, Graham
Institute of Education, London
g.griffiths@ioe.ac.uk
*Using scenes of dialogue about mathematics with adult numeracy learners – what it might tell us*
This session will present some early doctoral studies work into the learning of mathematics with adults. The study concerns the use of prepared dialogue scenes involving mathematics with groups of adult learners. It is intended to answer the following question. How might we characterise discussion following the reading of scenes of dialogue? The session will outline some examples of scenes and the response from the use of these with learners and teachers. It is envisaged that discussion of this will help to inform the construction and / or choice of scenes and what may be learned from their use.

**Gunnarsdóttir**, Guðný Helga; **Kristinsdóttir**, Jónína Vala & **Pálsdóttir**, Guðbjörg
University of Iceland, School of Education
gudnyh@hi.is, joninav@hi.is & gudbj@hi.is
*Professional development in mathematics teacher education*
Professional development is an important part of teacher education for both student-teachers and teacher educators. Student-teachers professional development starts at the onset of their pre-service education. Teacher education for compulsory schools (6 – 16 years old students) in Iceland has in recent years been undergoing radical changes. It has changed from being a three-year bachelor program to a more research based five-year master degree.
During this period of change we have studied our teaching as teacher educators with focus on the development of learning communities and reflective practices. In our mathematics education courses students have been introduced to various ways to collaborate and develop professionally and have been challenged to try them out in their studies and teaching practice. They have used lesson-study, collaborative lesson planning and co-teaching. They have also worked on group assignments on important issues in mathematics teaching and learning as well as assignments that challenge them to develop their own professional perspective and identity.
In the session we will discuss our studies on the development of our mathematics education courses with focus on how we create opportunities for our students to develop professionally.

**Hall,** Graham
University of Wales Newport
graham.hall@gllm.ac.uk
*Integrating Real-World Applications and Modelling into Mathematics Courses*
In an analysis of the development of mathematics education in China by Tang, Sui and Wang (2003) five different levels are identified for the incorporation of applications and modelling into mathematics courses, to which the authors have applied the terms:
* Cut-in
* Special Subject
* Investigation Report
* Paper Discussion
* Mini Scientific Research

These represent a progression from well-defined application questions set by the teacher, through increasing levels of student involvement in the identification, formulation and solution of real world problems, to totally independent project work.
In this session, examples will be given of the incorporation of each of the five levels of applications into mathematics and numeracy courses for vocational students at a Further Education College in Wales. Case studies are presented from the subject areas of: engineering, business, computing, hairdressing and beauty therapy, and health and social care. Copies of project worksheets will be available.

**Hassler**, Bjoern; **Connolly**, Teresa; **Hennessy**, Sara & **Blair,** Janet
University of Cambridge
bjohas@gmail.com
*Using Open Educational Resoures (OER) to support interactive mathematics and science teaching*
We have established a unique collection of resources focusing on interactive teaching in mathematics and science across the primary/secondary sectors and enhanced by using ICT. They are designed for use by classroom teachers, professional development leaders and teacher educators in those areas. The ORBIT constitutes an Open Resource Bank on Interactive Teaching that is hosted on a MediaWiki platform openly available for re-use and modification. We will report on our questionnaire and interview survey research into teacher and teacher educator perspectives on using OER generally, and more specifically on user perspectives of ORBIT as we consider its utility in supporting interactive teaching. The project was funded by JISC during 2012 and the wiki can be found at http://orbit.educ.cam.ac.uk/wiki/.

**Hernandez-Martinez**, Paul; **Duah**, Francis & **Solomon**,Yvette
Loughborough University, Loughborough University, Manchester Metropolitan University
P.A.Hernandez-Martinez@lboro.ac.uk
*Students as agents of change: collaboration in undergraduate teaching and learning*
In this mini-symposium we describe an intervention designed to enhance undergraduate engagement in mathematics through collaborative production of teaching resources and peer mentoring.
Paul Hernandez-Martinez analyses the cooperation of students from different backgrounds (mathematics and engineering) to produce mathematical modelling teaching resources. This analysis is based on the concept of Third Spaces (Gutierrez 2008), a particular kind of Zone of Proximal Development, where alternative and competing discourses and positionings transform conflict and difference into rich spaces for collaboration, learning and meaning-making.
Francis Duah reports on an ethnographic case study of four second-year student interns working with eight academic staff to collaborate on the design of two advanced mathematics modules. He explains the rationale for the introduction of the internships, and the nature of their interactions with each other and with staff, their decision-making processes and the distribution of their work. He argues that the internship role resulted in a deeper understanding of the mathematics for the interns, and of students' perspectives on learning for the staff.
Yvette Solomon takes up the story in terms of the developing relationship between staff and students, and the particular role of the interns as boundary crossers and brokers between staff and the student body in general. She reports on their work with staff as revealing tensions and contradictions which had an impact on the status quo and resulted in potential lasting changes. Together with the audience we will discuss how the lessons learned might be used to inform university teaching and learning more generally.

**Hickman**, Mike & **Monaghan**, John
York St John University, University of Leeds
m.hickman@yorksj.ac.uk
*Engaging students with pre-recorded "live" reflections on problem-solving: potential applications for "Livescribe" pen technology*
Building on Mike's PhD work with part time postgraduate (PGCE) primary student teachers, this presentation explores the use of "Livescribe" pen technology to facilitate collaborative mathematical problem solving and allow opportunities for participants to engage in 'live' reflection on their 'free' problem-solving performance in order to elicit reasoning. With recorded thinking aloud, followed and supplemented by a stimulated recall/task-based interview opportunity and problem solving/talk framework, participants are encouraged to articulate their problem solving strategies, experiences and understanding with potentially reduced influence from the researcher. This presentation provides an active opportunity to experience both the technology and methodology in use and invites participants to reflect upon the potential use of this approach in their own practice.

**Hough,** Sue & **Dickinson**, Paul
Manchester Metropolitan University
S.Hough@mmu.ac.uk
*Investigating the nature of Secondary Mathematics student teachers' knowledge of fractions*

We report on the first part of a study into the subject knowledge of student teachers. The students are enrolled on a Subject Knowledge Enhancement course prior to joining a secondary mathematics PGCE. The study is concerned not with their pure mathematical knowledge, but with the nature of their knowledge. Students were asked relatively routine questions on fractions and their answers analysed. They then studied the teaching of fractions, examining alternative learning trajectories in a number of University sessions, after which they taught the topic in school. The lessons were observed, videoed, and analysed. The results show the students are initially willing to work creatively in the classroom, but quickly resort to procedural methods as their own subject knowledge is challenged.
We focus on the part of the study which analyses the students' knowledge of fractions. Most students used a known procedure to answer the questions. Few students were able to justify their answers by making sense of the fractions as numbers, or representing the fractions pictorially.
We compare the teaching of fractions in the UK with the approach used in Realistic Mathematics Education (RME), referring particularly to the work of Streefland (1991) and Fosnot and Dolk (2002).

**Ismail,** Norulhuda
Institute of Education, London
imaan_484@yahoo.com
*A student teacher's recontextualisation of use of ICT in teaching mathematics during teaching practicum in Malaysia*
Student teachers are prepared for teaching through mathematics education courses in the university. In these courses, messages about the pedagogy and content of teaching mathematics are conveyed. During the teaching practicum, student teachers are also guided by mentors and university supervisors who have their own sets of messages about mathematics teaching. These messages are hoped to be portrayed by the student teachers during practicum teaching. My research focuses on identifying the ways in which these messages are conveyed to the student teachers. Then, on identifying the ways student teachers acknowledge these messages and incorporate them into their teaching. My research is informed by the theory of recontextualisation, and I use critical discourse analysis for the data gathered. However, I am still designing a systematic method of analysis to fit in with the theory and research focus. I have identified that the use of ICT in teaching mathematics is generally viewed positively in the university and also by mentors and supervisors alike. I would like to share some data and analysis of the ways this message is being conveyed to the student teachers, and how one student teacher, Saiful recontextualises this message into his own teaching of mathematics.

**Jaworski**, Barbara
Mathematics Education Centre, Loughborough University
b.jaworski@lboro.ac.uk
*Mathematical Competence Framework - an aid to identifying understanding?*
Research into the teaching of mathematics to engineering students to promote their conceptual understanding (ESUM: Jaworski & Matthews, 2011) has shown the problematic nature of planning for and identifying understanding. I will review the project briefly and introduce the idea of competencies from the Danish KOM project. Through the medium of designing inquiry-based tasks for students and use of the competency framework for analysis of tasks, I will open discussion as to the relevance of such a competency-based analysis and its usefulness (or otherwise) for recognising student understanding.
Jaworski, B. & Matthews J. (2011). Developing teaching of mathematics to first year engineering students.. Teaching Mathematics and its Applications. 30(4): 178-186

**Jones**, Ian & **Inglis**, Matthew
Loughborough University
I.Jones@lboro.ac.uk
*Assessing problem solving using Comparative Judgement*
Mathematical problem solving is notoriously difficult to assess accurately and reliably. We investigated an alternative approach to assessing problem solving, called Comparative Judgement, that is based on pairwise expert judgement rather than detailed mark schemes. There were two main components to the study. First, GCSE examiners were commissioned to write an innovative exam paper to assess problem solving that was administered to Y10 pupils (N = 750) of varied prior attainment. Second, the scripts were assessed using both Comparative Judgement and marking and the results were compared.
We found that GCSE examiners, when freed from the constraint of working to mark schemes, can write more substantial problem solving tasks than is typical in current GCSE exam papers. We also found that Comparative Judgement offers a reliable and valid approach to assessing such problem solving tasks.

**Kaarstein**, Hege
University of Oslo
hege.kaarstein@ils.uio.no

*Knowledge for teaching mathematics: Differences and similarities in three different measurement frameworks*
In order to measure the concept knowledge for teaching mathematics it is vital to have a construct, a model or a framework which defines and delimits the different elements or categories which comprise the knowledge in focus. Further, it is important to operationalise the knowledge in test items in such ways that construct validity is taken care of. I will present three almost identical items from three different studies that aim to measure knowledge for teaching mathematics. The items are categorised as mathematical content knowledge in one study and as mathematics pedagogical content knowledge in another. To understand how this is possible, the focus of my discussion will be on differences and similarities of the frameworks and on the operationalisation of the categories.
The chosen frameworks are
1. "Mathematical Knowledge for Teaching" from the Learning Mathematics for Teaching project (LMT)
2. "The Professional Knowledge of Secondary School Mathematics Teachers" from the Teachers' Mathematical Knowledge, Cognitive Activation in the Classroom, and Student Progress project (COACTIV)
3. "Knowledge for teaching mathematics" from the Teacher Education and Development Study in Mathematics (TEDS-M)

**Kuhlemann,** Stefanie
University of Oldenburg
stefanie.kuhlemann@uni-oldenburg.de
*Heuristic strategies student teachers use in analysing pupils' work*
Examining pupils' work and their thinking in order to give feedback is an important part of effective mathematics teaching. Therefore, teachers need to analyse and understand pupils' mathematical thinking without immediately assessing them.
Especially when pupils employ unusual strategies of solving a task pupils' thinking is not always directly obvious and easily comprehensible. Taking this into consideration there is a need for teachers to use heuristic strategies to reconstruct possible thinking processes.
In a qualitative study students, who are prospective secondary school mathematics teachers at the end of their academic education, were questioned in clinical interviews. These student teachers were asked to analyse pupils' written answers to three different mathematical tasks and to reconstruct possible thinking processes. Their analyses of the pupils' work were analysed to find out the heuristic strategies by which they reconstruct possible thinking processes.
In the session I will describe examples of heuristic strategies which student teachers use to analyze a pupil's work and reconstruct possible thinking processes of this pupil.

**Kilhamn**, Cecilia
University of Gothenburg, Sweden
cecilia.kilhamn@gu.se
*Geometrical patterns: the role of justification in group discussions*
Many mathematicians and researchers claim that finding and generalising patterns are at the heart of algebra. Swedish students have not been successful in solving geometrical pattern tasks in the TIMSS study and as a result it has been introduced as core content in the National Syllabus (Lgr11) for grades 1-6. In our analysis of video recordings of student groups working with a geometrical pattern task taken from TIMSS07 we have found that students' initial approach to the task differ. When students get stuck it is often a call for justification that leads them on, for example through questioning why an answer is correct or what the answer means in relation to the question. The call for justification can come from the teacher, from other students or from a students' inner wish to understand. We also found that when solving a geometrical pattern problem an extensive use of manipulatives can obstruct algebraic reasoning. In this research session we intend to show some examples of student group discussions concerning the task "In the figure, 13 matches were used to make 4 squares in a row. What is the number of squares in a row that can be made in this way using 73 matches? How do you know?"

**Kislenko**, Kirsti
Tallinn University
kirstik@tlu.ee
*Educating teachers in mathematics and natural sciences - a new innovative curriculum*
I present an innovative in-service training curriculum for teachers of mathematics and natural sciences. Common weaknessess in teacher education are connections between the subject and pedagogical courses, developing creativity, and use of technological tools in the teaching process. The aim of the new two-year Masters level curriculum is to educate pupil-centred teachers with two main subjects (mathematics and physics or chemistry or biology), who will be successful in modern schools.
There is a greater emphasis on: integration, problem-based approaches, extended school practice and the use of ICT. The curriculum promotes four levels of integration: within the subject, in-between the main subjects,

in-between the main subjects and other courses (such as history, didactics, methods of teaching, etc), and in-between the subjects and school practice. Interdisciplinary problem-based learning helps to enrich subject knowledge, develop connections, develop new technological applications, and foster the skills of co-operation. During school practice the status of the trainee teachers change – at first they are supposed to act as observers, then they become teaching assistants and finally partner teachers. In the curriculum the use of ICT is integrated into all pedagogical, subject and subject-didactics courses.

**Kleve,** Bodil
Oslo and Akershus University College of Applied Sciences
bodil.kleve@hioa.no
*Social inequalities, meta awareness and literacy in mathematics education*
In this presentation I will take social inequalities and pupils' different learning possibilities as a result of their social background as a starting point and consider mathematics on three levels: The level of Discourse, which primarily encompasses cultural relations and communities of meanings in school; the level of genre which concerns recognizable common cultural texts and the frames of reference which support their understanding, and finally, on the level of paradigmatic and syntagmatic modes of thought which are necessary for learning within mathematics. Meta-awareness and literacy competence characterize the winners in school. However, meta-awareness should not be reserved for those whose social background, or 'value Discourse' supports school activities. To decrease the school's reinforcement of social inequalities, teaching should be based on meta-awareness rather than acquisition through pupils' activities. On the level of Discourse, I argue that the only way pupils can become party to implicit knowledge is through awareness of mathematics as a secondary discourse. On the level of genre, it is important to be explicit about genres and to help pupils establish sufficient pre understanding. Finally, the argument is that both modes of thought, paradigmatic and syntagmatic are necessary for all pupils in the mathematics learning process.

**Lacefield**, William
Mercer University, USA
lacefield_wo@mercer.edu
*Nurturing Mathematical Practices in Primary School Teachers: Results of a University Course in Problem Solving*
The United States is in the process of implementing a set of Common Core State Standards for Mathematics. A major component of these Standards focuses upon mathematical practices that nurture learning of problem solving skills, critical thinking abilities, and positive dispositions toward mathematics. This session will focus on a semester-long graduate level teacher education course in problem solving. Course participants consisted of pre-service and in-service primary school teachers, who participated in exploration of the problem solving process by focusing on time-proven heuristics. Heuristics used during the course included diagram drawing, systematic lists, matrix logic, trial and error, working backward, subproblems, algebra, and finite differences. The teachers were continually asked to reflect upon how their work with primary-aged mathematics pupils might transform as a result of their completion of the problem solving course. During this conference session, participants will examine the objectives and structure of the semester-long course, selected samples of student work, and qualitative course outcomes. Discussion will include future possibilities for research inspired by the importance of mathematical practices.

**Lee**, Stephen & **Searle**, Jeff
Mathematics in Education and Industry & University of Durham
stephen.lee@mei.org.uk
*Stimulating an increase in the uptake of Further Mathematics through a multifaceted approach – evaluation of the Further Mathematics Support Programme*
Over recent years there has been a marked increase in the number of students studying A level Further Mathematics in England. In 2011 a high of 11 400 students sat the qualification, with the numbers having more than doubled from 5192 in 2005 (Department for Education figures). The increase has been evident despite the common perception that Further Mathematics is a difficult subject.
The work of Mathematics in Education and Industry's (MEI) government-funded Further Mathematics Support Programme (FMSP) has been highly influential in stimulating this increase through not only enabling all students who wish to study Further Mathematics to have access to tuition, but also through supporting teachers and students in schools and colleges in a variety of ways.
An external evaluation of the FMSP has been undertaken by the Centre for Evaluation and Monitoring at Durham University. This paper reports on aspects of the evaluation and how these relate to the multifaceted approach taken by the FMSP to increase participation in Further Mathematics, including: innovative tuition models, enrichment events, extensive provision for teachers to undertake professional development and also an insight into attempts by the FMSP to engage with schools and colleges that have not traditionally offered the subject.

**Lundberg**, Anna, L. V.
University of Gothenburg, Sweden
Anna.lundberg@gu.se
*Proportional Reasoning in a Grade 6 Algebra Class*
The aim of this paper is to analyse how a teacher handles a geometrical pattern task in a lesson in situ, and discuss possibilities to develop knowledge about proportionality and proportional reasoning through such a task. The pieces of knowledge in the lesson affect the teacher–students' interactions, in such a way that the teaching and learning processes cannot be studied separately from the mathematical content. Therefore, I assume that looking at the interaction patterns through classroom observations may allow me to see what is taught about proportionality and proportional reasoning
I have chosen one video recorded lesson out of 25 lessons with 7 teachers from the project VIDEOMAT. The task in the lesson is to build patterns using sticks, and to complete a table with the correct number of sticks. The teacher's goal is that children discover how many sticks are needed for each figure in the pattern and explain how they find their answers.
After the students have completed the task the teacher asks students how they got on. When several strategiesappear generating different answers, the teachers asks the student to use the sticks again to determine which answer is correct.

**Mason**, John
Open University and University of Oxford
j.h.mason@open.ac.uk
*Exchange as A (The?) Core Idea in School Mathematics*
I shall attempt to make the case that exchange is perhaps the core idea in school mathematics. Alerted by young children struggling with the difference between coins as objects and coins as having 'value', I began to explore the action of exchanging one thing for another. If exchange is augmented to include substitution then it shows up everywhere, from counting to algebra, from money to currency, from ratio to algorithms and Turing machines.

**Monaghan**, John & **Mason**, John
University of Leeds & Open University and University of Oxford
j.d.monaghan@education.leeds.ac.uk
*Exploring the notion 'cultural affordance' with regard to mathematics software*
About ten years ago the Gibsons' notion of 'affordance' was extended to cultural objectives underlying designed computer systems. In a paper which will come out shortly Giampaolo Chiappini extends this idea to mathematics software. John Monaghan will critically review these extensions and John Mason will critically review what John Monaghan says. We will keep these reviews moderately short so that we can have a discussion of the ideas presented.

**Morgan**, Candia; **Tang**, Sarah & **Sfard**, Anna
Institute of Education, University of London
c.morgan@ioe.ac.uk
*Doing the same mathematics? Exploring changes in students' participation in mathematical discourse over time through examining student responses to GCSE questions*
In the project "The Evolution of the Discourse of School Mathematics" we are using the lens of GCSE examinations to investigate changes over the last three decades in what is expected of students in England. We have identified differences in the discursive features of examination questions through this period and are now seeking to investigate how these differences may have affected the nature of student participation in mathematics discourse. We have designed and administered a test containing questions varying in characteristics typical of different points in time. In this session we will discuss the design of the test, and present some preliminary results.

**Moskofoglou-Chionidou,** Maria; **Liarakou**, Georgia & **Stefos**, Efstathios
University of the Aegean- Rhodes, Greece
mchionidou@rhodes.aegean.gr
*Primary University Students' & 6th Grade Pupils' Initial Perceptions about the Mathematics, Sustainability, Austerity Game Euro-Axio-Polis*
A game called Euro-Axio-Polis was constructed by 4th year University of Aegean students (primary education) and their university teachers to teach the terms "percentage" and "interest rate" to 6th grade pupils during their teaching practice. Additional aims of Euro-Axio-Polis are:
- challenging the prevailing operation of mathematics as a means of reproduction of the dominant ideology and the market economy,
- raising university students' and pupils' awareness of sustainability and austerity issues
- contributing to the students' social emancipation

40 fourth year primary education university students (3 males and 37 females) played Euro-Axio-Polis and Monopoly, to investigate differences between the two games. Students wrote five key words that characterised each game. 19 sixth grade pupils played the Euro-Axio-Polis game during students' teaching practice and wrote five key words about the game.
The research results suggest that Monopoly reflects capitalist economic terms and social values while Euro-Axio-Polis reflects values associated with sustainable development such as solidarity and equity. Pupils were more likely to make reference to socio-political issues such as parliament, education, democracy, elections and political power. Also pupils referred to more mathematical terms (percentages, operations and numbers) having played Euro-Axio-Polis.

**Naalsund**, Margrethe
Norwegian University of Life Sciences
margrethe.naalsund@umb.no
*Why is algebra so difficult? A study of Norwegian students' algebraic proficiency*
Norwegian students perform weakly in TIMSS algebra items. The question "Why is algebra so difficult?" is investigated by studying cognitive processes involved in solving algebra problems. Conceptual understanding, procedural fluency, adaptive reasoning, and strategic competence comprise *proficiency*, and serve as a theoretical framework for the data. Written test responses from 412 8th-graders and 417 10th-graders constitute the empirical data, supplemented by follow-up interviews with selected students. Diagnostic information (strategy choices, errors, explanations, and justifications) is emphasised in the analysis.
The findings suggest a cognitive gap between informal and formal reasoning in grade 8 and pinpoint differences and similarities in formal proficiency in both grades. Formal procedures seem to be used in a highly algorithmic manner, not guided by a deeper understanding of linked core concepts (e.g. equivalence). Many of the same problems were seen in both grades, such as misconceptions due to limited arithmetic knowledge and over-generalisations in the transition from arithmetic to algebra. An inability to explain and justify reasoning was evident among the majority of students. An overall message is that algebra teaching could benefit from an increased focus on different aspects constituting algebraic proficiency beyond the "skill versus concept" outlook.

**Nortvedt**, Guri A.
University of Oslo
g.a.nortvedt@ils.uio.no
*Attempting equal opportunities to learn – Norwegian experiences from using national mapping tests in primary school*
In their white paper 16 (2006-2007) the Norwegian Ministry of Education and Research made early intervention a national policy in Norway and, in 2008, a mandatory mapping test in numeracy was implemented to help primary school teachers identify Grade 2 students who are at risk of mathematics learning difficulties. A cut-of score of 20% was identified based on the first administration of the test. This cut-of has been used in later administrations.
More recently similar, but optional, tests have been implemented for Grades 1 and 3. Analyses indicate that schools that use the Grade 2 test only and schools that use Grade 1 and/or Grade 3 tests in addition have similar results with comparable numbers of students identified as being at risk. While at-risk students at all grade levels are confident in comparing quantities and counting by ones, group counting and sorting numbers are identified as critical aspects in numeracy as displayed by the tests.

**Nutti,** Ylva Jannok **& Fyhn,** Anne Birgitte
University of Tromsö, Norway
ylva.jannok.nutti@uit.no
*Mathematisation of Sámi cultural expressions as way to develop (Sámi) mathematics teaching*
The Sámi is an indigenous people that live in northern Norway, Sweden and Finland, and the Kola Peninsula in Russia. The education of Sámi pupils differ from country to country and this study focuses on the Sámi lower secondary school in Norway. In Norway the Sámi curriculum and the national curriculum are balanced legally, but there is no mathematics syllabus. Our purpose is to investigate possibilities and challenges for developing Sámi mathematics teaching, based on structures and patterns in Sámi cultural expressions. The development of mathematics teaching on basis of the Sámi culture needs to be the premise for the teaching and not just an appendix. As a point of departure we have chosen ruvdet, braided bands with a round shape. A band's colors inform about the carrier's age, gender and geographic belonging. The term ruvdet refers to the braiding process as well as to the final product. Our focus is how pupils in a Sámi lower secondary school mathematise ruvdet. In this presentation we are going to mathematise so that the culture is not used just as an appendix, and discuss pupils' work with mathematisation within a cultural context**.**

**Nyman**, Rimma & **Kilhamn**, Cecilia

IDPP, University of Gothenburg, Sweden
rimma.nyman@gu.se
*Enhancing engagement in algebra: A focus group study of teachers and their teaching in grade 6-7*
The main focus of this study is teachers' role in engaging students during algebra introduction in grade 6-7. Through analysis of video recorded algebra lesson and teachers' reasoning concerning student engagement in episodes taken from their own algebra teaching the aim is to find ways in which teachers can enhance engagement. Lessons in grade 6-7 were video documented in 4 Swedish schools, engaging a total of eight (8) teachers. The videos were then distributed to the teachers, who chose and presented sequences were they engage students in algebra tasks. These episodes were discussed in two focus group sessions moderated by a researcher. The findings obtained from the study consist of a video portfolio containing episodes and teachers' analysis of those. The main result that emerged during the analysis points out different ways of using student solutions as a valuable mediator of engagement. Furthermore, certain didactical features that teachers use to enhance engagement in algebra were shared by the teachers and included recognition of students' achievements and the way group presentations were designed and carried out.

**Osmon**, Peter
King's College, London
peter.osmon@kcl.ac.uk
*Vending machines: a modelling example*
Undertaking a modelling project is believed to be a rich form of applied mathematics learning. The range of such projects accessible to learners at Level 3 is restricted by their mathematical knowledge but also by the range of application domains that are meaningful to them. The everyday life domain is becoming dominated by information technology (IT), but I claim that the mathematics underpinning most IT is discrete mathematics and is under-represented in the curriculum. I further claim that the discrete mathematics needed to model many IT artefacts is not difficult and not very far out of reach. To illustrate, a model-making example is described that is a member of a commonly occurring class: models of vending machines - as members of the class of finite state machines. Both the application and the concept of state are familiar to us all. The example has other merits. The notation - state transition diagrams - is readily learned and the vending machine example is a good vehicle for introducing general problem solving heuristics: "divide-and-rule" where a larger problem is decomposed into smaller ones; and "refinement" where detail is suppressed initially but included after the structure of the solution has been set out.

**Ozdemir**, Ahmet Sükrü; **Pinar**, Senem & **Unal**, Hasan
Marmara University, Marmara University & Yildiz Technical University
aso23@marmara.edu.tr
*A different multiplication method from the 16th century Mathematics Book "Tuhfat al-A'dad li Zavi'l Ruşd va'l-Sadad" by İbn Hamzat al-MAGRIBI*
The purpose of this presentation is to explore and share a method of mutiplication for two
4 digit numbers, two 5 digit numbers and two 6 digit numbers described by Hamzat al Magribi in his famous book Tuhfat al-A'dad li Zavi'l Ruşd va'l-Sadad. The potential of history of mathematics and its uses in teacher education will be discussed.

**Partanen,** Anna-Maija & **Kaasila,** Raimo
Abo Akademi University & University of Oulu
anna-maija.partanen@rovaniemi.fi
*Gendered Styles of Linguistic Peer Interaction and Equity of Participation in a Small Group Investigating Mathematics*
In a teaching experiment, with two upper secondary classes in North of Finland, the basics of calculus were studied using an investigative approach and small group setting. The students were allowed to choose their partners by themselves, and almost all the groups consisted of girls or boys, only. Four small groups were chosen for video recordings in this ethnographic teacher research. The different styles of linguistic peer interaction of the girls and boys in those groups were analyzed applying the concept of sociolinguistic subcultures (Maltz and Borker, 1982). This analysis creates a context for the interactions in one of the groups where two girls and a boy discuss mathematics. Through three episodes, we shall show how the linguistic strategies typical of the boys prohibited the full potential of the contributions of the girls to be utilised in the collective construction of meaning in the group. Promoting democratic discussions in small groups may be challenged by gendered ways of talking and interacting.

**Raman-Sundström,** Manya
Umeå University
manya.sundstrom@matnv.umu.se
*Beauty in mathematical proofs*

This session deals with some questions central to the study of beauty in mathematics and mathematics education:
1. Is mathematical beauty objective or subjective?
2. What characterises beauty (if such a characterization exists)?
3. How does one convey the beauty of mathematics to students?
These questions are quite difficult. In fact some have been under discussion, amongst philosophers, historians, and mathematicians for hundreds of years. So our goal is not to settle the questions, but rather to raise them in the context of concrete examples which might provide an empirical platform for attempting to answer them. The format for the session will be a structured exploration. After some framing, participants will be invited to examine and judge a variety of different proofs, which will serve as a basis for discussing the three questions above. The workshop leader will then present some preliminary results from a seminar at her university, attended mostly by mathematicians, who have made judgements about the beauty of these proofs.

**Rønning Sør-Trøndelag**, Frode
Sør-Trøndelag University College, Trondheim, Norway
frode.ronning@hist.no
*Making sense of fractions in different contexts*
This session is based on a study of 4th grade children in a Norwegian classroom. The children work in various ways with elementary fractions, both in what could be called everyday contexts and more traditional school contexts. I am interested in investigating how changing the available tools and artefacts, as well as the representations of fractions, influence the children's sense making of the fraction concept.
The study is based in a view that knowledge is situated and that knowledge depends on the available artefacts that mediate between stimulus and response. The signs and symbols used to represent fractions are central, and my analysis is based on semiotic theory where the mathematical concept is seen as the idea that is created in the interaction between the sign and the reference context.
The results of my analysis are linked to work with fractions in school and I will raise the question: To what extent is it necessary to make sense of the notation for fractions in order to solve school tasks about fractions?

**Sharma**, Sashi
The University of Waikato
sashi@waikato.ac.nz
*Developing Statistical Literacy with Year 9 Students: A collaborative Research Project*
Despite statistical literacy being relatively new in statistics education research, it needs special attention as attempts are being made to enhance the teaching, learning and assessing of this strand. It is important that teachers are aware of the challenges of teaching and assessing of this literacy. In this collaborative research study, two cycles of teaching experiments were carried out in two year 9 classes. There were three phases in the teaching experiments: a preparation phase, teaching phase, and a retrospective analysis phase. During the teaching phase, the data set consisted of audio and video-recordings of classroom sessions conducted during the teaching, copies of students' written work, audio recorded interviews conducted with students, and field notes of the classroom sessions. The findings have implications for teaching and research**.**

**Schlarmann**, Kathrin
University of Oldenburg, Germany
kathrin.schlarmann@uni-oldenburg.de
*Conceptual understanding in linear algebra – Reconstruction of students' thinking processes*
The conceptual nature of advanced linear algebra causes a lot of difficulties for university students. In a survey I noticed that even those students, who passed the final examination, struggled with basic concepts of linear algebra. To get to know more about the students' thinking processes in detail, I focused on students while they were dealing with tasks: What are the characteristics of the thinking processes of students who are able to solve a task and of those who fail solving this task? In what way do these processes differ from each other?
In a case study with clinical interviews students were asked to work on tasks concerning the concept "basis of a vector space". I analysed the data by using the semiotic sequence analysis and the triad of Peirce to reconstruct the students' thinking processes with focus on their conceptual understanding.
In the session I will present the analysis of some of the students' thinking processes.

**Stansfield,** Jayne
Bath Spa University
j.stansfield@bathspa.ac.uk
*Feedback on feedback*
I am reporting on the changes in students' perception of assessment during a Mathematics Enhancement Course (MEC). Students' views were gathered pre- and post-MEC via an open question questionnaire with

semi-structured interviews for some. Pre- and post-MEC understanding features highly in the students' own sense of progress, but few had experienced feedback on their work prior to the MEC. Post-MEC feedback is viewed as the most useful aspect aiding their sense of progress.

**Treffert-Thomas**, Stephanie
Loughborough University
s.thomas@lboro.ac.uk
*Designing and developing an 'inductive' approach to the teaching of linear algebra within the format of a university lecture*
Research studies into the teaching practice of university mathematics teachers are still relatively rare. Building on the collaboration with a mathematician during my doctoral studies I have begun to collect new data and analyse further the data collected previously. The purpose of my current work is to gain insight into how the lecturer developed his teaching approach since the initial study, four years ago. I analysed his lecture notes and conducted an interview. I present data in relation to an 'inductive' approach to teaching based on examples and compare with current data analyses which is ongoing. This research is firmly embedded within the topic of linear algebra.

**Unal**, Hasan; **Ozdemir**, Ahmet Sukru & **Yildiz**, Zeynep
Yildiz Technical University
zeynepyildiz.2005@hotmail.com
*Preservice primary school teachers' performance on rotation of points and shapes*
In this study, the purpose was to reveal thinking styles and different point of views of preservice primary school teachers about "rotation" in mathematics. For this purpose, the study conducted with undergraduate students who are studying at the department of primary school teacher education. The subject of "rotation" in this study has two sub-topics which are rotation of points around a point and rotation of shapes about a point in a coordinate plane. A test about rotation was applied to 44 students and then interviews were made with five students. Results of the study include an analysis of correct and incorrect answers of students.

**Watson,** Steven
University of Nottingham
steven.watson@nottingham.ac.uk
*Teachers teaching student-centred problem-solving: A study of practice*
What sort of lessons do teachers plan and teach when they are asked to teach a problem-solving lesson? In this session I will describe a study into secondary mathematics teachers' student-centred problem-solving practices. Eleven teachers, from four schools, were given the brief to teach a 'problem-solving' lesson. The lessons were observed and videoed, the teachers were interviewed before and after the lesson and data were collected about teachers' backgrounds and experience. In this session I will present the common themes and contrasts and compare this with some of the extant literature on teachers' beliefs about teaching and learning.

**Weston**, Tracy & **Rowland**, Tim
University of Alabama; University of East Anglia/University of Cambridge
tweston@bamaed.ua.edu
*Developing an online Coding Manual for the Knowledge Quartet: An International Project*
We report the work of an international team of mathematics educators since 2011. The team uses the Knowledge Quartet (Rowland, Turner, Thwaites & Huckstep, 2009) in their research as a framework by which to observe, code, comment on and/or evaluate primary and secondary mathematics teaching across various countries, curricula, and approaches to teaching. The team includes the UK, Norway, Ireland, Italy, Cyprus, Turkey and the United States. The team has developed a 'Knowledge Quartet coding manual' for researchers, to be launched during the session, which will be made freely available for other researchers to use. This is a collection of primary and secondary vignettes that exemplify each of the 21 Knowledge Quartet (KQ) codes, with classroom episodes and commentaries provided for each code. This work provides increased clarity on what each of the KQ dimensions "look like" in a classroom setting, and is helpful to researchers interested in analysing classroom teaching using the KQ. This session will provide an overview of the Knowledge Quartet, describe the working methods of the team, present the website, offer examples of classroom vignettes that exemplify some of the codes, and provide time for questions and discussion with a panel from the team.

**Zagorianakos**, Andonis
Manchester Metropolitan University
Andonis.Zagorianakos@stu.mmu.ac.uk
*Intuition in service of objectification as the key lever of encapsulating mathematical phenomena.*
The presentation connects data from a larger study of ways that learners construct knowledge, through objectified concepts that they devise in order to manage their mathematical experiences.

The research attempts to exemplify a new approach to the origins of intuition, and its importance in shaping the production of mathematical knowledge. It studies the decisive intuitive aspect that was detected in the students' constructions–objectifications, adopting a phenomenological methodology and drawing on Husserl's notions of objectification, as it emerges in his late work and intuition, as it is clarified by Hintikka. The intentionally minimised teaching environment facilitated the trainee teachers' intuitive explorations, and their genuine and open attitude allowed the observation and transcription of several intuitive categories and operations.
Three students' constructions are analysed and five major intuitive aspects are detected and identified; a further categorisation of the students' use of their newly emerged objectifications is designated. Finally, some implications for teaching and learning are suggested.

## 17 November Working groups

**Clarke,** Nichola
University of Nottingham
nichola.clarke@nottingham.ac.uk
*Sustainability and Mathematics Education*
For this session, we will focus on aspects of design research for teaching sustainability issues through mathematics. In particular, we will focus on task design. We will discuss the notion of virtual water, and consider some mathematics-centred tasks based on that notion. We will consider issues for teachers working on cross-curricular themes, and consider how to tweak/revise/present the tasks to make them productive for teachers to use in classrooms. We will then discuss plans for research on the efficacy of teaching about virtual water in school contexts.
Some time will be put aside to develop general discussion about teaching about sustainability issues through mathematics.

**Coles**, Alf & **Solomon**, Yvette
University of Bristol, Manchester Metropolitan University
alf.coles@bris.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 talk, drawing on traditions both within mathematics education and more broadly. In this session, Yvette will bring some video data (with a transcript) of maths teaching undergraduates trying to understand spatial relationships between the sun, moon and earth. In the video the undergraduates use their bodies to work mathematically on the problem. We will work collaboratively to share approaches to, and interpretations of, this data.

**Rogers**, Leo
University of Oxford
Leo.rogers@education.ox.ac.uk
*History in and for the Mathematics Curriculum*
This session continues the earlier meetings of the group and will review some new publications, and offer a discussion on the theme "Proof in History and Proof in the Classroom".