# BSRLM Abstracts, University of Bristol, 2 March 2013

## Research presentations

**Andrews**, Nick
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*Teaching a sequence of lessons on geometrical constructions: what aspects of the topic are emphasised, how do learners encounter them, and when?*
Mathematical classroom activities involve the coming together of teacher(s), learner(s) and mathematics within a classroom environment. Teachers' decisions regarding such activities emphasise certain aspects of subject matter and modes of interaction over others. Thus decisions are discernable by what is emphasised. My focus is on teachers' decisions regarding what learners are to encounter, how they are to encounter it, and when during a sequence of lessons on a particular topic.
Subject matter can be conceptualised as a mix of affective, cognitive and enactive aspects, as in the Structure of a Topic (Mason and Johnston-Wilder, 2004). Modes of interaction can be conceptualised as a mix of three fundamental interactions (based on the didactical triangle): teacher-mathematics, teacher-learner and learner-mathematics interactions. For a single mathematical classroom activity, these two triadic structures provide a basis for describing what learners encounter and how.
Casting a sequence of lessons on a particular topic as an ordered set of activities, I will present a case study of lessons on sraight edge and pair of compasses constructions viewed through the lens detailed above. In doing so, I will seek to provide a structural description for the flow of the lesson sequence.

**Brown**, Laurinda
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*Learning as a mathematics teacher educator through narrative interviewing*
Over many years, I have carried out narrative interviews with practising mathematics teachers for a range of purposes; on their first lessons of the school year; on their role as mentors for mathematics student teachers; and focusing on their learning as teachers of algebra to year 7 students (to mention a few examples). In this session, I want to focus on two strands that illustrate my learning as a mathematics teacher educator; the first on what I have learnt about interviewing, particularly narrative interviewing where stories are co-constructed during the interviews; and the second on my learning about mathematics teacher development that gets applied back into my work on a secondary one-year PGCE course.

**Coles**, Alf
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*Metacommunication and listening*
This session will report on the results on an ESRC studentship project, investigating the development of mathematical thinking in one classroom and, in parallel, the development of a way of working with teachers, using video clips of lessons. Some striking parallels became apparent between the two contexts, in particular around the power of metacommunications (ie communications about the communication that was occuring) by the teacher or facilitator of teacher learning. The notion of a 'heightened' listening is put forward, to describe a commonality in terms of how the teacher/facilitator appears to need to pay attention to discussion, in order to offer metacommunications

**Clarke,** Nichola
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*Now you see it, now you don't: the epistemology of visual reasoning in the secondary school geometry curriculum*
I consider the epistemological position of students working on geometry in the secondary school mathematics curriculum. Using data from two case studies of students with low prior attainment of mathematics, I argue that the students' curriculum experiences of geometry place them in a confusing epistemological position, that may undermine teaching aimed at helping them move beyond argument on the basis of perceptual features.

**Darlington**, Ellie
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*The Use of Bloom's Taxonomy in Advanced Mathematics Questions*
Perhaps the earliest taxonomy developed for educational assessment was that produced by Bloom et al. (1956). Describing the purpose behind the taxonomy, Bloom remarked that there are real differences in whether teachers teach for understanding, for their students to internalise knowledge or for them to grasp the core of the subject. Designed for general application across all school subjects, many in mathematics education have deemed it particularly ill-fitting to mathematics (Kilpatrick, 1993; Romberg et al., 1990). Ormell (1974) describes the categories as being "extremely amorphous in relation to mathematics", claiming that they "cut across the natural grain of the subject, and to try to implement them… is a continuous exercise in arbitrary choice" (p. 7). The Mathematical Assessment Task Hierarchy (MATH Taxonomy) (Smith et al., 1996) was designed to assist the development and construction of advanced mathematics assessments in order to ensure that students are assessed on a variety of knowledge and skills. Here, I shall discuss the use of the MATH Taxonomy in classifying questions in A-level mathematics and further mathematics, as well as the University of Oxford Mathematics Admissions Test.

**Golding**, Jennie
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*'In this game you don't stand still': curriculum reform as a catalyst for teacher learning*
Why is there a wide range of different classroom enactions of policy developed with broad support? In this session I discuss a study that followed two departments through their first cycle of the Mathematics GCSE introduced for first teaching from September 2010. Although both departments appeared both motivated and well placed for a principled enaction, just one developed classroom practice in ways largely consistent with that envisaged, and for them the change appeared to act as a catalyst for considerable professional growth. A variety of lenses has been employed to analyse the differential departmental characteristics: possible implications for policy makers at a variety of levels are explored.

**Gonzalez-Calero**, Jose Antonio; **Arnau**, David & **Puig**, Luis
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*Solving word problems algebraically with a spreadsheet in primary school*
This session will present some results from an investigation into the teaching of algebraic solving of word problems in a spreadsheet environment in the sixth grade of primary school in Spain (11-12 year old pupils). The main aim of the study was to investigate whether the spreadsheet could be a precursor to the teaching of algebraic problem solving. Through the analysis of excerpts from a case study, the core of the session will focus on the difficulties that students showed when solving problems algebraically in a spreadsheet environment.
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**Iannone**, Paola & **Simpson**, Adrian
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*Oral assessment in mathematics: an opportunity for assessment for learning?*
In this session, we will outline students' descriptions of their experience of an oral assessment task in university mathematics. Twenty students who took part in the task agreed to be interviewed and analysis of their responses reveals a generally positive view of this assessment method, especially in relation to the feedback they received during the task. Students stressed how the learning which took place during the assessment and how feedback from tutors administering the task facilitated learning more than feedback received from the same tutors marking written coursework. In the light of the pressures from the general HE literature for change in assessment to facilitate and assist learning we will discuss how oral performance assessment may be a viable choice for undergraduate mathematics.

**Ineson**, Gwen & **Babbar**, Sunita
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*Exploring Approaches to Calculations: A comparison between primary and secondary trainee teachers*
This study included 72 primary and 24 secondary student teachers studying on a one year post graduate teacher training course at one higher education institution in England. This paper reports the results of

responses to an audit designed to explore the way in which trainees attempted simple calculations. They were asked to identify their preferred strategy for solving the problem and to identify ways in which they would support pupils encountering difficulties in solving them. Initial analysis indicates that secondary student teachers were more successful in finding accurate solutions but primary student teachers were able to draw on a wider range of approaches to support pupils.

**Ismail**, Norulhuda
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*Teaching mathematics problem solving to student teachers in a Malaysian context*
Problem solving is viewed as an important component in mathematics teaching and learning and this view is also shared among many mathematics teacher training programs in Malaysia. As part of my research project on student teachers' recontextualisation of problem soving, I would like to share how one mathematics teacher training program in Malaysia teaches problem solving to student teachers. The courses within the program which focus on problem solving are Methods for teaching mathematics, Laboratory in teaching mathematics and Microteaching. I am using a critical discourse analysis approach on the data, focusing on what counts as problem solving processes, the values espoused about problem solving processes and the pedagogical aspects of teaching problem solving. The Methods class focuses on exposing student teachers to several approaches in problem solving, the Laboratory class focuses on allowing student teachers to create a problem and solve it using a spreadsheet, and Microteaching focuses on one student teacher's effort to teach mathematics using problem based learning. The differences in the way the courses teach problem solving and the messages about problem solving are analysed.

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*Learning congruency-based proofs in geometry via a web-based learning system*
Congruence, and triangle congruence in particular, is generally taken to be a key topic in school geometry. This is because the three conditions of congruent triangles are very useful in proving geometrical theorems and also because triangle congruency leads on to the idea of mathematical similarity via similar triangles. Despite the centrality of congruence in general, and of congruent triangles in particular, there appears to be little research on the topic. In this paper, we use evidence from an on-going research project to illustrate how the use of a web-based learning system for geometrical proof can be utilised to develop Year 9 pupils' capability with congruent triangles. Using the notion of 'conceptions of congruency', as our framework, we first characterise our web-based learning system in terms of four different 'conceptions' of congruency by comparing the online tasks with activities from Year 9 textbooks. We then discuss how the web-based learning system would aid pupils when they are tackling congruency-based proofs in geometry.

**Joubert**, Marie
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*The 'official' view of mathematics education in the UK*
Since the beginning of 2011, at least 28 'official' reports related to mathematics education in the UK were published. The reports have been collected on a blog (www.mathsreports.wordpress.com). The blog is part of a project which aims to 'draw on the wisdom of the mathematics education crowds' to develop a shared understanding of what the emerging big messages from these reports are (and the extent to which they appear to have been taken into account in the new draft national curriculum). The project also uses a range of new and old communication tools, such as Mendeley, LinkedIn, Twitter, and conferences to provide various ways in which members of the community are able to provide their comments. This presentation is one of the mechanisms through which the community is invited to contribute.
In the presentation I will outline the scope and aims of the project and describe progress so far. To conclude, I will invite members of the audience to give their feedback on a) the overall idea of the project b) the methodology and c) the emerging analysis and synthesis. Further feedback will be welcome via the blog.

**Kathotia**, Vinay
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*The Nuffield Foundation and mathematics education*
The Nuffield Foundation is a charitable trust that works to improve social well-being by funding research and innovation in education and social policy. Underpinning our work is a belief in the importance of independent and rigorous research evidence. We have been one of the leading independent funders of education research and development in the UK for over 50 years, and science and mathematics education has been a major part of that.
The aim of this session is to provide an overview of our growing interests in mathematics education, describe the priorities we have for grants for mathematics education research and development, and discuss with BSRLM members how they might become involved in our work including applying for grants.
We are interested in supporting research and development projects designed to improve understanding, policy and practice in the teaching and learning of mathematics. We use the term 'mathematics' in a broad sense, including statistics and the range of quantitative approaches across all subjects and disciplines that can be considered as applying and doing mathematics. Particular themes of interest are outlined at www.nuffieldfoundation.org/mathematics-education and examples of our mathematics work can be found at www.nuffieldfoundation.org/mathematics-education-0 .

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*Two Year 7 Students' Understanding of Measures of Average in the Context of Informal Inference*
The concept of inference in statistics refers to "drawing conclusions about populations or processes based on sample data" (Zieffler, Garfield, delMas, & Reading, 2008, p. 40). It includes inferential techniques to draw conclusions from data, such as estimation and hypothesis testing. Researchers advocate making informal conclusions about a population or process from the early years (Makar & Rubin, 2009). The Handling Data section of the National Curriculum in England (DfEE, 1999) emphasises "making inferences from data" beginning from the Key Stage 3: "Pupils should be taught to compare distributions and make inferences, using the shapes of distributions and measures of average and range." (p. 41). In this study our aim is to investigate how Year 7 students develop conceptual understanding of key ideas in statistics and probability in the context of informal statistical inference through the mediating roles of technological tools and pupils' talk in groups. We will report on the preliminary findings from our ongoing design research in an afterschool program with seven volunteer 11-12-year-olds in Exeter. Two students' ways of comparing their reaction times using the TinkerPlots 2.0 software (Konold & Miller, 2011) and their understanding of measures of average will be discussed in this session.

**Kent**, Geoffrey
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*Intersubjectivity and Groupwork in School Mathematics: A Perspective of Communicative Action and a discussion of networking and complementarity of theoretical approaches*
Small group interactions around problem solving can be pragmatically understood using a theoretical framework of Communicative Action. This discussion of my doctoral work will cover the development of codes and models focused on understanding small group interactions from an intersubjective perspective informed by Habermas's Theory of Communicative Action. These models and codes were iteratively used to generate and refine analytical statements and working hypotheses from further interrogation of the data, which address micro-processes of communication and interaction in the context of wider socio-cultural issues in mathematics education, including issues of access, attainment and participation. Findings included the development of an Intersubjective Framework for Analysis of small group interactions, evidence that this framework can be productively used to identify ways in which the development of collaborative understanding expresses itself at the small group level, how it breaks down and how it can be supported. The use of the framework developed led to working hypotheses focused on how collaborative understanding can express itself through communicative action, how these processes can be inhibited and breakdown, and how they can be supported. These ideas will be complemented by a discussion of networking ideas of Intersubjectivity with Searle's ideas of collective intentionality.

**Kristinsdóttir**, Jónína Vala
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*Teacher development in a community of inquiry*
This study aims at learning to understand how teachers meet new cultural and mathematical challenges in their classrooms. It builds on former research on teacher development in mathematics teaching in Iceland that have revealed that many teachers take a passive role in their mathematics teaching and lack experience in creating meaningful learning environments for all children.
The research is a qualitative collaborative inquiry into mathematics teaching where seven primary school teachers research their mathematics teaching together with a teacher educator. The teachers work in two neighboring schools with diverse groups of students and want to improve their mathematics teaching.
On a monthly basis the teachers and the researcher meet at workshops where the focus is both on mathematics teaching and learning and teacher reflections on their own teaching. The study is cyclic and experiences from former cycles guide the steps taken in the following cycles. Videotapes from workshops, examples of pupils' work and notes from the teachers' classrooms are the basic data used in developing the work. As the teachers refine their teaching spirals of experience emerge and the group learns from former cycles while building new. Some preliminary findings of the processes that emerged at the workshops will be presented.

**Lacefield**, William
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*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.

**Maiduang**, Alongkot
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*Dynamic geometry environment and its relation to Thai students' higher-order thinking: reasoning in Euclidean geometry*
This research investigates the situation where learners interact with the Dynamic Geometry Software (DGS). It examines how learners interpret DGS key features; drag-mode and parent-and-child relationship, and how such interpretations relate to their higher-order thinking of reasoning. Inductive, deductive and abductive reasoning are pursued in this research. How the DGS environment plays a role in the learner's reasoning is the central research question.
Vygotsky's model of tool and Verillon & Rabardel's Instrumented Activity Situation model are used as a research framework. These models help to distinguish the independent roles of the learner, the DGS tool, the tasks and Euclidean geometry in the setting. The research is conducted in Thailand with a group of lower-secondary students. The method used is a task-based interview, where pairs of students perform geometric tasks with the DGS while the researcher challenges their reasoning.
This research finds the tension between the deductive nature of Euclidean geometry, the inductive nature of visual presentation in the DGS, and the influence of students' experiences in the paper-and-pencil environment on their interpretation of dynamic geometry. Abduction is found to be the students' main reasoning strategy, with a combination of inductive and deductive reasoning to support their verification.

**Osmon**, Peter
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*A-level mathematics reform: issues, principals, proposals*
During 2009-10, I investigated the mathematics entry requirements for university courses across a wide range of subjects. Four distinct mathematics requirements emerged. It seemed take-up might be improved if these could be mapped onto a post-16 mathematics qualifications pathway for learners. However it seemed impossible to devise such a pathway while satisfying all four requirements.
Post-16 mathematics reform now seems imminent and various developments have prompted me to review my findings, including: (a) take-up of post-16 statistics learning in New Zealand; (b) increasing need for mathematics beyond GCSE in the biosciences; (c) modelling as a motivating way to learn use of mathematical knowledge.
It now seems conceivable that a course of probability and statistics, leading to a qualification that is less than an AS-level, might encourage more post-16 learners to engage with mathematics and also top-up GCSE to provide a better mathematical foundation for HE courses in mathematically less demanding subjects. It now also seems possible that, with some reform and rearrangement of content, AS and A-levels could become well-matched to the mathematics knowledge needs of the three remaining subject groups. Altogether these could form a progression pathway of the kind envisaged.

**Pratt**, David & **Ainley**, Janet
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*Active graphing with uncertainty*
We make an initial report on a project that aims to bring together two approaches to the teaching of statistics: (i) Exploratory Data Analysis (EDA), which focuses on the exploration of different representations of data but avoids the use of probability, a well-known area of difficulty; (ii) Active Graphing (AG), which was developed in the late 1990s as an approach to support children's understanding of graphs through their use as analytical tools in experimental situations. However, observed data as typical in statistical situations do not typically have the structure that allows AG to be applied.
We report on a first attempt to merge these two approaches through a task inspired by Angry Birds in which children age 10 account in many different ways for the variation in distances the birds travel when projected by a catapult. These accounts range across deterministic explanations, which might refer for example to the tension in the catapult, and stochastic descriptions, where a range of possible distances might be given or a single tension.
In the session, we will invite you to work with us to make sense of these accounts and to propose directions for the project that might successfully tease out further insights.

**Rogers**, Leo
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*Proof in History - Proof in the Classroom*
Traditional expectations of mathematics teaching at secondary school are that pupils should reach some understanding of the nature and importance of proof. However, many attempts to communicate this idea to pupils have emphasised the pedagogical difficulties by assuming a Euclidean-axiomatic paradigm without enough attention to the possible epistemological processes involved in the contexts of learners.
Studies in proof processes in historical contexts suggest alternative possibilities. An exploration of research in the development of mathematics in ancient civilisations over recent years, supported by more recent work on visual thinking can offer alternatives that may be more appropriate for many contemporary classrooms.

**Rowlands**, Stuart
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*Some thoughts on encouraging creativity in the mathematics classroom*
Although not quite as prominent as it once was, creativity is the buzz-word that has generated much time and investment in committees, curriculum development, publications and politics. It has come to mean novelty and in many instances with such high praise that novelty has become detached from the very subject that gives it its meaning, even to the extent of treating some incorrect ideas with respect to

the subject as novel. Creativity, I would argue, only makes sense in Boden's transformation of the subject, something we normally attribute as acts of genius yet we all have that potential. With reference to the relevant literature I propose the following as elements to encourage creativity in the mathematics classroom: 1) an historical awareness of the ideas that contributed to the mathematics, the impact of those ideas and identifying with the difficulties of those ideas, 2) how creativity relies on the work of predecessors, 3) to make explicit the theoretical objects of study and to encourage philosophical discussion of those objects, 4) to be immersed in the mathematics yet to have the freedom to play with the constraints, 5) encouraging metacognition and critical thinking.

**Sovičová**, Miroslava & **Joubert**, Marie
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*A relationship between professional development and problem-solving resources*
Problem solving is taking on increasing importance in the global economy, and it is generally accepted that it is important that problem solving is taught in schools. However, it is well recognised that teachers lack confidence in teaching problem solving in mathematics and that professional development may support them in developing their confidence and skills.
It is well known that sustainable and scalable professional development is expensive and difficult to achieve and that curriculum materials (e.g. textbooks) have the potential to influence teachers' development.
John is an experienced teacher, interested in developing his skills especially in teaching problem solving. He is taking part in a research project which provides him with access to problem solving resources which are specifically designed to include an element of professional development.
This research explores the relationship between John's ongoing professional development experience and the design of the resources. It takes the key design principles and uses the ways in which the designers envisage how they might be enacted in the classroom to frame an investigation of John's learning.

**Watson**, Steven
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*An historical analysis of policy in relation to mathematics teachers' professional development in England*
In this session I will present an historical analysis of education policy in England in relation to mathematics teachers' professional development (PD) from the 1950s to the present. Since the 1970s successive governments have taken an increasing role in PD. It is often assumed that policy is informed by ideology and political perspectives, while this analysis suggests that policy is more pragmatic. Policy has been informed by a) increasing public expectation of education quality and b) the need to compete globally. In the session I will discuss some of the reasons for this. I will also consider the extent to which PD policy has influenced the PD that teachers experience as well the ways in which PD policy has had an influence on practice. Finally I will consider how current policy may influence PD in the future.

**Zagorianakos**, Andonis
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*The study of intuitions and their implications for the approach on learning and teaching of a pre-service teacher*
The research is a study of the Husserlian approach to intuition, as it is exemplified by Hintikka, in the case of a prospective teacher of mathematics. It is based on data collected from a course where the students were free to choose their own ways of exploring the tasks while working in groups, without the teacher's guidance, and it focuses on the work of one of the students. A phenomenological approach that takes objects as self-given, deriving from the student's intuitions and mathematised during the activity reveals mathematical objects that surfaced from her investigation and the particular circumstances that led to these objects. The research exemplifies the two intuitive stages introduced by Husserl, while introducing a method of discerning them, and argues for a new approach to intuitions and the essential part that they play in the construction of mathematical objects.

## Working groups

**Clarke,** Nichola
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*Sustainability and Mathematics Education*
We will continue to work on task design in this workshop. The focus will be the analysis, critque and development of materials produced for work with upper primary/lower secondary pupils on water and proportional reasoning. There will be opportunity to participate in a literature review of local curricula.

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*Using statistics in mathematics education research*
Along with other BSRLM members, we four attended a day meeting in October 2012 at the Royal Statistical Society on 'Good Practice in Using Statistics in Mathematics Education Research', sponsored by the Centre for Statistical Education at the University of Plymouth. At the end we wanted a means of widening debate on this important subject and thought of a BSRLM working group. This first meeting will have three parts: an opportunity for everyone to introduce their 'statistical research selves'; an introduction and then a discussion of Andy's paper in our journal RME, Vol 14, No 3; a discussion of where the group goes next. Please note that (a) in considering 'where next', that matters of professional development for members is a legitimate focus, and (b) the organisers will make efforts to ensure that the working group's discussions are at all times accessibe to every participant.

**Kent**, Geoffrey & **Coles**, Alf
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*Mathematics Education and the Analysis of Language*
The aims of this working group are to share and develop approaches to the analysis of classroom talk. We aim to dwell in the detail of how we work with language in our own mathematics education research. In this session, Geoff will share some data from the "Raising expectations and achievement levels for all mathematics" (REALMS) project (funded by Esmee Fairbairn) and offer one approach to analysis for participants to try out. Discussion will then broaden to other analytical approaches that could be used and how different approaches to analysis generate different insights. What possibilities are there for networking theories? Are there issues of complementarity?