



BSRLM Conference Abstracts
University of Nottingham (Business School South Building, Jubilee Campus)
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The complexities of drawing on multiple representations when teaching fractions

Research indicates that multiple representations have a critical but complex role to play in developing an understanding of complex concepts (e.g. Ainsworth, 2006). Moreover, fractions are widely recognised as being a complex concept to teach due to the multiple interpretations with which they are associated. In particular, there is evidence that learning opportunities are enhanced when representations associated with magnitude are used in conjunction with other perspectives; in England, however, there appears to be an over-reliance on part-whole representations (Rau & Matthews, 2017). Here, in order to explore the complexities involved in supporting students to develop a more comprehensive concept image of fractions, a lesson from a wider video study is analysed where multiple representation were used. In the wider study, eighteen secondary mathematics lessons were videoed, involving three participating teachers and six classes; one lesson with a Year 9 class is reported on here. The focus of the teacher's attention is traced as they introduced different diagrammatical representations to the class and as they responded to student contributions. Results indicate that whilst a wide range of interpretations were encouraged when fractions were described, the part-whole interpretation remained at the cornerstone of the teacher's explanations when difficulties arose. The paradox of multiple representations being both an access point and a potential barrier to developing understanding is explored.

Key words: *multiple representations; teachers' practice; lesson observation*
Session type: *Research paper*
Duration: *30 minutes*

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Year 12 problem-solving classes in mathematics: Student discourses, student identities and what they reveal

This session reports on an investigation into Year 12 students' perceptions of weekly mathematical problem-solving classes that they attend at their local university. It utilises Burr's social constructionism (2010) to conceptualise the mathematical activity in the classes and employs ideas concerning student identity (Boaler, 2002; Engstrom, 1995; Williams & Davis 2005) and theories of discourse (Burr, 2010; Sfard, 2008) in order to represent students' individual and shared positioning. The methodology adopted is one of 'directed conversation' in which students are given licence to collectively narrate their perspectives. The data suggests that students' identities in relation to mathematics are reinforced by their attendance, rather than radically altered. Their discourses of social problem-solving mathematics reveal key, recurring themes of 'challenge', 'variation' and 'thinking', from which I draw some initial recommendations for future action. The intertwining of problem-solving and 'school' mathematics is considered, with a key recommendation being the alignment of school mathematics more closely with 'research' mathematics.

Key words: *problem-solving; discourse; identity; constructionism; age range 16 - 18*
Session type: *Research paper*
Duration: *30 minutes*



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Promoting productive mathematical contributions from lower attainers through a focus on mathematical awareness

This UK classroom based doctoral research sought to promote mathematical awareness in lower attaining primary school pupils. Three primary class teachers worked alongside the researcher to design lessons in which classroom pedagogies aimed to raise pupil awareness of the mathematical properties and structures embedded in mathematical activities. Research lessons employed the use of video to capture the activity and interaction of lower attaining pupils working in mixed attainment pairs. Analysis focused on the nature of the mathematical awarenesses demonstrated by the lower attaining pupil and the impact of these in the mathematical development of the task. Each of the lower attaining pupils was able to contribute significant mathematical awarenesses that impacted positively on the mathematical reasoning constructed by the pupil pair as they navigated the task. Teacher questioning and the use of representations emerge as important factors in attempts to provoke pupil awareness. Findings from the study indicate that a focus on mathematical awareness has an important role to play in supporting lower attaining pupils to make meaningful contributions to mixed pair working.

Key words: *mathematical awareness; primary; lower attainers; reasoning*
Session type: *Research paper*
Duration: *30 minutes*

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Mathematics in Further Education Colleges (MiFEC): An initial report

Smith (2017) identified significant issues in post-16 mathematics education that need addressing if England is to achieve maths-for-all-to-18. The DfE-commissioned report also noted a lack of relevant and robust evidence about some areas of post-16 provision. In this session, early findings from the Nuffield-funded project Mathematics in Further Education Colleges (MiFEC) will be presented. The project adopts a mixed-method, multi-scale approach to understanding, and thereafter advising on, the quality of post-16 mathematics education in England's Further Education (FE) colleges. Documentary analysis and initial interviews with college principals highlight weaknesses in the FE system and show how complex interdependencies shape the mathematics learning experiences of young people, particularly those on vocational and technical pathways. The resulting challenges for the design and implementation of mathematics policy within a complex system will be discussed, with an emphasis on the impact of current policies on students with low attainment at GCSE level.

Key words: *post-16 mathematics; Further Education; policy*
Session type: *Research paper*
Duration: *30 minutes*

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Designed student responses to unstructured problems: A tool to support social metacognitive regulation

When students work productively together they simultaneously manage their own efforts while understanding what others are doing and saying. Monitoring and regulating the construction of meaning involves individual metacognitive processes operating socially. This can take three forms: learners regulate their own cognitive



processes; scaffold their partner's understandings, by taking on the role of a tutor; or mutually regulate their joint understanding. These processes of social metacognitive regulation (SMR), however, can remain elusive for many students. The aim of this design research study was to develop an intervention to support students in this endeavour. In so doing, local theory concerning their use in a secondary school classroom was established. The resources designed included worked-out solutions to unstructured problems, in the form of designed student responses (DSRs). The intention was that features such as their coherence, and anonymity, and a focus on understanding, rather than performance, would engender a less demanding situation than when students jointly-solve problems. The expectation was that when students worked together with DSRs, they would practise SMR. These developed practices could then be applied to the more challenging environment of constructing a joint solution to a problem. Through the analysis of student transcripts and the artefacts they produced, comparisons were made between the way SMR manifested itself when they constructed a solution and worked with DSRs. The findings indicated that when working with DSRs, proportionally more SMR episodes arose, and more of students' talk included high quality reasoning.

Key words: *designed student responses; social metacognitive regulation; unstructured problems; collaboration*
Session type: *Research paper*
Duration: *30 minutes*

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Why do secondary mathematics teachers situate real world equity issues in their classroom?

The study reports on what motivates some secondary mathematics teachers to situate real world equity issues into their teaching. The study also aims to determine the possible barriers these teachers may conceive to embedding these issues into their mathematics lessons. Data was collected through eight semi-structured interviews of an exploratory nature, divided between teachers who have a mathematics-related degree and those from other disciplines. The purpose of the interviews was to determine the teachers' own experiences and pedagogical approaches relating to the place of real world equity issues in the secondary mathematics classroom. An adapted version of Ernest's model of mathematics-related belief systems was used as card sort prompts for the interview. The same model was also used to analyse the interview data and identify what motivated teachers to situate real-world equity issues in their lessons. The study arrived at conclusions that teachers from diverse mathematical beliefs and academic backgrounds are motivated to situate real-world equity issues in the mathematics classroom because they have an underlying concern for the pupils. This underlying concern is not necessarily reflected in the teacher's mathematical belief system.

Key words: *Critical Mathematics Education; social justice; teachers' beliefs*
Session type: *Research paper*
Duration: *30 minutes*

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Critical Mathematics Education (CME) Working Group meeting

The CME Working Group (launched in November 2015) is open to all and aims to promote research that brings about positive social change through mathematics education. CME aims to identify and challenge ways in which mathematics is commonly used to maintain the status quo and reproduce inequities in society. It proposes an alternative and empowering conceptualisation of mathematics, which enables people to better understand their social, political and economic situations, and to advocate and bring about changes leading to a more just and equitable society.



Key words: *Critical Mathematics Education; empowerment; equity; social justice*
Session type: *Working group*
Duration: *60 minutes*

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Early Years and Primary Mathematics (EYPM) Working Group - Second meeting

Following the recent release of the 'Improving Mathematics in Key Stages 2 & 3' guidance report by the Education Endowment Fund (EEF), the EEF is exploring the possibility of producing an EYFS and Key Stage 1 version of the guidance which, as we understand, will continue to be based on a review of the research evidence. Given the research expertise of our EYPM Working Group members, we believe we could offer suggestions on the focus of this guidance. Specifically, we will discuss what kind of EYPM-related research questions would get the EEF to review qualitative research as well as quantitative randomised control trial (RCT) studies, which the EEF is more traditionally associated with. In this meeting, we will also aim to create a database of research interests and expertise of our group members so we will have a clearer sense of the range of research interests and expertise we have within our group.

Key words: *early years mathematics; primary mathematics; Education Endowment Fund (EEF)*
Session type: *Working group*
Duration: *60 minutes*

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Overlapping circles: Using participant generated maps in a study of influences on teacher development

This presentation evaluates the usefulness of participant generated 'influence maps' as a tool for data collection during qualitative interviews. In the context of a multiple longitudinal case study following the trajectories of a small sample of English primary school teachers as they progress through their first two years as qualified teachers, I have developed this tool to support participants to articulate their views on the influences on them as early career teachers of mathematics, and the connections between these influences. Interviews form a key element of many qualitative research studies, but getting participants to think deeply about the questions being asked and give fully reasoned responses can prove difficult. Deeper and broader responses have resulted from the use of the influences maps, giving richer, more personal data than using conventional interviewing techniques, whilst this approach has proved to be a very interesting and motivating experience for the participants. New insights have emerged as to how early career teachers see the influences on their development as teachers of mathematics.

Key words: *visual data collection; early career teacher development; influences on teachers; primary*
Session type: *Research paper*
Duration: *30 minutes*

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Hello from the other side: Teaching for Mastery and the Reception teacher

Teaching for Mastery (TfM) is a high profile pedagogical and policy narrative in mathematics education for 5-11 year olds in England. In schools developing a TfM approach with 5-11 year olds, the pedagogical position for teaching mathematics to the 4-5 year olds can be ambiguous. This paper focuses upon an individual Reception



class teacher and her Reception class from a primary school in the East Midlands of England. Drawing on Foucault's work on panopticism, and Lyotard's on performativity, the paper examines the development of TfM for this teacher struggling with the demands of a neo-liberal, marketised, education system. Via data generated through participatory action research a thematic analysis of interview, field note, focus group and conference artefact data is presented. The paper demonstrates how 'Horizon Content Knowledge' (HCK) allied to the prevalent performative zeitgeist - framed the intersection between TfM pedagogy and mathematics policy. In doing so, HCK is adapted to become 'Horizon Pedagogical Knowledge' (HPK). Here, HPK maps to how the informant's knowledge of the TfM approach in primary settings, and indeed beyond, shaped her practice. The paper explores her knowledge of how, rather than what, children learn mathematically in the future and highlights the complexities of the Reception teacher's position- on the other side of the TfM policy agenda.

Key words: *early years; mastery; policy*
Session type: *Research paper*
Duration: *30 minutes*

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Are we speaking fluently about fluency? Interpretations and implications for practice

In light of current assessment policy in primary schools in England (arithmetic tests and the new times tables check), there seems to be a growing focus on the importance of mathematical fluency among some - but not all - practitioners. However, multiple and contradictory interpretations of mathematical fluency are employed across policy and theoretical literature, with definitions ranging from their focus on speed of recall to flexibility and concepts. I will consider assumptions underlying these interpretations and their implications for practice. Focussing on flexibility and procedural innovation in calculation, I will suggest how mathematical fluency might be conceived, and present a case for opening up discussion about primary practitioners' and trainees' understanding of this term in the current policy climate.

Key words: *fluency; flexibility; calculation; primary*
Session type: *Research paper*
Duration: *30 minutes*

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Factors facilitating or hindering change in the assessment of university mathematics

Mathematics is one of the most traditional disciplines in terms of assessment and has the highest percentage of exams in the UK. There are however signs that mathematics lecturers are implementing some changes to assessment. This is caused both by the preoccupation of PGCE courses with innovative assessment and by institutional pressures from senior managers who often equate 'innovative with 'better'. The HE literature reports factors of resistance towards the adoption of new assessment (Deneen, & Boud, 2014) and factors that hold new lecturers back when considering new assessment (Norton et al., 2013). Those include little incentive to innovate and lecturers' fear that their students may not welcome change. Noticeably, not much is written regarding factors that facilitate change. Joughin et al. (2017) offer a description of unconscious biases against assessment changes and suggest factors that could facilitate change. One of the assessment modes trialled in mathematics recently is oral assessment, disappeared in the UK in the 18th century but widely used in Europe. We present preliminary results of an interview study with mathematics lecturers in one university in the UK after the introduction of oral assessment in a Y1 linear algebra module. We chose to focus on the factors that facilitate assessment change and we will read those in relation to the facilitating factors reported in Joughin et al.'s (2017). We conclude with a reflection on the implementation.



Key words: *assessment; university mathematics; oral exams*
Session type: *Research paper*
Duration: *30 minutes*

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Statistics Working Group: A hands-on introduction to Bayesian statistics

In this session of the working group, we will give a very brief practical introduction to some basic Bayesian analyses of quantitative data. The session will fall into three parts. In the first, there will be a short presentation on how Bayesian approaches differ from traditional frequentist statistical analyses (t tests, ANOVAs, etc.). Particular attention will be paid to so-called Bayes factors, and how these can be used to assess evidence for or against a null hypothesis. In the second section, a concrete example of a Bayesian analysis will be given based on Foster's (2017) recent ESM paper (available at <https://tinyurl.com/BSRLMStats1>). Finally, the third section will consist of a practical guide on how to calculate Bayes factors using the free software package JASP. If participants would like to follow this tutorial on their own laptop, they could download and install JASP from <http://jasp-stats.org> in advance of the session, along with Foster's (2017) data, available at <https://tinyurl.com/BSRLMStats2>.

Key words: *Bayesian analyses; quantitative data; statistics*
Session type: *Working group*
Duration: *60 minutes*

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Do students make progress during Year 7?

We present the results of comparative judgement (CJ) assessments with Year 7 students. CJ is an assessment approach where answers to questions are compared side by side and judges are asked to choose the 'better' response. This continues over a several cycles until each response has been judged enough times to produce reliable scores. CJ differs from criteria-based approaches because judges use professional judgement to arrive at a holistic decision, rather than rigid criteria. An advantage of CJ over criteria-based approaches is that responses to different questions can still be compared as long as the judgement is based on the same construct (e.g. 'better understanding'). Therefore, responses from different points in time can be included in the CJ process and placed on the same scale. This enables a measure of 'absolute progress (the difference in their scale positions at different time points) to be calculated for a candidate. In this presentation, we draw on the results of assessments carried out in September 2016 and June 2017. The sample included matched results for 28,443 students. From these results, we will explore the following research questions: On average, what progress do Year 7 students make?; What proportion on Year 7 students do not make progress?; What proportion of schools have pupils making overall progress?; and Is there a relationship between progress in maths and progress in English at the individual and school level?

Key words: *assessment; comparative judgement; progress; Year 7*
Session type: *Research paper*
Duration: *30 minutes*



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Structure resource system, articulation between dynamic and static aspect

An integration of the resources of Sésamath took place in the mathematical workshop of an Algerian college. The resources were used in their original language. Experimentation has been extended for use in Algerian institutional classes after adaptation and translation into Arabic. I am approaching the teacher's resource system based on concepts already present in the documentary approach (Gueudet & Trouche, 2009). I consider static and dynamic aspects and propose a model of articulation between this system and the components of the schemes (Vergnaud, 1991). I present analysis based on data collected according to the reflexive investigation methodology (Gueudet & Trouche 2009). I consider in particular the schematic representation of Nadine's resource system, which is both the object of analysis of the 'adaptation-translation' scheme and the implementation of Sésamath resource. I consider two aspects: a static analysis which consists in defining the constitutive elements of the system, their relations, and dynamic aspect marked by action rules that affect the components.

Key words: *documentary approach; resource system; schema; middle school mathematics*
Session type: *Research paper*
Duration: *30 minutes*

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Middle school students' errors in two-dimensional representations of Polycubical shapes

The present study as a part of a design-based research has focussed on the seventh grade students' understanding of two types of polycubical shape problems. The first type of the problems asked students to draw two-dimensional representations (the orthogonal views from the front, left, right and top) of given three-dimensional representations. In the second type, students were asked to construct poly-cubical shapes and then represent them isometrically in a two-dimensional environment where corresponding views from the front, left, right and top were provided. The current study found various types of common errors of students specifically for the first and second type of problems. Redrawing the 3D shape or a part of it, drawing the part only at the very front, swapping the left and right views, drawing the view upside down and drawing squares at the back to another row/diagonally can be listed as the most common errors for the first type; and drawing only one of the views as 3D (mostly the front view), swapping the left and right views, not using the isometric paper properly and drawing a 2D shape or combining the given views as 2D and 3D are found to be the most common errors for the second type. The next iteration of this research will be focussing on designing lessons to overcome the seventh grade students' errors above-mentioned errors.

Key words: *assessment; middle school students' errors; 2D representations of 3D shapes; 12- to 13-years old*
Session type: *Research paper*
Duration: *30 minutes*



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Bringing theory and practice together to develop a mathematics-specific observation tool for use with mathematics trainee teachers

This presentation provides insight into the development of a mathematics-specific observation tool to use with trainee teachers. The tool was developed in partnership with school-based mentors in order to support a PGCE course development focus on: what knowledge mathematics teachers need to be effective mathematics teachers, using for example Ball et al.'s (2008) categories of specialised and horizon content knowledge; Brousseau's notion of didactics (see, for example, Brousseau, 2013) as a route into thinking about how to structure mathematical knowledge and plan and design lessons. Use of the tool initially enabled university tutors to have post-lesson discussions that: had a greater focus on the mathematical structure of lessons; enabled them to support beginning teachers to understand how the choices they make about the narrative of the mathematics in a lesson, and the mathematical decisions they make in lessons, affect their teaching and pupils' learning. The observation tool was published as a case study to support the ACME report: Professional learning for all teachers of mathematics (ACME, 2016). Since its introduction, the tool has been used in a range of ways, resulting in: mathematics-focused observations and post-lesson discussions becoming more common-place in partnership schools; beginning teachers using the tool themselves to observe experienced teachers; beginning teachers using the tool to analyse video footage of their own lessons.

Key words: *teacher training; observational tools*
Session type: *Research paper*
Duration: *30 minutes*

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Passionate about patterns: A space for inclusion of children with autism?

This session presents preliminary case study research that examines what a nursery child with autism spectrum disorder learned when included in a pattern project designed for children in mainstream nurseries. This presentation considers the growth the child made in pattern recognition, number knowledge, and communication skills during the course of his participation in this project. It also considers the way in which the pattern instruction was adapted to meet the child's needs. The discussion will investigate the different forms of inclusion, and the role of inclusion in supporting children's academic and social skills.

Key words: *patterns; Autism; inclusion; Early Years Foundation Stage (EYFS)*
Session type: *Research paper*
Duration: *30 minutes*

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Design for teaching and learning that supports answering GCSE Mathematics questions - the case against "Hey Diddle Diddle"

There is an increase in questions that probe students' reasoning in the latest design of the curriculum. As part of ongoing design research that seeks to support teaching and learning towards answering such questions, this seminar will focus on didactical and pedagogical aspects of classroom tasks. Analysis of the new genre of GCSE



questions that demand students engage in chains of reasoning provides evidence of the need for students to have knowledge of key ideas, fluency with basic procedures but most importantly relational understanding of important mathematical concepts. Focusing on the particular context of basic statistical measures and representations we will highlight how procedural understanding embodied in rhymes such as “Hey diddle diddle, the median’s the middle” is almost certainly unlikely to provide students with the necessary grounding for success at GCSE - let alone statistical competence to make sense of the world in which we live. We will draw on materials from the “Improving learning in mathematics” resources, often referred to as the “Standards Unit Box”, to consider how these can be used to support students in developing the relational understanding that is necessary when answering the new genre of question.

Key words: *GCSE Mathematics; statistics*
Session type: *Research workshop*
Duration: *30 minutes*

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Providing effective intervention for supporting children with Mathematics Learning Difficulties (MLD): The findings from six case studies

Interest in Mathematics Learning Difficulties (MLD) has increased rapidly. However, studies about how to support learners to overcome MLD are still limited. Thus, my PhD focused on finding effective strategies that assist learners with MLD or both MLD and Reading Difficulties (RD) in mathematics learning. This qualitative study involved case studies of six Grade 5 (ages 9 to 10) boys attending Church schools in Malta; three with MLD and three with both MLD and RD. Each participant attended 20 intervention sessions using *Catch Up Numeracy*. Sessions were audio recorded and transcribed. The data collected was analysed manually using predetermined themes but also open to other emerging themes. I specifically looked at the learners’ internalization process, since Vygotsky’s (1896-1934) theories underpinned the study, to identify which strategies seemed to be most effective in supporting this process. The data analysis will be presented. My findings indicated that there are three types of effective strategies – More Knowledgeable Other (MKO)–driven strategies, tools-driven ones and learner-driven strategies. A model was developed to show the symbiotic relationship between these effective types of strategies. The model demonstrates how these strategies are interrelated and facilitate the internalization process. This model will also be shared and discussed.

Key words: *mathematics learning difficulties; intervention; internalisation; framework for analysis*
Session type: *Research paper*
Duration: *60 minutes*