



#BSRLMNov15

**BSRLM Conference Abstracts
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Reflections on a legitimate peripheral participation activity in a community of practice and implications for secondary mathematics teacher education

This study describes a legitimate peripheral participation (LPP) activity designed for prospective mathematics teachers and discuss the reflections of both mathematics teachers and prospective mathematics teachers on this activity. As part of the LPP activity, a total of fifteen prospective teachers (in two groups) in Turkey prepared and gave two seminars for experienced mathematics teachers in two partnership schools. First part of each seminar focused on computer assisted mathematics teaching and consisted of examples of teaching ideas using Geogebra and Cabri Geometry. In the second part, experienced teachers reflected on the seminars. Data collection tools are observation, focused group interviews and semi-structured interviews. Seminars were video-recorded and prospective teachers were interviewed as a group just after the seminars. They were also interviewed three months after the seminar and reflected on their computer assisted teaching practices in schools. Data were analysed using content analysis via Atlas.ti software. Findings will be discussed with regard to issues raised by experienced mathematics teachers, prospective teachers' reflections on these issues and their own teaching.

Age range: *Teacher education*
Key words: *communities of practice; legitimate peripheral participation; prospective mathematics teachers; computer assisted teaching*
Session type: *Research papers*
Duration: *30 minutes*

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A case study of a prospective upper secondary mathematics teacher's professional identity: Who does he want to be? What does he do in practice?

The aim of this study is to explore a prospective mathematics teacher's professional identity and how it reveals itself in school context. Data was collected in the last year of a teacher preparation program during field experience courses in a state university in Istanbul, Turkey. Data collection instruments are reflective writings, interviews (both semi-structured and unstructured) and observation. The prospective teacher's reflective writing about 'what kind of a mathematics teacher he wants to become' is analysed through content analysis. Among the emerged themes, three of them were specified for a further analysis: 'I want to use technology during my teaching', 'I want to use daily life examples of mathematics' and 'I want to have a strong content knowledge'. These three aspects of our prospective teacher's professional identity are explored in school context using descriptive analysis of data from interviews and observations. Findings will be discussed with regard to how our prospective teacher used technology and daily life examples during his teaching.



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Age range: *Teacher education*
Key words: *prospective mathematics teachers; professional identity; field experience*
Session type: *Research papers*
Duration: *30 minutes*

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Bangladeshi rural secondary school girls' participation in higher mathematics optional course: What are the influences?

Earlier research has shown that women are still underrepresented in Science, Technology, Engineering and Mathematics (STEM) field compared to men in many countries, including those from the European Union (European Commission, 2006) and the United States (National Science Foundation, 2009), but its causes remain debated (Halpern et al., 2007). The negative effect of gender stereotypes relating to women's perceived lower ability in domains, such as mathematics and reasoning considered to be the one possible explanation for this underrepresentation (Davies et al., 2002). This paper reports on a pilot study based on three Focus Group Discussions (FGDs) with 30 Grade 10 girls of three rural secondary schools in Bangladesh. The thematic analysis of FGD data explores that girls' attitudes towards mathematics, perceived usefulness of mathematics, school experiences and parents' socio-economic status have greater influence on their choice of studying 'higher mathematics' as an optional subject.

Age range: *Secondary education*
Key words: *Bangladesh; Focus Group Discussions (FGDs); girls; higher mathematics; influences; pilot study; rural secondary school; STEM*
Session type: *Research papers*
Duration: *30 minutes*

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Possible parallels between visual representations and informal knowledge

An experienced mathematics teacher in the UK developed a sequence of three lessons about fractions for a low-attaining set in Year 7, drawing on visual representations. The lessons were designed by the teacher based on suggestions made by a group of researchers that have been observing lessons in the school for six months. The goal of these lessons was to enhance low-achieving students' understanding of fractions by exploring the educational potential of visual representations. In this seminar, I will present part of the data collected from the students during and after these three lessons and some ideas that emerged from the initial analysis of this data. I will argue that visual representations served as a basis for students to develop their understanding and to extend their knowledge, similar to what was observed by Mack (2001) regarding informal knowledge. Also, I will present my plans for data collection and analysis and would be very grateful for feedback.

Age range: *Secondary education*
Key words: *visual representations; fractions; low-achieving*
Session type: *Research papers*
Duration: *30 minutes*



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Creating the conditions for children in Year 6 to persevere in mathematical reasoning

This presentation reports on the initial findings from a small-scale intervention that explored perseverance in mathematical reasoning in children aged 10-11. The study took place in two Year 6 classes in different schools. In each school, four children, selected by the class teacher based on their limited capacity to persevere in mathematical reasoning, formed the study group. The initial intervention provided children with representations that could be used in a provisional way. The findings suggest that this created affectively enabling conditions that facilitated the children to make mathematical trials and spot patterns. However, the initial intervention did not result in the study group forming generalisations. The intervention was subsequently augmented to include specific opportunities in the activity to generalise and to form convincing mathematical arguments. This seemed to enable the study group to persevere in their mathematical reasoning, from making trials and forming and testing conjectures to forming generalisations and explanations of why they were true. The children also reported a sense of pride and satisfaction in their understanding. A tentative framework describing this interaction is proposed.

Age range: *n/a*
Key words: *perseverance; mathematical reasoning; affect; cognition; representation*
Session type: *Research papers*
Duration: *30 minutes*

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Can multiplicative reasoning and arithmetic help children understand fractions?

The aim of this study is to investigate the basis of reasoning about fractions in children, before they are taught systematically about fractions in school. We assess two different abilities, reasoning and arithmetic, as predictors of children's learning of fractions. Reasoning focuses on mathematical relations, for example knowing that if a cake is shared in equal parts between three children, then each one gets $\frac{1}{3}$ (Hallett, Nunes, & Bryant, 2010; Hecht, Close, & Santisi, 2003). Arithmetic involves procedures and rules, such as carrying out multiplication and division. We report the results of the first data collection of a longitudinal study. In total 124 9-year old children participated who were at the end of Year 4, when they start to receive formal instruction on fractions. They completed a reasoning task, an arithmetic task and a non-verbal intelligence test. Results from factor analyses confirm these two abilities should be treated as different skills, while analyses of covariance between schools suggest a school effect on children's arithmetic scores.

Age range: *Primary education*
Key words: *fractions; reasoning; arithmetic*
Session type: *Research papers*
Duration: *30 minutes*



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Measuring the impact of teaching interventions using comparative judgement

Although there is a demand for randomised controlled trial (RCT) studies in mathematics education, these are still rather rare. One potential reason for this is that teaching intervention studies often aim to improve students' conceptual understanding of a mathematical topic, and that this type of knowledge (as opposed to procedural knowledge) is notoriously tricky to measure adequately. Researchers require valid and reliable instruments for each topic of interest, and these can take years to design and validate. What if there was a quick and effective method of measuring any concept of interest? Here we report the results of an RCT study comparing the impact of two teaching interventions introducing early algebra to Year 5 pupils. Importantly, we used a method known as comparative judgement (CJ) alongside a traditional instrument to measure the impact of the teaching intervention on pupils' conceptual understanding of the use of letters in algebra. Results showed that the CJ method performed slightly better than the traditional instrument and was sensitive enough to detect a significant effect of teaching intervention on pupil's conceptual understanding.

Age range: *Primary education*
Key words: *outcome measures; teaching interventions; randomised controlled trials*
Session type: *Research papers*
Duration: *30 minutes*

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Opportunity to learn secondary mathematics: A curriculum approach with TIMSS 2011 data

Previous studies have shown that socio-economic status (SES) and 'opportunity to learn' (OTL), which can be typified as 'curriculum content covered', are significant predictors of students' mathematics achievement. Seeing OTL as curriculum variable, this paper explores multilevel models (students in classrooms in countries) and appropriate classroom (teacher) level variables to examine SES and OTL in relation to mathematics achievement in the 2011 Trends in International Mathematics and Science Study (TIMSS 2011). Results suggest that the combination of SES and OTL explains a considerable amount of variance at the classroom and country level, but that this is not caused by country level OTL.

Age range: *Secondary education*
Key words: *TIMSS 2011; opportunity to learn; socio-economic status; large-scale assessment*
Session type: *Research papers*
Duration: *30 minutes*



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Teaching primary school children about probability

To learn about probability, we need to know about randomness, the importance of the sample space, and the proportional nature of calculations about probability. Most studies of teaching children about probability tackle just one of these three aspects of probability. We shall describe a new 15-session Probability teaching programme which covers all three aspects. In each session, small groups of children work in pairs on problems about one of the three aspects of probability: these problems involve familiar material (e.g. TV programmes and popular songs) and familiar contexts (e.g. shuffling cards). Each session ends with a discussion between the different pairs on their solutions to the problems. The effectiveness of this programme was tested in an intervention study in which we randomly assigned 75 children in their last year in primary school to one of three groups: a Probability group given the Probability programme, an Active Control group taught about directed numbers, and a business-as-usual Control group given no intervention programme. The three groups were at roughly the same level in a pre-test evaluation of their understanding of probability, but the Probability group outstripped the other two groups in equivalent post-tests given to them after the teaching programmes were over.

Age range: *Primary education*
Key words: *probability; randomness; sample space; proportional reasoning*
Session type: *Research papers*
Duration: *30 minutes*

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BSRLM and BERA: Maximising the opportunities for our affiliation

The BSRLM affiliation with BERA, through which the BERA special interest group (SIG) 'Mathematics in education' is convened, brings with it the opportunity to share research and project outcomes that are regularly seen at BSRLM day conferences with the wider education community. Although ensuring the mathematics education community's presence at the annual BERA conference is an important part of this affiliation, the BERA SIG also has a small budget with which to organise other activities, events and publications. This Working Group is convened to explore how BSRLM might strengthen its affiliation with BERA through future activities, publications and events.

Age range: *n/a*
Key words: *research impact; research-informed practice*
Session type: *Working groups*
Duration: *30 minutes*



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Facilitating the professional learning of teachers of mathematics through a video club

This session will detail findings, related to the role of the facilitator, from an ESRC-funded project to promote the use of 'video clubs' for the professional development of teachers of mathematics. In the first iteration of the club, seven teachers met on six occasions, over a three-month period, and shared video recordings of their own classrooms, all meetings were themselves recorded. While it is a common finding that discussion norms can be hard to establish, the way of working adopted in the club meant participants adapted to intended norms from the first meeting. Audio recordings of meetings were analysed, within the enactivist methodology of the project. Implications for working with video are drawn out, in particular, how discussion norms can be established and the importance of shifting levels of generality in discussion.

Age range: *Teacher education*
Key words: *video; facilitating teacher learning*
Session type: *Research papers*
Duration: *30 minutes*

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The functionality of digital technology in formative assessment

Digital technology is often utilized for the purposes of conceptual development, diagnostic assessment or summative assessment in mathematics. Less often is the role of technology considered in formative assessment, although this is a process shown to have a positive impact on learning. In this session, we present some interim findings for discussion from our research for the EU FASMed (Improving Progress through Formative Assessment in Science and Mathematics Education) project showing how different uses of iPads in lessons can either benefit or obstruct formative assessment processes. Based on the emerging themes from our research we introduce an initial categorization of the functions of digital technology within different forms of formative assessment, illustrated by examples from the research. This shows how the functionality of the technology can be related to key opportunities for formative assessment within lesson planning and implementation such as pre-lesson work, whole class discussion, collaborative work and the evaluation of sample student work, thereby opening up possible new avenues for teachers in assessment for learning.

Age range: *Secondary education*
Key words: *formative assessment, technology, pedagogy*
Session type: *Research papers*
Duration: *30 minutes*



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Teaching problem solving to primary teacher trainees

Problem solving is currently at the forefront of Mathematics Education. PISA results showed that pupils in Wales, had poor problem solving skills. There is a need for problem solving to be taught in our schools. It may be that teachers and teacher trainees need to be able to solve problems themselves in order to teach problem solving. This small case study is focussed on how problem solving can be taught to undergraduate teacher trainees and what impact it has on their own problem solving. A problem solving course was designed and evaluated. Problem solving skills were analysed, by pre- and post-investigations, using Schoenfeld's (1995) timeline. The study also explored the use of Video Stimulated Reflective Dialogue (VSRD) on the teacher trainees' metacognition. Problem solving can be taught subject to certain factors e.g. knowledge of heuristics, subject knowledge. The teacher trainees were motivated and enthusiastic in the sessions. Their problem solving skills changed from a more novice like approach to a more expert like approach with respect Schoenfeld's (1995) timelines. Schoenfeld's timelines were useful in small group situations but it depended on whether the students worked co-operatively or collaboratively. The use of VSRD was found to be useful in exploring the teacher trainees' metacognition.

Age range: *Teacher education*
Key words: *problem solving; teacher trainees; Schoenfeld; Video Stimulated Reflective Dialogue (VSRD)*
Session type: *Research papers*
Duration: *30 minutes*

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Maths Hub, mastery and messy research

Maths Hubs, funded by government and coordinated by the National Centre for Excellence in Teaching Mathematics (NCETM), were set up in England 2014. Their aim is "harnessing all maths leadership and expertise within an area, to develop and spread excellent practice, for the benefit of all pupils and students" (www.mathshubs.org.uk). Part of the remit of the Hubs is to support local 'work groups': activities initiated by practitioners. Work groups can take a variety of forms, including curriculum development, CPD, practitioner research. This paper reports on the response to this opportunity taken by a team at one university working with one of the North West Maths Hubs. Two primary teachers working in university partnership schools undertook short classroom based research projects around themes of teaching for conceptual understanding, and use of concrete apparatus. The teachers were supported by two university ITE tutors with interests in teaching for 'mastery' and in teachers' professional development. There were interesting outcomes to this study beyond the impact on children's learning. The teachers reported developments in their own thinking and practice. Also, the community of practice within the university primary mathematics partnership has been enriched through a focus on active practitioner research.

Age range: *Primary education and teacher education*
Key words: *mastery; conceptual understanding; practitioner research*
Session type: *Research papers*



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Duration: 60 minutes

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The importance of subject knowledge for mathematics teaching: An analysis of feedback from Subject Knowledge Enhancement courses

Over the last ten years, Subject Knowledge Enhancement (SKE) programmes have become an established part of the Initial Teacher Education (ITE) landscape in England, providing the opportunity for those who do not have sufficient degree level mathematics for direct entry to Post Graduate ITE programmes the opportunity to develop their mathematics knowledge prior to undertaking teacher preparation. More recently, SKE programmes have become more diverse in terms of mode of delivery with a growth in popularity of on-line provision. This session will present an analysis of feedback and evaluations from students on face-to-face mathematics SKE programmes at several institutions through consideration of Ball et al.'s (2008) domains of mathematical knowledge for teaching. Evaluations are also considered in terms of the outcomes and benefits, both intended and unintentional, of these programmes.

Age range: *Teacher education*

Key words: *initial teacher education; content knowledge; pedagogic knowledge*

Session type: *Research papers*

Duration: *30 minutes*

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Using the Singapore Bar method to support the interpretation and understanding of word problems in Key Stage 2

The research project was conducted in a large junior school where children, normally confident with calculation, experience difficulties with the interpretation of word problems. School assessments reveal a disparity in achievement in mathematics between girls and boys. The Singapore Bar method was chosen to provide a clear visual representation in order to support all children identifying the underlying structure of word problems. The research began with a pre-test for all children. Staff meetings and collaborative teaching sessions were held to introduce bar modelling and support the teachers. Data was gathered through pupil interviews, staff questionnaires and work scrutiny, as well as analysis of pre and post-test responses. In the post-test, a relatively small number of children chose to use it overall. Gender differences were evident. The areas in which it was most commonly used were problems involving fractions, 2-step money problems and division.

Age range: *Primary education*

Key words: *Singapore Bar; word problems; fractions; Key Stage 2*

Session type: *Research papers*

Duration: *30 minutes*



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Girls, mathematics and identity: Creative approaches to gaining a girls'-eye view

Despite the fact that issues around gender and mathematics have received much attention and gender gaps are generally diminishing over time, differences in mathematical self-efficacy, post-compulsory study and entry into mathematics-related careers persist. My doctoral research has sought to shed light on the formation of girls' mathematical identities through investigating how they characterise mathematics and mathematicians, the role of other people and what they recognise as mathematics in their daily lives. This session reports upon some of the qualitative tools used to gain children's perspectives including scrapbooking, digital photography, drawings, concept-mapping and relationship wheels, along with presenting some findings and implications for practice.

Age range: *Primary education*
Key words: *gender; mathematical identity; pupil perspectives; qualitative methodologies*
Session type: *Research papers*
Duration: *30 minutes*

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Opportunities for Critical Mathematics Education in a world rediscovering socialism

Mathematics can empower people by helping them understand political, social, and economic situations. Yet, while mathematics can be used for advocating change, it is predominantly used in maintaining the status quo. Critical Mathematics Education (CME) challenges this by identifying particular instances where mathematics is being used to maintain injustice, or where mathematics can be used to understand and act against injustice, and by creating alternatives through mathematics education. CME alternatives use mathematics as a means for people to understand their political, social, and economic situations. This involves supporting people to see how mathematics shapes society, so that they can imagine an alternative that can be realised through mathematics. The working group aims to promote research which brings about positive social change through mathematics education. It does this at a time when socialism in particular and the left more generally in Britain is fast gaining huge popular support galvanised by the election and politics of Jeremy Corbyn and an energised Labour Party. This is a time of opportunity for the left, and specifically for the left in mathematics education, to reengage explicitly with politics placing equity and social justice at the centre of a new Critical Mathematics Education movement. Join us.

Age range: *n/a*
Key words: *Critical Mathematics Education; social justice; action research*
Session type: *Working groups*
Duration: *60 minutes*



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Teaching children with mathematics difficulties

This paper focuses on the accounts of teachers in a longitudinal study of two children identified with specific mathematics difficulties from the same English primary school. We found troubling themes of practices in which children experienced suffering as well as encouragement and mathematical support. Alongside a 'pedagogy of compassion' (Boylan 2009), we identify a 'pedagogy of desensitivation', arising from the necessity to prioritise the reputation of the school over the needs of the children (Ball, Maguire, Braun & Hoskins, 2011). A complex educational context combines a regime of accountability with a policy of inclusion of children with mathematics difficulties in mainstream classes and enduring practices of 'ability' grouping and setting (Marks, 2011). We draw on a post-structuralist perspective, holding on to the ethic of not essentialising the teachers in the study as persons to blame. However, such a perspective can appear to disregard the practical concerns of parents and teachers, by framing mathematics difficulties as socially constructed. In this paper, we discuss the issues of combining post-structural insights with psychological understandings, which we argue are also needed when researching the teaching and learning of children with mathematics difficulties.

Age range: *Primary education*

Key words: *post-structuralist; teachers; children with mathematics difficulties*

Session type: *Research papers*

Duration: *30 minutes*

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Wider effects of introducing Further Mathematics

We report on four 15-month case studies of mathematics departments who have in the last few years embarked on teaching Further Mathematics A Level with the support of the Further Mathematics Support Programme. Data collection has been termly, from at least three teachers in each department, including the teacher in charge of Key Stage 5 and the Head of Department, and has employed group semi-structured interviews, observations of lessons related to changes identified, and individual follow-up interviews, with tools developed iteratively. The study asked what wider impact introduction has had on individuals, on pedagogy, and on structures.

Age range: *Secondary education*

Key words: *pedagogy; teacher identity; master discourse*

Session type: *Research papers*

Duration: *30 minutes*



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Tracking nursery children's counting

This study explores how children's competence in counting develops during the Nursery year in a state-funded primary school in central London where all of the children speak English as an additional language. For this doctoral research project, I have been tracking the developmental journey of seven individual children in the Nursery setting. I have carried out task-based interviews with the children over the year and have evaluated their counting skills and their ability to spot mistakes made by a puppet when counting in a real-life context. I have also observed the children counting in class and reviewed their class teacher's planning and assessment of counting to triangulate the data gathered in the task-based interviews. I interviewed the parents of the children involved at the beginning of the study to establish relevant contextual information. My data collection is now complete and in the presentation I will discuss the findings from the analysis of the data. I will focus on three contrasting case studies to illustrate the differences in children's development.

Age range: *Early years education*
Key words: *counting; EAL; nursery*
Session type: *Research papers*
Duration: *30 minutes*

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A secondary mathematics teacher changing her practice: An exploration of the reasons

Teacher development initiatives have the final goal of fostering students' learning. A possible way to achieve that is to encourage teachers to use different teaching strategies in their classrooms; in other words, to change their practices. Collaborative discussions are recognised as an effective approach to engaging teachers in professional learning. My research goal is to investigate what happens when teachers and researchers engage in a collaborative discussion focused on tasks to teach fractions to low-achieving students. My presentation will be based on what I have learned so far from the lesson observations and from an interview with the mathematics teacher. I noticed changes in her practices and argue that these are the result of her operating outside her comfort zone (Penteado & Skovsmose, 2009) without losing her capacity to control the lesson. During this academic year, I will build on this pilot study and hope to develop hypotheses about the features that may foster teacher change. I would be very grateful for feedback and suggestions.

Age range: *Secondary education*
Key words: *professional development; change; collaboration; comfort zone*
Session type: *Research papers*
Duration: *30 minutes*



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The use of podcasts to support teaching and learning in undergraduate mathematics programmes

This study examines the views and attitudes of undergraduate mathematics students whose lecturer had produced a series of podcasts which were made available online for the students to use as a learning resource to supplement their studies. The aim of the study was to ascertain the extent to which the students used these podcasts, and to examine their views about the effectiveness of the podcasts within the learning process. The research involved the use of questionnaires and focus group discussions with small groups of students.

Age range: *Higher education*
Key words: *podcasts; resources; teaching and learning; undergraduate*
Session type: *Research papers*
Duration: *30 minutes*

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Standardised effect sizes in education research: Useful or misleading?

In recent years there has been a growing tendency for educational researchers to present their results using standardised effect sizes, such as Cohen's d s. For instance, the Educational Endowment Foundation's Teaching and Learning Toolkit offers teachers a way of deciding how to change their practice based on lists of standardised effect sizes. Similarly, John Hattie's influential book "Visible Learning" ranks interventions according to their purported effect size. But is this practice helpful? Some suggest that standardising effect sizes can result in misleading conclusions. This session of the BSRLM Statistics Working Group will consist of four presentations and a discussion. Two presenters will argue for the increased use of standardised effect sizes in research communication, and two will highlight potential dangers in this approach. The session will conclude with a general discussion on the topic.

Age range: *n/a*
Key words: *effect size; quantitative methods; trials*
Session type: *Working groups*
Duration: *60 minutes*

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Mathematics teachers' perspectives on students' use of graphing calculators

The graphing calculator has been an important technological tool in mathematics classrooms since its invention and introduction in 1985. Investigating teachers' perspectives on how using graphing calculators affects student learning is important. I conducted a descriptive intrinsic case study for eleven mathematics teachers who taught a Functions, Statistics, and



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Trigonometry (FST) course developed by the University of Chicago School Mathematics Project (UCSMP). The aim of this study was to analyze mathematics teachers' perspectives specifically about the effects of using available graphing calculator technology on student learning. I found that teachers reported that their students in general were positive about graphing calculators. Teachers stated the positive effects of using graphing calculators on students' learning, such as talking more about the essence of the problems, better visualization, and deeper understanding. However, some teachers reported that meanings were missing because students did not interpret their answers when they used graphing calculators. Teachers in general reported that students' arithmetic skills were affected negatively because they had access to the graphing calculators. In addition, some teachers stated their students relied on the graphing calculators too much. Therefore, this study has substantial implications for mathematics teachers to consider when they use graphing calculators or similar technologies.

Age range: *Secondary education*
Key words: *technology use; student learning*
Session type: *Research papers*
Duration: *30 minutes*

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The impact of mathematics game based learning on children's higher order thinking skills

A short presentation on research carried out. The aim of the study was to explore how mathematics game based learning can be used in a small group setting to support children's development of higher order thinking skills. Based on this aim, the overarching research question was: in what ways can mathematics game-based learning support children's higher order thinking skills? Presentation followed by discussion and idea sharing on the following topics: What games based learning are you presently involved in? What are the games that you recommend for each age range to teach numeracy in primary school children? Participants will go away with new ideas of digital maths games to use in both school and home setting.

Age range: *Primary education*
Key words: *game-based learning; higher order thinking skills; problem solving*
Session type: *Research papers*
Duration: *30 minutes*

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A critical analysis of financial literacy in mathematics education in England

This paper analyses the way in which financial literacy has been framed in the context of mathematics education in England over the past 5 years. In particular, it examines the policy positions that were developed in government to support the integration of financial literacy into the national curriculum and the programme of study for mathematics in Key stages 3 and 4 (Years 7 to 11). The policy discourse will be analysed in the context of the great recession and the politics of austerity in England. Inspired by Slavoj Žižek, the paper will seek to identify aspects of economics which have been omitted from the dominant policy discourse in England



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around mathematics education and financial literacy and the ideological features which are implied by these omissions. Finally, an example of how double entry book-keeping, a financial concept central to capitalism, can potentially be used to teach financial literacy in the context of school mathematics, which also provides people with a mathematical insight into financial issues that are central to the public discourse on economic policy.

Age range: *Secondary education*
Key words: *financial literacy; Critical Mathematics Education*
Session type: *Research papers*
Duration: *30 minutes*

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A look at two algebra tasks involving sequential data, that seem to prompt a recursive rather than functional approach to the underlying linear relation

In this session, I want to discuss, and show extracts from, an interview with a group of three Year 8 pupils undertaken by myself and their teacher as part of the design research work of the ICCAMS project. The interview involved two tasks in which pairs of values connected by a linear relationship were presented sequentially, either in a table or as coordinate points on a Cartesian grid. The pupils were asked to make near and far generalisations, which they tended to do by working recursively, either in a step-by-step manner or by chunking. From the interviewers' point of view, the recursive and functional perspectives are intimately linked, and on occasions during the interview it was easy to believe that this was true for the pupils too. However, a closer examination of the interview suggests that for these pupils at least, the connection is tenuous. I hope to touch on this and other implications for teaching that emerged from the interview, as well as on how the interview informed the design of the ICCAMS lesson materials.

Age range: *Secondary education*
Key words: *algebra; generalising; rule; relation; function*
Session type: *Research papers*
Duration: *60 minutes*

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Communicating mathematically on the web: What difference does handwriting recognition software make?

In this study, a group of four upper secondary mathematics students collaborated mathematically on the Web, as part of a larger study. The students completed two mathematical tasks. They were equipped with MathPen – a handwriting recognition software – for the first task, which was subsequently removed for the second task. The students' online activities were video recorded using screencast recording, which also included an audio recording to capture vocalised thoughts and expressions of emotions. When we compared the students' learning experiences between the two tasks, we observed that when the students were equipped with MathPen, they were able to communicate mathematically and made progress in their algebraic discussion. When MathPen was removed, the same students had difficulties with algebraic manipulations. This seems to indicate that mathematical formats not



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only impact on mathematical communications to others but also have a role in facilitating algebraic thinking.

Age range: *Secondary education*
Key words: *mathematical communication; online education*
Session type: *Research papers*
Duration: *30 minutes*

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Exploring young children's reasoning and naming of fractions

This study investigates the effects of a teaching intervention on children's reasoning and naming of fractions in Quotient, Part-whole and Operator situations. A Pre-test, Intervention and Post-test design was used with 37 six- to seven-year-olds from state-supported primary schools in Braga, Portugal. The children had not been taught about fractions in school. Reasoning and labeling questions were presented in the three situations in the Pre- and Post-test. During teaching, each intervention group learned about fractions in only one of the three situation. Children who were taught in the Quotient situation made significant progress in the reasoning and naming fractions, but did not transfer this learning to the other situations. Children taught in the Part-whole or in the Operator situations only learned how to label fractions; they showed no progress on reasoning items. However, they used the labels in both Part-whole and Operator items. Thus quotient situations led to better understanding of equivalence and order of fractions, but their learning was situated. Educational implications of these findings are discussed.

Age range: *Primary education*
Key words: *learning fractions; part-whole, quotient and operator situations*
Session type: *Research papers*
Duration: *30 minutes*

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In pursuit of an orientation for life preparation: A case study of the subject mathematical literacy in South Africa

In this presentation, I will present an initial attempt to theorise the structure of knowledge associated with practices that engage both contextual and mathematical elements in pursuit of preparation for enhanced functioning in life. The secondary school subject Mathematical Literacy in South Africa will be used as a specific site of analysis to illustrate this theorising. I will characterise this 'life-preparedness orientation' as dominated by an agenda for sense-making in contextual scenarios that bear a high degree of resemblance to authentic practice. I will argue further that this orientation comprises practices that engage knowledge from four domains, comprising everyday knowledge, mathematical competency, modelling, and criticality borne of reasoning and reflection. The theorised components of the life-preparedness orientation will be illustrated in relation to an empirical textual task. Commentary and suggestions will be invited from the audience to advance this preliminary theorising.

Age range: *Secondary education*



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Key words: *mathematical literacy; mathematics and context; preparation for life*
Session type: *Research papers*
Duration: *60 minutes*

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The use of diagrams to promote additive reasoning in primary school

The question of how problem solvers represent information about a problem in a way that helps them to find a solution is central to understanding mathematical learning. This paper focuses on diagrams, i.e. external iconic representations that are structural or functional analogs of what they represent. In mathematics education, diagrams are hypothesized to function as tools for thinking and to facilitate teacher-pupil communication, thereby advancing learning. A short-term intervention was implemented in a randomized control study with 5th Graders to assess the effectiveness of diagrams in advancing problem solving. Three groups received instruction in problem solving, two with the support of diagrams and one without diagrams. In the three groups, the researcher promoted learning by asking pupils to explain their reasoning and by posing probing questions. A control group did not receive any intervention. Diagrams facilitated teacher-pupil communication as indicated by dialogues. At post-test, the taught groups outperformed the control group in a problem solving measure that contained problems of the same type as those used in the intervention, irrespectively of the use of diagrams during teaching. Thus, this short-term intervention did not provide support for increased success in problem solving when diagrams are used in teaching.

Age range: *Primary education*
Key words: *problem solving; diagrams; Singapore Model method*
Session type: *Research papers*
Duration: *30 minutes*

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Interpreting and constructing lesson observation data of primary mathematics teacher trainees

I am researching the discussions that primary mathematics specialist trainees have about the teaching and learning of mathematics, with their school based training mentors in their PGCE year. I see developing greater awareness of these conversations as being important with the move towards PGCE courses which are predominantly school based. I am currently studying lesson observation documents, written by school based mentors and university based tutors, as they observe primary mathematics specialist trainees teach. My findings indicate that greater attention is given to the running of a lesson than the mathematical content of the lesson. Given that lesson observations, and subsequent feedback sessions, provide an opportunity for mentors and trainees to discuss the teaching and learning of mathematics, the written documents suggest that talk about mathematical content may be limited. In this session, I would like to invite participants to look at a range of lesson observation documents and consider how what is recorded might be re-shaped in order to give a greater focus on the mathematical content of the lesson.

Age range: *Primary education and teacher education*



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Key words: *teacher training, primary mathematics specialism*
Session type: *Research papers*
Duration: *30 minutes*

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Playing the levelling field: Managing mathematics assessment in English primary schools

A considerable amount of research has focused on the use of assessment to raise pupil outcomes in mathematics (e.g. Hogden & Wiliam, 2006), the way teaching practices construct assessment outcomes (e.g. Bradbury, 2012; Cooper & Dunne, 2000) and the notion of ‘ability’ and its effect on pupils (e.g. Marks, 2014). Whilst important, policy and practice in assessment also play a major part in teachers’ own professional lives. In this paper, I make a contribution to our understanding of this effect by reporting on a small-scale empirical study. Instead of focusing on pupils’ learning, it examines how assessment practices are used by teachers in managing their own professional work; that is, the way in which practices have an effect on teachers themselves as professional actors. I use Bourdieu’s (1986, 1998) theoretical framework: capitals acquired through habitus within a field, as well as the concept of *illusio* to explain teachers’ own investment in these practices. In particular, I examine how the generation and use of data which commodifies pupils’ learning is used by teachers for a range of professional purposes, often in tension with each other. These, I argue, have important consequences for pupils’ mathematics schooling.

Age range: *Primary education*
Key words: *assessment; professional lives; marketisation; Bourdieu*
Session type: *Research papers*
Duration: *30 minutes*

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Using the history of mathematics in education

In contrast to the 2007 secondary curriculum, the new English mathematics curriculum alludes only to Roman Numerals in primary. Despite the words: ‘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.’ in the Purpose of Study section there is no further mention of historical or cultural roots of mathematics in the aims, or in the programmes of study. The increased expectations for lower and middle attainers, challenges teachers to make more mathematics accessible and memorable to more learners. The history of mathematics can provide an engaging way to do this. There are also opportunities in post-16 mathematics. 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, in August 2016. Do come and work with us towards this exciting collaboration.

Age range: *Secondary education*
Key words: *history of mathematics; curriculum*
Session type: *Working groups*



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Duration: 60 minutes

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Evaluating mathematical thinking: Developing a framework for students "deep" understanding in Key Stage 5 mathematics

The Cambridge Mathematics Education Project (CMEP) develops web-based resources that support the teaching and learning of post-16 mathematics at school. CMEP aims to promote dialogue in post-16 mathematics classrooms and a more connected view of mathematics. CMEP provides rich, open-middled, or open-ended tasks, which encourage students to generate their own examples, to move between algebraic and graphical representations, and to evaluate mathematical statements. Additionally, the Project offers teacher support to promote classroom activity that is centred on student thinking. CMEP's Evaluation Team aims to evaluate the success of CMEP resources in encouraging all students to understand mathematics for themselves. One aspect of this involves developing a research framework to investigate the types of environments and experiences that arise during implementation of CMEP resources in KS5 mathematics classrooms. While recognizing the centrality of teachers in the implementation of CMEP resources, our challenge is not to make pedagogy the primary focus of research, but rather to develop a framework that will support the investigation of contexts that serve to enable and promote mathematical thinking. The aim of this session is to present the framework-in-progress and engage in dialogue of how it can be improved for further use in research.

Age range: Secondary education

Key words: mathematical thinking; evaluation; curriculum; Key Stage 5, enabling environments

Session type: Research papers

Duration: 30 minutes

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An analysis of the inherent difficulties with mathematical induction

Although proof by mathematical induction (MI) is one of the important methods of mathematical proof, gaps exist in current mathematics education research. Few studies on MI have been reported in mathematics education, and these existing studies have not given enough explanation as to why MI is difficult for many prospective teachers to understand. This study provides an analysis of the inherent difficulties with mathematical induction that are experienced by prospective mathematics teachers in secondary schools. We take the notion of "mathematical theorem" proposed by an Italian research group (e.g. Mariotti et al., 1997) as a theoretical framework, and use it to describe in more detail the inherent difficulties with MI from this standpoint. Data are collected by a set of questions based on Stylianides, Stylianides and Phillippou (2008) with additional input from the "mathematical theorem" perspective. The results suggest that the difficulties are concerned with students' understanding of logical relations which we call "sub-theorem" or "meta-theorem".

Age range: Higher education

Key words: mathematical induction; mathematical theorem; prospective mathematics



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

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Teacher practices for promoting cognitive engagement in low and high achieving secondary mathematics classrooms

With persistent concerns about student engagement, interest and participation in mathematics, this presentation reports on the beliefs and practices of teachers with classes of engaged and motivated students. Particular interest is directed towards the promotion of student cognitive engagement and self-regulation for thinking deeply and broadly about mathematics learning. Using a case study approach, questionnaires, lesson observations and interview data were collected from four teachers with low and high achieving Year 7 mathematics classes. The aim of the study was to investigate the beliefs of teachers effective at promoting engagement and how they differentiated their practices to engage students with varying levels of achievement. Nine categories of teacher practices were found. This presentation reports on the practices promoting cognitive engagement including: task value, content goals, strategy use and self-regulation, student autonomy, monitoring and feedback

Age range: *Secondary education*
Key words: *cognitive engagement; self-regulation; early secondary; mathematics*
Session type: *Research papers*
Duration: *30 minutes*

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Teaching A-level in Early Career

Teachers in England typically begin their substantive posts having had very little experience of teaching A Level because their initial training is focused on 11-16 year olds. This project investigates the question 'How, and with what effect, are early career teachers inducted into teaching A-level mathematics?' We are conducting five longitudinal case studies where participants from different ITE routes taught A-level either during their training year or immediately after. In the first year data has been collected from lesson observations and interviews with teachers and department heads. Early analysis suggests that A-level teaching in early career is viewed as a welcome contrast, offering relief through its change of work conditions, but also as a concentrated microcosm that allows insights into the complexities of teaching and learning. Development within A-level teaching has mathematical and managerial aspects; only one participant reported their development as led by professional interactions with mentors or co-teachers based on mathematics pedagogy.

Age range: *Secondary education*
Key words: *A-level; teacher education*
Session type: *Research papers*
Duration: *30 minutes*



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Issues of contingency in teaching for 'mastery'

Inspired by the 2015 special issue of Research in Mathematics Education – 'Mathematics teaching: Tales of the unexpected' – this paper relates ideas about contingency to the demands on primary school teachers in England to deliver a new 'mastery' National Curriculum. Drawing on an observation of and interview with one newly qualified teacher, Mandy, this paper explores how her ability to enact a 'mastery approach' is stifled by both her commitment to the established school routine for lesson planning and her lack of experience. Unexpected events from her lesson are described and related to the concept of contingency as outlined in the special issue and the question is asked: is a well-rehearsed response repertoire necessary for teaching for 'mastery'?

Age range: *Primary education*
Key words: *English primary National Curriculum; mastery; contingency*
Session type: *Research papers*
Duration: *30 minutes*

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Formatively assess Key Stage 2 students' conceptual understanding of multiplication visually, symbolically and contextually

Conceptual understanding is defined by Kilpatrick, Swafford and Findell (2001) as one's ability to "represent mathematical situations in different ways" and the degree of students' conceptual understanding can thus be measured by examining "the richness and extent of the connections [between representations] they have made" (p. 119). More recently, England's recently revised primary mathematics curriculum (Department for Education, 2013) also emphasises the importance of multi-representational thinking for mathematics learning by stating that: "Mathematics is an interconnected subject in which pupils need to be able to move fluently between representations of mathematical ideas" (p. 3). In this presentation, I will be presenting my experience in developing a formative assessment tool to explore children's conceptual understanding of multiplication. The tool is consisted of three scales: the Visual Representation (VR) scale, the Symbolic Representation (SR) scale, and the Contextual Representation (CR) scale. Together, they form the Overall Representation (OR) scale that, I would argue, can be used to measure mathematics learners' conceptual understanding more accurately. The data were collected from 52 Year 4 children at a primary school in Berkshire. Feedback will be gratefully received. (This is part of a larger study, which sets out to explore the effectiveness of getting children to create their own picture book to help develop their conceptual understanding of multiplication and division)

Age range: *Primary education*
Key words: *conceptual understanding; formative assessment; multi-representational thinking; visualization; multiplication*
Session type: *Research papers*
Duration: *30 minutes*



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To chunk or not to chunk: Learning division - the 'why' before the 'how'

In this small-scale study, I focus particularly on the mathematical area of division (particularly the chunking and standard algorithms). This is part of a larger research project which is exploring the changes in the curriculum over the last 30 years. The research then continues by looking at the triangulation of support between child, parent and teacher. This research takes place in a larger than average-sized state funded primary school in the south-west of England where the percentage of free school meals is lower than the national average. For one group of 17 low achieving primary students, having been taught chunking for a day and getting confused, the standard method for short division was taught successfully. When given free choice of method, six months later, the standard was chosen by every child and they got the questions correct. Nine more able students were taught chunking successfully but not taught the standard method. Six months later, given a free choice of method, they were still using chunking successfully. One student was able to do the standard method and commented that they found it easier with fewer mistakes to be made. With the focus on fluency and mastery, I am interested in whether there is a need for pupils to learn 'why' before 'how' (conceptual or procedural) or vice versa.

Age range: *Primary education*
Key words: *division; procedural; conceptual; mastery; fluency*
Session type: *Research papers*
Duration: *30 minutes*

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Analysis of classroom discourse from a Bakhtinian perspective: A case of digital incorporation technology in a pre-calculus lesson in a private school in Mexico

A high school in Mexico served as a scenario for incorporating and exploring the use of Texas Instruments graphic calculators and personal mobile devices in a Pre-Calculus classroom. This research project takes an instrumental genesis and a social semiotic perspectives in order to investigate the types of instrumental orchestrations performed and to characterise the kinds of instruments developed across the lessons. The purpose of this 60-min session has a methodological focus and presents some of the results already obtained in terms of the different instrumental orchestrations identify along the first stage of the fieldwork. During the second part of the session, I attempt to verify the analysis carried on over a selection of excerpts from the classroom discourse from which I am hoping to get some feedback from the audience. This analytical procedure, drawn from a social semiotic approach, is focused on determining linguistic aspects such as dialogicality, heteroglossia and voicedness, which are concepts taken from a Bakhtinian perspective in order to characterise the instrumental geneses developed when language is considered as a psychological and cultural tool orchestrated for learning purposes.

Age range: *Further education*
Key words: *instrumental genesis-social semiotics*
Session type: *Research workshops*
Duration: *60 minutes*



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Mathematics anxiety, progress and attainment: Does gender still make a difference?

In this session, we report on a recent study of 103 Year 9 students in a Hampshire secondary school which identified relationships between mathematical anxiety progress, attainment and gender. Using a mathematics anxiety rating questionnaire based on the Abbreviated Mathematics Anxiety Rating Scale (A-MARS) Questionnaire (Alexander & Martray, 1989), a mathematics anxiety 'score' was calculated for each student. National curriculum (2008) levels were used to indicate progress and attainment between end-of-key stage 2 measures and end-of-key stage 3 measures. We report on the relationships between anxiety, progress and attainment for four broad groups of students: higher attaining girls; higher attaining boys; lower attaining girls; lower attaining boys. For example, one of our findings indicates that greater mathematical anxiety is indicated by higher attaining boys, whereas the reverse was the case for higher attaining girls.

Age range: *Secondary education*
Key words: *gender; mathematics anxiety; attainment*

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