

BSRLM Conference Abstracts
Loughborough University (James France Building)
Saturday 11th June 2016

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Using data from recollections of SMILE to overcome 'historic loneliness'

In England, the neoliberal political agenda has created an environment in which teachers are constantly subjected to a discourse of marketisation, managerialism and performativity. It is also part of the neoliberal project to cut us adrift from our past and to de-historicise our lived experience of the present. We are suffering from what John Berger has called a sense of 'historic loneliness'. Many teachers are engaged in re-storying themselves against this audit culture. We are currently exploring using stories from the past - in this case, recollections of SMILE, a teacher-led mathematics curriculum project with roots in inner London in the 1970s - to combat this 'historic loneliness' and to create a space in which to understand, interrogate and oppose the dominant discourses. We have conducted extended interviews with groups of SMILE teachers from an earlier era and are now looking at ways to make these data perform this potentially transformative function. In this workshop, we will present a small part of the data in three different ways - as edited transcript, as story and as aphoristic fragment - and invite participants to compare and contrast the effectiveness or otherwise of these forms of presentation.

Age range: *Not age specific*
Key words: *using data; transcripts; neoliberalism*
Session type: *Research workshops*
Duration: *60 minutes*

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Influence of parents' socioeconomic status and level of education on children's mathematics education at secondary schools: Pilot study findings from rural Bangladesh

Previous studies show that parents' socioeconomic status and level of education seem to have important influence on children's overall educational achievement, mathematics achievement and their career ambitions. The better economic status of the household played a positive role in increasing the arithmetical knowledge of the children in Bangladesh but gender differences were found to be equally prominent among the children in each of the four categories of household: always in deficit, occasionally in deficit, in balance and in surplus (Nath et al., 1997). However, mothers' higher level of education leads to a reduction of gender imbalance in the society that suggests the necessity of educating girls up to a sufficient level alongside of boys. This paper reports the findings from a pilot study conducted across three rural secondary schools in Bangladesh. Data were collected from parents and children through semi-structured interviews and focus group discussions respectively.

Age range: *Secondary education*
Key words: *influence; level of education; mathematics education; parents; socio-economic status*
Session type: *Research papers*
Duration: *30 minutes*

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Tools, conceptions of mathematics and goals in undergraduate engineering courses

Nowadays, the integration of digital and online resources into the teaching of tertiary mathematics has become a standard for most universities. In addition, there have been developments in providing support to students through tutorials and more recently support centres. Moreover, students themselves have now access to a plethora of digital and online resources that they can use alongside more traditional (e.g. textbooks or their own notes) or institutionally provided resources. However, there is limited literature exploring the kind of resources that students actually use when studying mathematics, with previous studies focusing mostly on digital/online or on institutionally-led resources, but not both. This study will consider all available resources, digital/online, institutionally-led, traditional and human resources. Furthermore, several studies have shown that students' conceptions of mathematics relate to the approaches they adopt when studying mathematics. There is a need therefore to investigate the connections between conceptions of mathematics and resources used. This paper presents initial findings from a survey of second year engineering students. A paper-based questionnaire was distributed during the first academic semester of 2015-2016 and in total 201 students completed it. The design of the questionnaire was guided by Activity Theory and explores the resources used by students, their conceptions of mathematics and the goals that students set for their mathematics modules.

Age range: *Further / Higher education*
Key words: *tools; conceptions of mathematics; goals; activity theory*
Session type: *Research papers*
Duration: *30 minutes*

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Algebraic nature of negative numbers

Historically, the full acknowledgement of negative numbers was closely tied to the advent of symbolic algebra. In a way, admitting that a letter, say x , might stand for a negative number, was a large step away from the longstanding process conception of negatives as positives that are preceded by a "minus" sign, and a crucial step towards realizing negative numbers as fully-fledged objects. This session will tell the story of an unfinished design research study that turned history on its head and supported a rather radical approach in which the object perception of negative numbers preceded the process perception of those numbers in an algebraically nurtured learning situation. The session will try to encourage the audience to collaborate in finishing the study!

Age range: *Secondary education*
Key words: *functional approach to algebra; geometrical-algebraical permanence; negative numbers; algebraic variables*
Session type: *Research papers*
Duration: *30 minutes*

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Working atmosphere in the secondary mathematics classroom: When things do not work according to the lesson plan

In this workshop we will discuss MathTASK, a collaborative research and development programme on secondary mathematics teachers' knowledge and beliefs – and the transformation of these into pedagogical practice. Here we will focus on a recently developed strand of our programme: through the award of a small grant (Ian Hunter Prize) we created a team consisting of secondary mathematics teachers (newly qualified and experienced), researchers in mathematics education (faculty and doctoral students) and mathematics teacher educators to explore how to achieve balance between creating opportunities for high quality mathematical thinking and attending to classroom management and behaviour issues. Especially with relation to classroom management and behaviour, we deploy Terry Haydn's 10-point scale on the working atmosphere in the classroom, a construct that was not devised specifically for the mathematics classroom. The proposed workshop will explore the conjecture of whether the Scale can be adopted for, and provide meaningful insight into, the working atmosphere in the secondary mathematics classroom. The workshop will replicate the structure of our team meetings: we will offer an example of a classroom incident, we will introduce the Scale and we will work on characterizing the incident in the Scale's terms.

Age range: *Teacher education*
Key words: *working atmosphere; mathematics teacher professional development; task*
Session type: *Research workshops*
Duration: *60 minutes*

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Developing frameworks for evaluating and researching the Shanghai mathematics teacher exchange: Practices or assemblage

There is currently a great deal of interest in 'mastery' pedagogies in England in mathematics. This has influenced the new primary mathematics curriculum. As part of the promotion of teaching for mastery the government has funded the China-England teacher exchange, also referred to as the Shanghai exchange. The initiative has involved primary teachers and headteachers from 48 schools visiting Shanghai and/or hosting Shanghai teachers in 2014/15. Schools have, to varying extents, continued to both adopt and implement Shanghai practices. I report the development of conceptual frameworks developed to support the longitudinal evaluation of the exchange. The first categorises aspects of practice in terms of systemic, school and classroom practices. This allows for change in specific practices in different schools to be compared and to evaluate the extent to which Shanghai informed approaches are being implemented. However, such an approach has limitations in understanding how different practices interrelate and the relational effects of changes. An alternative is consider actors rather than practices, to consider English Primary mathematics education as an assemblage and the Shanghai exchange as an attempt to reassemble this. This perspective helps to foreground tensions within current educational policy in mathematics.

Age range: *Primary education*
Key words: *mastery; evaluation; primary; policy; assemblage*
Session type: *Research papers*
Duration: *30 minutes*

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Researching the teaching of geometric similarity with dynamic technology: The influences of teacher knowledge and pedagogic practices

This research workshop shares the next phase of our work in the Nuffield-funded 'Cornerstone Maths' Project in London. We are researching the nature of teachers' mathematical knowledge for teaching (MKT) and associated mathematical pedagogic practice (MPP) as they develop their use of dynamic maths technology in Key Stage 3 lessons. We focus on the hard-to teach topic of 'geometric similarity'. Following a brief overview of the project, its research methodology and participants, we will outline some draft findings related to this topic. We will suggest that addressing the ontology of 'within' and 'between' ratios when comparing polygonal shapes might be an important facet in teachers' knowledge and practice. We will present a case study of one teacher and our ongoing analysis, in which we have utilised Selling, Nicole and Ball's (2016) 'Mathematical Work of Teaching' as a construct to help us make sense of classroom practices with technology.

Age range: *Secondary education*
Key words: *technology; teacher knowledge; geometric similarity*
Session type: *Research workshops*
Duration: *60 minutes*

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Building and sustaining active research collaborations with teachers of mathematics

Many researchers are deeply concerned about opportunities to work with and involve teachers in the process of doing, reflecting on and engaging with the findings of mathematics education research. The current educational landscape in which teaching schools and Maths Hubs are being encouraged to engage with and participate in more 'research-informed' practices offers a range of challenges but also opportunities to develop new collaborative ways of working. The working group is meeting for a second time to work on some research findings, ideally from the participants' own work, for which an early draft of a communication for a wider (practitioner) audience has been written. During the working group session, these communications will be constructively critiqued and further developed. New members to the group are most welcome - please e-mail Alison (a.clark-wilson@ucl.ac.uk) if you would like a copy of the report from the last meeting of the Working Group.

Age range: *Not age specific*
Key words: *research impact; research dissemination; collaborative research design*
Session type: *Working Groups*
Duration: *60 minutes*

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Sustainability and Mathematics Education Working Group

This session represents a re-booting of the "Sustainability and Mathematics Education" Working Group. There will be a short presentation on 'Mathematics Education in the Anthropocene' which will prompt questions related to: (a) teaching and learning mathematics; (b) learning to teach mathematics; (c) teaching teachers of

mathematics. What might these activities look like in the twenty-first century and in the face of global and societal challenges? There will be time for discussion and an exploration of possible avenues for future work.

Age range: *Not age specific*
Key words: *sustainability; Anthropocene*
Session type: *Working groups*
Duration: *30 minutes*

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The creation of problems by prospective teachers: Origami activities

In this study, the problem formation state of the elementary school prospective teachers related to the origami activities was researched. The participants of the research consisted of 64 prospective teachers who took the selective course 'Origami and Mathematics' in a university. The assignment 'Composing a mathematics problem that can be solved by origami' was given to the prospective teachers after regular classes each week and they were asked to complete this assignment in two days. In the end of the nine week period, the acquired problems were analyzed within the context of elementary school curriculum subject, problem type, origami usage in problem solving, problem solving methods and mathematics language. The prospective teachers used geometry subjects during the first weeks, however they used subjects such as fractions, equations and exponential numbers towards the end while composing problems. In the field of geometry, angle, area, side length, similarity, alternation geometry, three dimensional objects came into prominence. In more than half of the composed problems, origami was used actively and problems directed to lecturing were observed along with problems related to practice. Furthermore, with the influence of the observed models in the classes, the prospective teachers were seen to be composing eccentrically multiple-choice and non-routine problems. In the end of this study, the conclusion was that the prospective teachers used origami actively in the problem solving process while their problem creation skills and mathematical language were improved with origami as well.

Age range: *Teacher education*
Key words: *mathematics with Origami; problem creation; problem solving; prospective teachers*
Session type: *Research papers*
Duration: *30 minutes*

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What effect can using a new textbook scheme have on teachers? A local evaluation of the National Textbook Trial

The National Textbook Trial, using adapted versions of textbooks currently used in Singapore Schools aims to support teacher professional development and help teachers to embed a mastery approach to the teaching of Mathematics. This paper describes a small, local evaluation of the use of the textbooks by primary classroom teachers as the basis of teaching pupils in years one, two and six. Seven teachers in three schools were interviewed in the Autumn term (with follow up interviews planned for the summer term). Three key themes emerged. Perhaps the most important of the findings is that the textbook schemes (comprising the textbooks, pupil workbooks, teacher guides and teacher professional development offered alongside) provides a well-structured mathematics curriculum. The second finding is that the textbook schemes promote mixed ability teaching and collaborative working with peer support of lower achieving children. Thirdly, the participating teachers gave a very strong message that the textbooks were not sufficient on their own and that teachers continue to need good pedagogic skills in order to make the best use of the textbook schemes. Finally, I observe that the adapted Singapore textbooks could be worth the investment alongside continuous evaluation and revision by experts.

Age range: *Primary education*
Key words: *textbook; mastery; curriculum; pedagogy*

Session type: *Research papers*
Duration: *30 minutes*

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Developing procedural fluency: Exercises or rich tasks?

Fluency in important mathematical procedures is widely recognised as a critical goal within the learning of school mathematics. But are repetitive exercises the only or best way to develop procedural fluency? For some time I have been designing “mathematical etudes” (Foster, 2013), which seek to embed the practice of essential techniques within richer, exploratory and investigative contexts. Anecdotally, these are popular with teachers and may be more enjoyable for pupils, but how effective are they in comparison with traditional exercises? In this exploratory quasi-experimental study, Year 8-9 (age 12-14) mathematics pupils (N = 193) in three different secondary schools in England practised the solving of linear equations during one lesson either by completing as many short traditional exercises as possible or by tackling a related mathematical etude. Pre- and post- tests were administered at the beginning and end of the lesson. Gain scores on the exercises were just significantly greater than on the etude ($d = 0.28$, $p = .049$) and a 2x2 ANOVA showed a just significant interaction between the condition (etude/exercises) and the time (pre/post-test). Examination of pupils’ work suggests that those doing the etude wrote less than those doing exercises. Possible directions to take this work in will be discussed.

Age range: *Secondary education*
Key words: *mathematical fluency; quasi-experimental study; rich tasks; task design*
Session type: *Research papers*
Duration: *30 minutes*

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Interpreting Lesson Study as a professional praxeology to uncover the influence of epistemological and didactical models on teachers’ learning

Lesson study is a teachers’ practice that is commonly interpreted as a part of teachers’ professional life in Japan (Fujii, 2016). It has attracted the interest of teacher educators since the TIMSS video study and Stigler and Hierbert’s (1999) seminal work. Much research has been focused on how to transfer this practice into other cultural and school contexts. Stigler and Hiebert (2016) consider this as a critical issue, since when educators try to import lesson study into a new culture and different institutional contexts they often find that it becomes distorted and difficult to sustain. And while changes are expected, and probably necessary, Murata (2011) warns against changing the essential characteristics of the process. As with any human practice, lesson study can be seen through the lens of the Anthropological Theory of Didactics (Chevallard & Sensevy, 2014). The interpretation of lesson study as a praxeology facilitates separating lesson study tasks (Lewis et al., 2011) from theoretical discourses that implicitly or explicitly explain how teachers tackle them, which very often are embedded in a vague notion of ‘culture’. This may provide insight into how we may develop the scope of lesson study by designing and/or supporting teachers’ work using explicit epistemological and didactical models.

Age range: *Teacher education*
Key words: *Lesson Study; teacher professional development; Anthropological Theory of the Didactics*
Session type: *Research papers*
Duration: *30 minutes*

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A tale of two fraction sub-constructs: The part-whole and quotient

It is widely recognised that children find the learning of fractions difficult. One of the reasons for this is that fractions is a multi-faceted construct. The part-whole sub-construct of fractions is one of five fraction sub-constructs and is typically the first that children encounter at primary school. Previous empirical research have presented mixed findings as to the effect of the part-whole sub-construct on the learning of other fraction sub-constructs. This presentation reports findings from an investigation into how a sample of Year 5 children, from the Commonwealth of Dominica, who have only been taught the part-whole sub-construct of fractions, derive the fraction associated with solving partitive quotient problems. The findings from this empirical research paints a nuanced portrait of how the partitive quotient sub-construct knowledge emerges alongside the existing part-whole knowledge, in contrast to the dichotomy of findings in existing empirical research. The methodological approach utilised for the research is that of a microgenetic, qualitative, case study. Some implications of the findings for teaching and learning of fractions at the primary school level of education also form part of the presentation.

Age range: *Primary education*
Key words: *children's learning; fractions*
Session type: *Research papers*
Duration: *30 minutes*

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Beginner teachers assessing semi-structured problems

Post-16 'A Level' mathematics curricula in England are being re-developed with a renewed emphasis on problem solving. We report on an exploratory study probing whether and how the envisaged changes resonate with beginner teachers' beliefs, their capacity to engage with formative assessment of solutions and their knowledge of summative assessment tools in this context. We position teaching for problem solving at this level as demanding complex skills and flexible, elaborate and connected cognitive schemata (Livingston & Borko 1990, Berliner 2004). We draw on evidence from face to face development sessions with beginner teachers and interviews probing some of the issues exposed, and compare beginner teachers' responses to sample assessment items with those of more experienced teachers of A Level mathematics. The study suggests the proposed changes are well-aligned with the professional values of a range of teachers, but that even well-qualified beginner teachers are often mathematically and pedagogically ill-prepared for this focus. As in Horn (2005) they value and can rapidly learn from focused professional interactions to develop such skills. Almost all participants, beginner and experienced, professed themselves daunted and in need of considerable development and supporting materials in order to enact the proposed changes.

Age range: *Further / Higher education*
Key words: *problem solving; assessment; pedagogy; beginner teachers*
Session type: *Research papers*
Duration: *30 minutes*

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Defining learning outcomes for statistical modules: A repertory grid technique

In a big data society, undergraduate students need skills in handling and interpreting data and using new tools to process and visualise it. To specify the module learning outcomes, higher education institutions in the UK use

nationally agreed benchmark statements, subject matter expertise and in some cases standards from standard setting and professional bodies. Module learning outcomes, although a regulatory requirement, are a challenge to set. Using data from twelve repertory grid interviews with statistical methods lecturers, this study aimed to identify the statistical skills, knowledge and understanding students should develop during their undergraduate studies. Qualitative and quantitative data analyses of the repertory grid data indicate that the statistical methods lecturers participating in this study emphasised the content of instruction and assessment rather than the module learning outcomes. This data further suggests a statistical reasoning curriculum that emphasises 'basic' statistical techniques and non-statistical skills: conceptual understanding, application of statistical methods, general strategy, selecting the most appropriate method of statistical analysis, interpreting results in the 'best' possible way and communicating about data rather than mathematics and probability theory i.e. inductive rather than deductive reasoning. This presentation discusses implications of the methodological approach and findings.

Age range: *Further / Higher education*
Key words: *statistics education; repertory grids interviews*
Session type: *Research papers*
Duration: *30 minutes*

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What is the future for quantitative educational research methods?

In this session, key on-going developments taking place in quantitative educational research methods will be discussed, and the likely future changes over the next decade or so will be considered. There are a range of issues and developments that together are shaping what is do-able and what is seen as acceptable in terms of robust quantitative approaches to research. There are also on-going debates about the use and misuse of p-values, and whether 'borrowing' from the medical sciences, such as through randomized controlled trials, is appropriate in social science settings. Attempts will be made to characterise the arguments on both sides of some of these issues, and consider what the future holds for quantitative research methods in education.

Age range: *Not age specific*
Key words: *quantitative methods; RCTs*
Session type: *Working groups*
Duration: *60 minutes*

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Prompting for progress: Using teacher voice for the implementation of Realistic Mathematics Education with low-achieving mathematics students

In teaching a group of low-achieving year 10 students (14 and 15 years old), I struggled to motivate them because they could not see the point of doing their General Certificate of Secondary Education examinations (GCSEs, taken at the end of compulsory education aged 16) when they were only going to get the lowest grades (Fs and Gs). The work of Freudenthal and the Realistic Mathematics Education Group (RME) at the Freudenthal Institute provided an alternative way of doing things, allowing students to take away more flexible mathematical ideas to use beyond the classroom. My research question was, 'How can we promote the use of more sophisticated methods by students?' For this project, 4 teachers taught a series of lessons to their Year 10s using the idea of realistic situations. The lessons were based on prompts taken from academic papers and a set of RME textbooks. From our group 'teacher voice' discussions after the lessons, a common theme was when to intervene to take conceptual thinking on, what we called 'prompting for progress'. The 'teacher voice' sessions supported teachers in using the resources to support conceptual development.

Age range: *Secondary education*
Key words: *teacher voice; teaching mathematics; Realistic Mathematics Education*

Session type: *Research papers*
Duration: *30 minutes*

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Prospective upper secondary mathematics teachers' levels of statistical thinking

This paper investigates prospective upper secondary mathematics teachers' levels of statistical thinking. Participants are twenty-two prospective teachers who were in the fifth (last) year of a teacher preparation program in a state university in Istanbul, Turkey. Both quantitative and qualitative methods were used to collect data. Participants completed a test with open-ended questions which require interpreting scatterplot graphs, line graphs and tables using the concepts of mean and standard deviation. Data were analysed using Mooney's (2002) 'Middle School Student Statistical Thinking' (M3ST) framework. This paper particularly focuses on the 'analysing and interpreting data' component of the framework. Data were analysed using four levels of statistical thinking: level 1 (idiosyncratic), level 2 (transitional), level 3 (quantitative) and level 4 (analytical). None of the participants were at level 1 while most of the participants (72%) were at level 3. Only one participant's responses were found to be analytical (level 4). Two themes emerged from the qualitative data: errors of mathematical language and misinterpretation of data. Findings of this study indicates the importance of training prospective mathematics teachers to develop a strong content knowledge of statistics since it is a newly introduced topic in the Turkish national curriculum of mathematics.

Age range: *Teacher education*
Key words: *statistical thinking; analysing data; interpreting data*
Session type: *Research papers*
Duration: *30 minutes*

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Pre-service mathematics teachers' strategies to find the general term of sequences: Discovering the unseen beyond the seen

The purpose of this study is to investigate pre-service mathematics teachers' strategies while finding general term of sequences. This research has qualitative paradigm with a case study research design. Participants of this study consist of 20 pre-service mathematics teachers who studied their second year in a secondary mathematics teaching department in a state university in Istanbul. The research instruments are Test of Sequence Problems (TSP), which was developed by the researchers, and clinical interviews. TSP was firstly conducted on the study group. Then, six pre-service mathematics teachers selected from the study group for the clinical interviews using purposive sample method. The collected data were analysed with content analysis methods by utilising descriptive statistics. Findings show that pre-service teachers use different strategies from each other and had a difficulty to find the general term of sequences. Moreover, they did not verify the general term that they were looking for in the terms of being valid for all numbers in the sequence.

Age range: *Teacher education*
Key words: *pre-service mathematics teachers; sequences; generalization strategies*
Session type: *Research papers*
Duration: *30 minutes*

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Lesson Study at the upper secondary level in Japan: Focus on the 'Problem Solving Approach'

School education in Japan is looking for a way of placing more emphasis in lessons on process skills rather than content. This is proving difficult in upper secondary level mathematics in Japan because traditionally teachers do not use the Problem Solving Approach and the Authentic Lesson Study that have played a key role in developing Japanese classroom teaching at the primary and the lower secondary levels. Some teachers believe that the problem solving approach is impossible and is not required at the upper secondary level. In this presentation, I report on Lesson Study conducted at Year 11 in Japan. Based on the lesson plan, and findings from the lesson, particularly the observed student activities, we will discuss issues in learning problem solving as well as the future possibilities for Lesson Study at upper secondary level.

Age range: *Teacher education*
Key words: *Lesson Study; problem solving approach; upper secondary level*
Session type: *Research papers*
Duration: *30 minutes*

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From informal strategies to the use of standard algorithm: Is anything lost?

Students' oral and written presentations of solutions of problem-solving tasks. Informal strategies or use of standard algorithm for subtraction? Based on a video research study in a Year 4 classroom we are studying students' presentations of their solutions of a problem-solving task where different arithmetic calculations were carried out. Sitting in pairs (learning partner), they solved the problem before presenting their solutions orally in class. Based on transcripts for video recordings, students' written notes and post interview with the teacher, we studied how students were in different phases on their way from use of informal strategies to the structured procedure for subtraction (standard algorithm). Our findings suggest that in their oral presentations students who used informal strategies displayed their number sense and a well-developed subtraction concept. Of those who had used the standard algorithm, some explained the procedure in detail while others just referred to the algorithm. Consequently, they did not display their number sense and subtraction concept to the same extent. According to the teacher, the students who used the standard algorithm had developed a more mature number sense than those still using informal strategies. With socio mathematical norm as a theoretical framework, this is discussed.

Age range: *Primary education*
Key words: *informal strategies; standard algorithm for subtraction; socio-mathematical norms; learning partner*
Session type: *Research papers*
Duration: *30 minutes*

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Transition to university mathematics

The focus of my talk is on the messages that first year undergraduate mathematics students receive from their lecturers in the academic context. Through this study, we tried to identify the messages that were transmitted and the influences that these messages had on students' transition from school to university mathematics. Ten first year students who followed an honours undergraduate degree in Mathematics in a research-intensive university in the UK participated in the study. We focussed our attention on two modules in particular that the students were

required to study for their first year. The data was gathered through observations of the lectures, focus groups with the students, individual interviews with the students and the two lecturers, and questionnaires. For the analysis of the data some aspects of Basil Bernstein's theory of pedagogic device have been used in order to understand better the underlying structures of the transmitted messages. In my presentation I will talk about one of the students, Alex. The results suggest that strongly framed messages were more influential on Alex. However, there were occasions that the impact of the message was not dependent on the way that it was transmitted but on its content.

Age range: *Further / Higher education*
Key words: *transition; university; mathematics*
Session type: *Research papers*
Duration: *30 minutes*

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Using dot patterns to model multiplication

We are currently in the process of extending some of the ICCAMS lesson materials, and have been investigating how the use of models can support low attaining Year 7 and Year 8 students' understanding of multiplication. In this session we will look at some of the materials that we have trialled and report on the insights shown by three 'nurture group' students during an interview on a task involving two related and highly structured dot patterns.

Age range: *Secondary education*
Key words: *multiplication; models; dot patterns*
Session type: *Research papers*
Duration: *30 minutes*

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The fragility of A level Further Mathematics in schools/colleges in England

Over the last decade there has been a marked increase in the number of students studying, and schools/colleges offering, A-level Further Mathematics in England – 14,298 entries across 1428 state institutions in 2015, compared to 5,627 entries across 762 state institutions in 2005. The work of Mathematics in Education and Industry's (MEI) government funded Further Mathematics Support Programme (FMSP) has been influential in stimulating the increase. Though increases in entries and accessibility appear impressive, are they masking a fragility in access – the modal entry for A level Further Mathematics in schools still remains at just one student. This paper draws on FMSP analysis and aspects of an independent evaluation (2014-16) of the current FMSP programme by academics at Sheffield Hallam University. This includes the creation of an 'FM Security' construct derived from National Pupil Database data for 2013 to 2015. Findings show a third of schools or colleges move between statuses over this period. Concepts of organisational Further Mathematics capital is used to interpret the analysis. In addition, the reasons for these patterns are reflected upon in respect to the wider Further Mathematics education landscape, including recent policy changes that potentially threaten to reverse the positive trends in Further Mathematics.

Age range: *Further / Higher education*
Key words: *Further Mathematics; post-compulsory mathematics; policy; mathematics capital; widening participation*
Session type: *Research papers*
Duration: *30 minutes*

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Deep and shallow approaches to learning mathematics are not mutually exclusive

From time to time, students are characterised as having a deep or shallow approach to learning. A deep approach to learning tends to attract more approval than a shallow approach. Is this dichotomy useful when teaching students? Students on a Year 0, Foundation course at a university were divided into those tending to have a relational approach (26) and those tending to have an instrumental approach (18). Their performance in a test of problem solving in an aspect of applied mathematics was compared. Contrary to expectations, the test scores and interviews with the students indicated that those with a relational approach did not benefit when asked to apply their learning in new contexts, and those with an instrumental approach were not markedly disadvantaged. In short, the dichotomy in learning approaches was not reflected in performance when attempting to solve problems in mechanics. It is suggested that, at least amongst learners, neither approach is likely to be entirely self-sufficient, but should be seen as acceptable starting points of potential routes to success. In a given topic, the tutor's role should be to help students along these routes so that both gain understanding and competence, although not always in that order.

Age range: *Further / Higher education*
Key words: *deep and surface learning; mathematics*
Session type: *Research papers*
Duration: *30 minutes*

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'Do more number activities with your child': Is this the right advice to be giving parents?

Parents are often advised that to help their young children succeed in maths they need to do more number activities. However, there is little evidence to support this advice. Only a small number of studies have explored the home numeracy environment, and these few studies have found varied results. The variability in the results could be due to the method of using a questionnaire to measure the frequency of activities. I will present a novel text message method to measure the frequency of activities in the home numeracy environment. Parents with children aged between 24 months and 59 months were sent text messages on a daily basis for 21 days asking them 'Have you done any number activity with your child today? Reply yes or no'. Parents also completed a questionnaire typically used in previous studies to measure frequency of number activities. The results revealed that just doing more number activities is not correlated with mathematics performance, suggesting that just telling parents to do more everyday number activities is not beneficial and the effects of the home numeracy environment are more complex.

Age range: *Early years education*
Key words: *home numeracy environment; parents; questionnaire*
Session type: *Research papers*
Duration: *30 minutes*

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Using the history of mathematics in education

The new English National Curriculum states, "Mathematics is a creative and highly inter-connected discipline that has been developed over centuries, providing the solution to some of history's most intriguing problems." The history of mathematics provides an intriguing and engaging way of making some of the increased expectations in

the new curriculum accessible to learners. In this working group session, we will consider the history of functions and how it relates to today's classroom learning. The function concept took a long time to develop into the sophisticated idea that we have today, and 'functions' are one of the most important ideas that we find examined in Key Ideas in Teaching Mathematics: Research-based guidance 9 – 19 (Watson, Jones, & Pratt, 2013). The idea of a function provides access to many ideas that are currently separated among the different headings of the Programmes of Study for KS3 and KS4 Mathematics. The function concept can be represented in many ways and used to illustrate the powerful and essential links between different areas of mathematics by tracing the founding ideas through the historical context. We are working with colleagues in Denmark, where the history of mathematics is an essential part of the curriculum, towards a conference on the History of Mathematics in Education, to be held at Bath Spa University, 22-24 August 2016 <https://www.atm.org.uk/2016-history-of-mathematics-conference>. Do come and work with us towards this exciting collaboration.

Age range: *Ages 7 - 19; Teacher education*
Key words: *function concepts; resources; epistemology*
Session type: *Working groups*
Duration: *60 minutes*

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Not everyone talked about cats: Learning from Year 5 learners' responses to lessons using Numicon

In this session, I will outline my recent research and present some of its findings. In upper Key Stage 2 mathematics classrooms, production of independent written work in response to questions in textbooks features prominently. Individual output, rather than multi-learner interaction, is the focus and mathematical artefacts, which were present in earlier school life, are absent suggesting they are no longer relevant. Through a piece of action research, the responses of 90 Year 5 children to one such artefact, Numicon, during and after 3 mathematics lessons about number, were considered. Though some quantitative data was collected from all children, this presentation will focus primarily on conclusions drawn from the verbal responses of individuals, articulated immediately after each lesson, in semi-structured small-group interviews. These show that Numicon use could still benefit Year 5 children. Crucially, its limited quantity in schools necessitates sharing of equipment thereby stimulating talk between learners. Within this, there is the potential for verbal thought exchange about mathematics which can enhance learners' understanding. The complexity of enabling this sort of talk to occur between pairs of learners in upper Key Stage two mathematics classrooms will be discussed.

Age range: *Primary education*
Key words: *Numicon; Year 5; talk; pairs*
Session type: *Research papers*
Duration: *30 minutes*

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Engagement with mathematical discourse in closed-book examinations: Lecturers' perspectives and student responses to a Probability question

In this session we report and discuss part of an ongoing doctoral study which explores assessment discourses on closed-book examinations at university level. We take a commognitive perspective (Sfard, 2008) and we characterise lecturers' intended and actual assessment discourses when designing examination questions and marking examination scripts – as well as students' mathematical discourse as evident in their examination scripts. In this session we focus on data collected from a Year 1 module on Sets, Numbers and Probability offered in a UK mathematics department. Our data consists of the closed-book examination questions, compulsory and optional; semi-structured interviews with the lecturers; and students' written responses to the questions. In the session, first we will introduce the study; then, we will share a sample of the analysis from the data on the compulsory Probability question of the examination paper, with reference to the interview with the lecturer who

set the question and to the written responses of 54 students. Finally, we will highlight the commognitive conflicts that our analysis has revealed. Colleagues will be invited to participate through engaging with the examination question and the samples from the data (lecturer interview, student responses) as well as through reflecting on our proposed data analysis.

Age range: *Further / Higher education*
Key words: *assessment discourse; closed-book examination tasks; lecturers' perspectives; students' engagement*
Session type: *Research workshops*
Duration: *60 minutes*

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Bending over backwards: Developing appropriate flexibility in primary mathematics

This session introduces findings from my doctoral research into how young children develop number sense. I illustrate the importance of flexibility in primary mathematics classrooms using data from my ethnographic study. Using a Bourdieusian framework, I demonstrate that flexibility can be considered a “rule of the game” of mathematics, but that knowledge of this rule is not equally available to all pupils. By focussing on the areas of estimation and strategy choice, I illustrate that the notion of flexibility in primary school demands that children operate algorithmically, with particular responses in specific situations. More significantly, I suggest that standard practices in primary mathematics education, such as ability grouping, actively prevent some children from learning flexibility due to the mathematical opportunities which are offered to them. I also demonstrate that wider classroom practices, such as question and answer patterns, give particular children greater opportunity to be seen as ‘flexible’ in their approach to mathematics. I argue therefore, that current practices in the development of ‘flexibility’ in primary mathematics lead to inequalities in the outcomes for different groups of pupils.

Age range: *Primary education*
Key words: *number sense; flexibility; estimation; strategy choice*
Session type: *Research papers*
Duration: *30 minutes*

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Artefacts, boundaries and classrooms: The ABC of Lesson Study

The Lessons for Mathematical Problem Solving (LeMaPS) project has been using the Japanese model of lesson study to research the teaching and learning of problem solving and modelling in the U.K. The theory of instrumental genesis has been used to provide a lens on teacher learning in this context. In particular, we have considered instrumentation and instrumentalisation as recursive aspects of professional learning and consider how these processes can be supported by collaborative design between teachers and educators. Consequently, our focus has been on artefacts that emerge at boundaries between meetings of these different professionals from their respective communities. In our research, we have observed the use of a range of artefacts in classrooms and are starting to track their diffusion and adaptation between lesson study groupings. Here, I report some emerging observations and theorisations using data from both the UK and South Africa.

Age range: *Teacher education*
Key words: *Lesson Study; problem solving; theory*
Session type: *Research papers*
Duration: *30 minutes*