



BSRLM Conference Abstracts
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Development of prospective mathematics teachers' knowledge of assessment in technology-enhanced environments

This study examines the development of prospective mathematics teachers' knowledge of assessment in technology-enhanced environments. Forty prospective mathematics teachers were enrolled in a teacher preparation program which aims to develop technological pedagogical content knowledge (TPCK). With the aim of integrating technology into assessment, workshops were conducted which focused on: (i) the pedagogy of assessment (summative and formative purposes of assessment), (ii) technical knowledge of using mathematical software, (iii) technological assessment tools such as dynamic worksheets, concept map software, computer-assisted homeworks and e-portfolios, (iv) technological pedagogical knowledge of assessment (knowledge of summative and formative assessment in technology-rich environments). Forty prospective teachers prepared lesson plans and detailed teaching notes for teaching various mathematical concepts such as functions, limit, continuity, derivative, integral, probability and trigonometry before and after the workshops. Ten of them performed micro-teaching lessons (taught lessons to their peers). Data analysis indicated an improvement in using assessment for formative purposes especially classroom assessment and formative questioning.

Key words: *assessment; prospective mathematics teachers; technology integration; technological pedagogical content knowledge*
Session type: *Research paper*
Duration: *30 minutes*

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Observations about some UK primary teaching that has been influenced by the mastery agenda

From 2014, the UK government has been financing exchange visits between English and Shanghai teachers of mathematics to young pupils. The political thinking behind the decision was that, despite major differences in training, workload and cultural background, primary school teachers could change their teaching to the methods employed by teachers in Shanghai and use a 'mastery' approach. The political intention may have been to alter pedagogy, that is the environment, expectations and practices of mathematics teaching. However, a major difference observed by the English teachers is the grain size of the focus of lessons, the Shanghai teachers focusing on critical aspects of a mathematical idea where the English teachers have been used to working with varied pedagogy on broader conceptual areas. In this paper, we use variation theory as an tool to analyse part of a lesson which was developed after the teacher observed lessons in Shanghai and placed, through the NCETM website, in the public domain.

Key words: *mastery; variation; primary mathematics teaching*
Session type: *Research paper*
Duration: *60 minutes*



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Why do few children at rural secondary madrasas in Bangladesh choose to study an optional course in higher mathematics?

There are number of influences on children's choice to study or not to study higher level mathematics at secondary level beyond the compulsory mathematics. In Bangladesh, children of the science stream education may choose to study 'Higher Mathematics' as an optional course among the other subjects such as Agricultural Education, ICT & Career, and Biology. The present study reveals that a negligible number of girls and boys in rural secondary madrasas (Islamic schools) choose to study a Higher Mathematics optional course compared to the other subjects. This paper reports a preliminary analysis of six focus group discussions with Grade 9 and 10 children across three rural secondary madrasas in Bangladesh. The analysis suggests that parent's socio-economic status, their religious beliefs, children's gender, mathematics curriculum, mathematics teacher, anxiety about mathematics, success in mathematics, private tuition culture, and children's future ambitions all play a role in making their choice about studying a higher mathematics optional course.

Key words: *Bangladesh; higher mathematics; influence; rural secondary madrasas; socio-economic status*
Session type: *Research paper*
Duration: *30 minutes*

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Implications of Giaquinto's epistemology of visual thinking to the teaching and learning of fractions

Marcus Giaquinto's ideas about visual thinking and its epistemology may have implications to the teaching and learning of mathematics in general. In this session, I will present his main ideas and discuss how they can be related to reasoning and argumentation in mathematics. My presentation will be focused on fractions, which was the topic of my Ph.D. research project, and I will argue that the implications may be particularly relevant to low achieving students.

Key words: *visual thinking; fractions; teaching; learning*
Session type: *Research paper*
Duration: *30 minutes*

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Forced GCSE mathematics resits: Students' voices

Since the introduction of forced resits in Further Education (FE) colleges, the current policy-informing research and reports have been centred on employers, teachers and colleges. As a practitioner-researcher, I concentrate on those most affected by the policy, yet voiceless in the policymaking context – the students. In this session, I will present some initial findings, gathered in the 30 student interviews at 3 FE Colleges. Personal mathematical histories have been examined, alongside the effects the forced GCSE resits have had on the students and their lives, in the context of – but not limited to - mathematics education.

Key words: *GCSE; Further Education; social justice; social mobility*
Session type: *Research paper*
Duration: *30 minutes*



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Analysing teachers' activity in mathematics classroom with dynamic geometry software: Contrasting two approaches

Teachers of secondary mathematics in England and France have incorporated dynamic geometry digital environments into their teaching practices, for use by students to support them to engage with and make sense of geometric ideas. These classroom practices are greatly influenced by the prevailing 'institutional constraints' in each country such as: the curriculum, technology access, prevailing pedagogies, etc. In this research workshop, we will use a common video clip (with appropriate translations) to analyse a teacher's classroom activity using two different theoretical frames. The first frame is informed by both activity theory and the instrumental approach - and aims to highlight characteristics of common classroom practices of technology-use and the factors that influence these. The second analytical frame draws from 'hiccup' theory to highlight contingent moments within the teachers' practice that might indicate significant learning moments for the teacher in the process of developing classroom practice with dynamic geometric technology. We anticipate a fruitful and productive discussion through which we might establish connections between the two approaches, whilst also understanding the validity and limitations of each approach to inform our future joint research.

Key words: *dynamic geometry software; teacher knowledge and practice; comparative study; activity theory; instrumental approach; hiccup theory*

Session type: *Research workshop*

Duration: *30 minutes*

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Building and sustaining active research collaborations with teachers of mathematics

This Working Group will meet for the fourth time to explore collaborations between teacher and researchers in the processes of doing, reflecting upon and engaging with the findings, of mathematics education research. The following themes will be discussed: *How to nurture collaboration - even within those that start out as non-collaborative?; Understanding the teacher perspective - What does a teacher want to get out of it? How to build honesty and trust between participants?; How to clarify roles and be clear about what skills each person brings to a project?; How to define boundaries – that can move over time as roles change?; How to emphasise joint purpose rather than joint activity?* In addition, there will continue to be opportunities to share and discuss draft writings for wider audiences via the BSRLM website's blog. We welcome new participants.

Key words: *collaborative research; teacher inquiry; research-informed practice*

Session type: *Working group*

Duration: *60 minutes*

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An observation about a misconception involving division

In my experience teaching, I found a small number of students (but consistent over time) would interpret "divide by 3" as meaning: halve and halve again. Until very recently, I never had a sense of what might be going on here. In this session, I will report on a (new, to me) possible interpretation of the misconception. From this example, I



then offer some broader thoughts on the process of coming to know a piece of mathematics and what might have gone awry for those students. I distinguish and exemplify three movements: gathering attention, symbolising and habit-forming.

Key words: *division; misconception; learning concepts*
Session type: *Research paper*
Duration: *30 minutes*

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The mathematical potential of teaching strategies used to prepare pupils for problem-based questions in high-stakes testing in England

Studies have shown that teachers and schools adapt their provision in a range of ways in response to the pressures of high-stakes testing (Marks, 2014). Ehren et al. (2016) described the teaching strategies Year 6 teachers in England reported using to prepare pupils for mathematics SATs. In this presentation, we explore in more detail the mathematical potential of the instructional strategies described, focusing on strategies specific to problem-based test questions in the area of number. We also explore what the nature of teachers' responses to questions about how they support children to prepare for maths SATs tells us about their understanding of the mathematical concepts and skills being taught and tested. In doing this we look, for example, at perceptions of the effect of having a real-life context to the problems and of the conceptual and linguistic challenges in decoding word problems.

Key words: *assessment; problem solving; pedagogy*
Session type: *Research paper*
Duration: *30 minutes*

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Emergent pedagogies from an online course on digital technologies for mathematical learning

In this talk, we will present the design principles behind our on-line master level module Digital Technologies for Mathematical Learning that focuses on the teaching and learning of mathematics with digital technology. We have conducted evaluations of this course and we will be reporting on the following emergent of pedagogies: (i) the online pedagogy of the tutors, ensuring that online teaching and learning is effective and (ii) the participating students' TPACK (Technological Pedagogical Content Knowledge) as they start experimenting with the digital technology in their classroom practice. In order to support the participants on this online masters level course engage critically with the research knowledge base of the module, (a) we trialled the use of online video cases with the aim of supporting the development of the participants' Research-informed Technological Pedagogical Content Knowledge (RiTPACK) with a particular focus on how digital environments supports students' mathematical work; and (b) we tasked the participants to design and trial activities that bridge students' interactions with digital media and the mathematical concepts in order to be successfully integrated in the mathematics classroom.

Key words: *online pedagogy; digital technology; TPACK*
Session type: *Research paper*
Duration: *30 minutes*



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Development of components of mathematics in 7-to-11-year-old children: A study using Dynamo Assessment

Dynamo Assessment is a computerized assessment that tests children's performance on 14 mathematical components. 4 of these components involve number magnitude (visual quantity approximation, ordering numbers, number comparison, estimation); 4 involve number meanings (counting; single-digit number symbols; multi-digit number symbols; sequencing) and 6 involve number relationships and arithmetic (number facts; mental strategies; number bonds; problem solving; tens; and multiplication). It has mainly been used to plan interventions. This study aimed to find out more about typically developing children's performance. 2759 children between 7 and 11 underwent the assessment. Key findings are that all tests correlate significantly with one another, and that performance on all tests improves with age. When the Number Magnitude scores were grouped together, the biggest age change seemed to occur between ages 9 and 10. The same was true for the Number Relationships scores. When the Number Meaning scores were grouped together, the biggest age change seemed to occur between ages 8 and 9. The Number Meaning and Number Magnitude scores correlated negatively with the reaction times to these tests (faster children did better), but the Number Relationships score correlated positively with reaction time (slower children did better). Implications for our understanding of mathematical development are discussed.

Key words: *mathematical development; assessment; 7-to-11-year-olds; number concepts; arithmetic*
Session type: *Research paper*
Duration: *30 minutes*

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Have statistics lost their power in public policy discussions?

This session will focus on the use of statistics in society in general, rather than in mathematics education research, basing discussion on a piece in The Guardian, by Will Davies (Goldsmiths): "How statistics lost their power" <https://www.theguardian.com/politics/2017/jan/19/crisis-of-statistics-big-data-democracy>. This article begins with a stark assessment of the role of statistics in public discussion in general: "Rather than diffusing controversy and polarisation, it seems as if statistics are actually stoking them. Antipathy to statistics has become one of the hallmarks of the populist right, with statisticians and economists chief among the various "experts" ostensibly rejected by voters in 2016." The piece goes on to consider the meaning and some consequences of "big data", as well as the results of trends towards "identity politics" and globalisation. The discussion will be introduced by Jeff Evans, and other members of the organising group (as available). Those wishing to participate are, of course, encouraged to read the Guardian article (approx. 5,000 words). There will be ample time to introduce issues from the floor. The organising group will bring examples of statistical claims that relate to educational policy for analysis in smaller groups, and participants are encouraged to bring further examples.

Key words: *big data; identity politics; technology; globalisation*
Session type: *Working group*
Duration: *60 minutes*



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Teaching mathematics in English: Examples of mathematics activities in French European classes in lyc ee

All the following activities have been carried out in class, improved after being tested, and proofread by English teachers: 1) A bunch of card games: These self-contained, ready-to-use activities cover the following areas: numbers and calculation, algebraic expressions, probabilities and geometry. Their main purpose is to help students to memorize the specific vocabulary linked to these various fields in a playful way. They come in the form of card games, named 'snake', 'matching game', 'memory', 'mistigri' and 'word panelling'. The rule is given for each game. The cards are printed on cardboard cut-outs that can be laminated; 2) Tessellation: This teaching sequence is dedicated to the problem of the tessellation of the plane, and allows students to prove the following: 'The only regular tilings consist of equilateral triangles, squares and hexagons'. Those activities are preferably intended for pupils of European section, aged 16 or more, and aim to develop the following language skills: listening, reading comprehension, speaking, writing; and 3) Squaring the circle: Having watched a video, how students can understand a famous problem, summarize it on a poster and present it to their classmates.

Key words: *Mathematics vocabulary; tessellation*
Session type: *Research workshop*
Duration: *30 minutes*

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Best practice in mixed attainment: Challenges, outcomes and opportunities

Drawing on findings from the Education Endowment Foundation-funded 'Best Practice in Grouping Students' project (BPGS) together with other evidence, the session aims to provide analysis and critical commentary on the status of mixed attainment grouping in the secondary mathematics classrooms in England, with an emphasis on the potential of grouping practices to achieve more socially just outcomes. We will give three linked presentations. The first explores the responses of teachers to the proposition of mixed attainment practice. Drawing on data from the early phases of the 'Best Practice in Mixed Attainment' feasibility trial, we identify and explore the different explanations provided by teachers as to why mixed attainment practice is seen as difficult or problematic, even where teachers believe mixed attainment teaching to be desirable. The second draws on research carried out to investigate the effects of grouping practices on teachers' beliefs and practices and on teacher and student mindsets. The study compares two schools, one teaching mathematics to students in mixed attainment groups and the other teaching mathematics to 'ability' set groups. The third paper discusses how some schools buck the trend and adopt mixed attainment practices.

Key words: *grouping; social justice; equity; secondary*
Session type: *Research paper*
Duration: *60 minutes*

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Beginner teachers' preparation for teaching and assessing for semi-structured questions

We report on design research probing the knowledge, skills and beliefs beginner teachers bring to the enhanced demands for reasoning and problem solving in new (2014 on) curricula. What should and can be further developed, in the specific context of advanced school mathematics and its assessment? The study drew on



questionnaires and short intervention workshops; key workshop elements were repeated with experienced teachers. Data analysis considered a) the range and depth of participants' engagement with 'target' assessment and teaching issues and b) the knowledge and experiences they used to justify their reflections. We found the intentions of changes are well-aligned with the professional beliefs of both beginner and experienced teachers. Beginner teachers can acquire specific assessment-related skills through carefully structured workshops, drawing initially on their own experiences of learning but also 'replaying' experiences of classroom observation and discussion with experienced teachers. They were able to articulate principles for resolving tensions between validity and reliability, and started to rehearse formative classroom strategies for supporting exploration, persistence and written reasoning. Experienced teachers showed wider command of such strategies, though many were challenged to genuinely re-envision their practice. Acquiring the associated deep expertise is demanding and daunting for both beginner and experienced teachers.

Key words: *assessment; reasoning; teacher training*
Session type: *Research paper*
Duration: *60 minutes*

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Mathematical modelling as a motivating activity

Students entering courses in further education may lack both the mathematical skills for successful course completion and the motivation to develop these skills, due to poor experiences of learning mathematics at school. The authors, working as numeracy tutors, have conducted research into effective methods of delivering embedded mathematics across a range of academic and vocational subjects. Mathematical modelling has been identified as a particularly valuable student activity. Modelling projects provide experience in practical problem solving, and allow students autonomy in designing their own solution methods. Skill is gained in the collection and processing of data, often with the use of computers. Mathematical techniques can be presented in a student-centred learning environment, with opportunities to develop the wider numeracy skills of: working with others, and communicating mathematical concepts. Examples of modelling projects are demonstrated from courses in: science, geography, biology, computing, business studies and engineering. A common theme is the opportunity provided for students to move readily between different representations of data sets, using numerical, graphical or algebraic forms as appropriate.

Key words: *mathematical modelling; arithmetic-algebra connection; student-centred learning; embedded numeracy*
Session type: *Research paper*
Duration: *60 minutes*

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Missed opportunities? Learning the role of the teacher educator

What exactly is involved in making the change from teacher to teacher educator? Following many years teaching mathematics in secondary schools I am new to the role of teacher educator. In this session, I will present some recently collected data from a group of ten mathematics teachers that I am working with from five different secondary schools. The teachers are working as a group on developing students' mathematical reasoning in their classrooms and the classrooms of their wider departments. One of my roles within this group has been to facilitate a reflective discussion around any related activity that the teachers have initiated in their schools and classrooms. In analysing the transcriptions of one of these reflective discussions, I have been struck by the many missed opportunities for prompting the teacher to go into more depth. This has led me to consider in great detail what my role as a teacher educator may be and through the analysis of this data I am in the process of educating my own awareness in a way that is different to the awareness I developed as a teacher of mathematics.



Key words: *teacher education; teacher change; mathematical reasoning*
Session type: *Research paper*
Duration: *30 minutes*

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Measuring students' epistemic beliefs: A question of methodology

Research on students' discipline-based epistemic beliefs gathered momentum with the work of Perry in the 70s. Since then the methodology used to investigate such beliefs has changed from long, time-consuming qualitative studies to more efficient quantitative studies based on epistemic beliefs questionnaires, such as the Mathematics-Related Beliefs Questionnaire (MRBQ, Op't Eynde and de Corte, 2003). However, recent studies (DeBacker et al., 2008) have questioned the reliability of these measures and have raised doubts about the findings based on them. In this session, we present results from a pilot qualitative evaluation of the MRBQ. We designed interview questions which reflected the questionnaire items and we administered those with 6 mathematics students. At the interview, we asked the students to fill in the MRBQ questionnaire first and then we interviewed them. Even from this small sample, we saw that the interpretation of some of the questions varied across students and that the answers to the interview questions often were not always consistent with the answers to the matched questionnaire items. We will discuss advantages and disadvantages of this methodology and present some future research plans.

Key words: *epistemic beliefs; qualitative evaluation; university mathematics*
Session type: *Research paper*
Duration: *30 minutes*

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Student-partners in teaching design and tutorial teaching in university foundation mathematics

Our Catalyst Project has two main areas of inquiry: 1) The design of computer-based tasks in matrices and complex numbers; 2) The involvement of students in the design of teaching and in the tutorial teaching of foundation level students. We are working with 4 student-partners to design tasks using Autograph in the two topic areas. These tasks will be used in tutorials with foundation students. The student-partners were foundation students last year, and we hope to learn from them about student perspectives in doing and learning mathematics as well as the approaches to teaching that they value (or not). We will report on the first weeks of this project.

Key words: *computer-based mathematics task design; students partners; co-learning in mathematics teaching*
Session type: *Research paper*
Duration: *30 minutes*



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Sharing perspectives on mathematical methods: A dialogic investigation

Bakhtin's work on perspectives is forming the basis for a dialogic investigation into perspectives on the mathematical methods used by secondary school students and teachers to solve problems. I aim to find out more about why people use the mathematical methods they do, both when teaching and when solving a problem. As part of the beginning stages of this PhD project, I have been working to generate a series of artefacts from students to form prompts for teacher and student discussion groups. Students from Year 7 (aged 11) to Year 13 (aged 18) in a UK comprehensive school completed questions designed to encourage a range of different methods to be used. Discussion groups, planned for the next four months, will focus on sharing perspectives on mathematical methods. These perspectives will form a framework for classroom observations to see teachers and students talking about methods in context. This session will involve considering a sample of artefacts and engaging in discussion with others about the similarities and differences between the methods chosen by the students to answer the questions. It is designed to supplement the teacher and student discussion groups by adding another layer of perspectives to my work.

Key words: *mathematical methods; perspective; dialogue; Bakhtin*
Session type: *Research workshop*
Duration: *60 minutes*

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Collaborative teacher projects in mathematics: Teachers in charge

There is some criticism in the mathematics education professional development literature that the majority of studies are designed and run by teacher educators and second that the voice of the teacher is not well represented (e.g. Adler, Ball, Krainer, Lin, & Novotna, 2005). This presentation aims to address this criticism by reporting on 49 funded research studies, requiring collaboration between at least two schools, but otherwise designed, conducted and reported on by teachers of mathematics. The presentation explains how and why the studies were initiated. It then uses a theoretical framing based on the work of Guskey (2002) to present the findings reported by the teachers: their responses to the collaborative professional development, their learning, changes in their organisations, changes in their practice and improved student learning. Although it is too soon to know if any changes are sustained, the reports suggest that overall the projects generated enthusiasm, energy and a real sense of having done something worthwhile. To conclude, two questions are considered: 1) To what extent can the model of collaborative professional development reported in these studies be seen as successful? 2) What, if anything, can the research field learn from the teachers' voices?

Key words: *professional development; teacher voice; collaboration; learning; practice*
Session type: *Research paper*
Duration: *30 minutes*

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Measuring learning from two-stage collaborative exams in mathematics

In a two-stage exam, students complete the exam individually before working in small groups to answer the exam questions again. This style of exam is gaining in popularity; for instance, they are now widely used at the University of British Columbia, even in high-stakes settings. The idea of a two-stage exam is to exploit the students' desire to know the correct answers immediately after they have sat the exam, and to provide the students with some



immediate feedback. But do they help students to learn? We will survey some relevant literature on two-stage exams, with a focus on studies into the effect that they may have on students' learning. In particular, we will report on a pilot study where the students completed an individual "third stage" a few days later so that the possible effect of the group stage on their learning could be evaluated. We will also discuss possible future directions for this work.

Key words: assessment; examinations; group work
Session type: *Research paper*
Duration: *30 minutes*

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Unification by proofs: The case of star polygon

It is well-shared that an important function of proofs in mathematics education is explanation; that of providing insight into why mathematical statements are true. In this presentation, we examine the notion of this explanatory function from a relatively unexplored perspective, namely Kitcher's idea of explanatory unification. Although Kitcher proposes his model within the field of the philosophy of science (including mathematics), his idea of explanatory unification (or synthesis) can be valuable in mathematics education contexts in informing ways of enabling students to engage in authentic mathematical practice and cultivating their mathematical and higher-order thinking in mathematical proving. As a step in exploring explanatory unification by proofs in school mathematics, we illustrate this activity with a classroom episode where secondary school students (aged 13–14 years old) in Japan explored the sums of the interior angles of star polygons. Based on this classroom episode, we discuss how the idea of explanatory unification can be used to inform opportunities for students to unify different mathematical statements and proofs and to deepen their mathematical understanding.

Key words: *proof; unification; explanation; understanding; secondary school*
Session type: *Research paper*
Duration: *30 minutes*

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Describing the circles of a modeling activity: The drug concentration by the human body

This study explores the effects of two teaching experiments that focus on exponential modeling activity and collaborative inquiry learning in workplace problem solving. This research is part of the European Project MASCIL and refers to the solution of the drug concentration problem by the human body. Ten heterogeneous groups of high school students in B' Lyceum (Year 11, similar to AS class) in Greece took part in this research. In particular, audio and video recordings and qualitative content analysis are used in this research. Results show that students, while solving the problem, used prior knowledge and developed mathematical abilities, which are divided in three modelling circles: *arithmetic, geometry and algebra*. More specifically, students collaborate, making calculations and graphs and supporting argument from algebra and analysis. Moreover, the authentic workspace context encouraged the students' involvement in the investigation of the level of medication in blood over time, studying exponential change model. The constructions of mental images of students' about the notions of monotony and least upper bound play a vital role. It is important to note the students' difficulties in the transition from recursive to the general type of geometric series.

Key words: *drug concentration; exponential function; modelling activity; authentic workplace problem solving; collaborative inquiry learning*
Session type: *Research paper*



Duration: 30 minutes

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An account of three 13 year old students' attempts to solve 'a quarter plus an eighth'

In this session, I will report on an interview on a fractions task (initially set in the context of a recipe) with three 13 year old students (Year 8 / Grade 7), undertaken by their maths teacher and myself. I will also look at a follow-up interview with two of the students that took place a fortnight later. In the first interview, the students eventually solved the task but some of the difficulties they encountered re-emerged in the second interview. I will argue that the students' responses fit a social constructivist perspective that mathematical understanding is formed of a complex network of ideas, where these ideas are not always well-formed or well-connected or well-fitting, and where students will tend to select ideas haphazardly, and where the development of the network will tend to be slow and fluctuating. In turn this suggests that, in a lesson, it is useful to elicit students' ideas as these are likely to be of value to other students, in terms of consolidating, extending, or challenging their own ideas.

Key words: *fractions; formative assessment; mathematical understanding; Key Stage 3; Key Stage 2*
Session type: *Research paper*
Duration: *30 minutes*

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Models of mediation between students and mathematics in secondary classrooms

In this discussion, mediation is taken to be how teachers actively reconcile students with mathematics, for example, by modelling engagement. Drawing from Positioning Theory (Harré & van Langenhove, 1999), I examine what emerges from positioning a mathematics teacher as mediator, in a triangular relationship bridging between students and mathematics. Using data drawn from my PhD research, which is centred on examining the observable positive emotions of teachers in action, I discuss possible mechanisms involved in mediation in the classroom, including the role of emotions. I present three different patterns of mediation: *flipping, chained and distal*. I will draw from data collected through observing experienced secondary mathematics teachers to illustrate each pattern. I suggest some implications of the patterns in terms of teacher and student affect, such as mediating through play, or temporal mediation between current state and imagined futures of students, both of which act to align students with positive mathematics positions. I also consider some risks inherent in each pattern of mediation since the patterns that I consider as supportive of positive student alignment involve continual, rapid, intense, skilfully structured and emotionally driven shifting of positions, both by the teacher and of the students.

Key words: *modelling; UK secondary; teacher development; classroom practice*
Session type: *Research paper*
Duration: *30 minutes*

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A learner's experience of flow when engaged with mathematics

Learners of mathematics often have a great enjoyment when carrying out mathematical tasks, questions or problems. I contend that this experience can be labelled as 'flow'. The learner experiences 'flow' when he or she is totally absorbed in the situation and/or task to the exclusion of all else, with a complete connection. Flow has



been described as 'being in the zone' and is a quality of experience. In this paper, I start from the premise that flow is an essential part of the mathematical learning process, and that although flow 'states' will have common characteristics, the individual will attach the meaning, because each individual has a unique experience of flow. Over a period of two and a half years, I worked with a group of secondary students, anticipating how flow can assist positive relationships with mathematics. I recorded, videoed and questioned students' experiences of flow in the classroom. Initial findings suggest certain didactics (including task design, delivery methods, and questioning techniques) elicit flow and engender an 'optimal experience'.

Key words: *research informed practice; secondary learners; flow; curriculum; classroom delivery*
Session type: *Research paper*
Duration: *30 minutes*

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CAPTeaM activities for supporting teachers towards attuning and resignifying in inclusive mathematics classrooms: 'Feeling' the mathematics of disabled learners

In this workshop, we will engage participants with activities from the CAPTeaM project (Challenging Ableist Perspectives on the Teaching of Mathematics). CAPTeaM sets out from the assumption that, rather than being the consequence of internal, individual factors, students' underperformance in mathematics can result from explicit or implicit exclusion from mathematics learning. The study aims to challenge teaching practices that contribute to such exclusion and engages teachers with tasks that invite them to reflect upon the challenges of teaching mathematics to disabled students. The study is funded by the British Academy International Partnership and Mobility scheme and its team comprises researchers from Brazil and the UK. Data is collected as participants interact with two different types of tasks. In the first type, teachers are presented with classroom episodes which show the mathematical activities of disabled students. In the second type, small groups of participants solve a mathematical problem while at least one of them is temporarily and artificially deprived of access to a sensory field or familiar channel of communication. In the workshop we will engage participants with a Type II task, ask them to reflect on the experience of said participation and sample from our currently ongoing data analyses.

Key words: *inclusive mathematics education; ableism; task design; activities for teachers*
Session type: *Research workshop*
Duration: *60 minutes*

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The role of defining in pre-proving activity

In this paper, I present and discuss findings from a research study the aim of which is to investigate the activity of proving as constituted in a Cypriot classroom for 12 year old students. By drawing on Cultural Historical Activity Theory and collaborative task design, this study explores the way the teacher is working with the students to foreground mathematical argumentation. Analyses of video-recorded whole class discussions show how processes of explaining and exploring are key sub-systems within the central activity of proving as they provide a key pathway, which often includes defining. I refer to these developments as pre-proving. However, emerging contradictions within explaining and exploring make the constitution of pre-proving in the classroom inherently complex. In this paper, I illustrate how defining, an activity integrated in the activity of explanation, plays a crucial role in regards to pre-proving activity.

Key words: *proving; defining; explanation; justification*
Session type: *Research paper*
Duration: *60 minutes*



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A framework for reading comprehension of structures of proof by mathematical induction

This study proposes a theoretical framework for reading comprehension of structure of proof by mathematical induction in order to characterize various difficulties that have been reported in mathematics education researches. Especially, we focus on the prospective mathematics teachers' difficulties in understanding of the necessity of the base step and the logical validity of the inductive step. In this study, we pay special attention to the notion of 'mathematical theorem' proposed by an Italian research group, and elaborate this notion to describe in more detail the structural understanding of mathematical induction. We also take the existing models of proof comprehension, in order to consider what is specific to the proof by mathematical induction.

Key words: *proof; reading comprehension; mathematical induction; prospective teachers; structural understanding*
Session type: *Research paper*
Duration: *30 minutes*

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Teaching A-level mathematics in early career

We report a research project investigating the place of A-level teaching within mathematics teacher education and early career development. The dearth of literature focused on A-level preparation means we have drawn on several related fields to structure our work, namely teacher career development, teacher knowledge frameworks and teacher learning. The study takes a multiple case-study longitudinal approach with a purposive opportunity sample: participants were five teachers from three different routes into teaching, each having some sole responsibility for A-level teaching in their first year of qualified teaching. Analysis suggests that: induction into A-level teaching is variable in rationale and deployment; an initial safety net of formal mentor support was soon replaced by informal teachers conversations focused on logistics and shared pupils rather than pedagogy and shared content; teachers developed some aspects of pedagogic content knowledge from A-level teaching more intensively than in their main school teaching, due both to smaller, amenable classes and to engaging with the A-level mathematics content.

Key words: *advanced mathematics; teacher training*
Session type: *Research paper*
Duration: *60 minutes*

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Supporting teaching and learning functions with the use of technologies

The aim of this session is to illustrate how French teachers can use technologies in their mathematics classrooms to maximize students' learning of functions. The Sign family that we use as an illustration denotes a family of mathematical situations at the interface between geometry, magnitudes and the functional world which can be described in the following way: an initial geometrical form is given (square, rectangle, circle, or even a 3D form); and a point variable in this form (along a side, a bisector, a diameter) allows its division into different parts; from this division a sign is created whose area depends on the position of the variable point. Several questions naturally emerge regarding the variation of this area or of the area of its different components, its minimum and maximum



values. According to the choices made in terms of didactic variables, one can generate a great diversity of didactic situations, varying the context of the task, the functional dependencies at stake, the autonomy given to students in the functional modeling, the technology used, and the didactic organization. The Sign family is quite traditional in the French curriculum as we will explain during the workshop.

Key words: *new digital technologies; functions; Geogebra*
Session type: *Research workshop*
Duration: *30 minutes*

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Exploring changes in children's mathematical task and strategy conceptualisation using microgenetic research designs

Microgenetic research designs entail highly-concentrated observation of learners' behaviour within specific domains, contexts and periods of time, aiming at capturing change in learning as it occurs. Microgenetic analyses enable researchers to scrutinise various forms of data and explore differences in the process of change within and across individual learners. In this paper, we present a brief overview of the method with reference to some of the most significant studies that have been conducted utilising microgenetic designs for examining children's strategy change in mathematics. Subsequently, we focus on selected examples from two different qualitative microgenetic studies that aimed at tracing changes in young children's behaviour when solving a specific additive numerical task and fraction word problems respectively. In seeking to capture changes in how children conceptualise a task and their strategies, our analysis moves beyond the exploration of changes in what children 'do' in problem solving. In particular, we extend to observations and exploration of changes that occur in what children 'say'; that is, their verbalised reasoning and explanations, not only when patterns of strategy use develop but also when such patterns of use remain stable or regress. Implications for how change in learning can be captured and conceptualised are discussed.

Key words: *microgenetic research; learning; problem solving; primary education*
Session type: *Research paper*
Duration: *30 minutes*

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Investigation of identity formation of a novice mathematics teacher

This study investigates a novice mathematics teacher's identity formation throughout a six-year period. The participant was first interviewed as a teacher candidate about her choices for becoming a mathematics teacher and her own model of an ideal mathematics teacher in the last year of the teacher preparation program. The second interview took place six years after the first interview, in the fifth year in the profession. The interviews lasted about an hour and were recorded with a voice recorder. Verbatim transcripts of the interviews were analysed using content analysis. Data analysis indicated that the job satisfaction of the teacher decreased over the years due to the lack of resources in schools and the low socioeconomic status of students. It has been found that the spiritual fulfilment of being a teacher was taken to the forefront after five years of professional experience. It was also found that an unchanging factor affecting identity formation is the role of previous mathematics teachers of the participant.

Key words: *identity; identity formation; novice teachers; mathematics teacher education*
Session type: *Research paper*
Duration: *30 minutes*



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