



BSRLM Conference Abstracts
The Open University, Milton Keynes

Saturday 9th March 2019
#BSRLMMar19

Fay Baldry

An exploration of the treatment of mathematical 'errors'; one teacher's regular utterance of a bald 'no' and its implications.

This paper explores one teacher's treatment of errors with two different classes, as they occur within Initiate-Response-Evaluate (Cazden, 1988) interactions and in more student-led exchanges. Data are drawn from a wider classroom-based video study in secondary mathematics classes in England. This paper focuses two classes from one teacher where for a minority of lessons, bald negative evaluations of student contributions were a regular occurrence; this appeared to be atypical, both in relation to the other teachers in this study and the wider literature. Analysis showed that teacher-initiated interactions were followed by indirect evaluation of 'errors', whereas student-initiated exchanges were more likely to conclude with bald negative evaluations. The interactional patterns related to these different treatments and the implications for student learning is considered.

Key words: *Classroom norms, errors, mathematics education*
Session type: *Research paper*
Duration: *30 minutes*

Barneclutt, Jessica

Teachers in transition: the challenges of facilitating student led PBL

In secondary school mathematics classrooms in the UK, students are typically taught mathematics through teacher led pedagogies that focus on the students passing their mathematics GCSE. This session will discuss a study conducted in a school which is transitioning to teach with a hybrid of project based learning (PBL) and teacher led pedagogies, with 14 and 15 year old mathematics students. There is limited research that looks at utilising a hybrid such as this or the challenges teachers face in this transition. The study adopted a qualitative approach and found that the biggest challenge to teachers was facilitating student led learning. The session will explore why teachers found this demanding, highlight the particular challenges they encountered and report on the strategies they developed to aid student led learning.

Key words: *PBL; student led learning; secondary*
Session type: *Research paper*
Duration: *30 minutes*

Cave, Peter*

Maths-Related Activities among Japanese Preschool-Aged Children: Informal and Formal Learning

Japanese children have long been outstanding performers in international maths attainment tests. However, little research has investigated whether this might be related to maths-related activities before the start of primary school. This study, carried out over seven months in two small cities in Japan, examined such activities through preschool observations and interviews, and questionnaire surveys of preschools and parents. It found that preschools in the locations studied almost uniformly conformed to national curriculum guidelines that aim to develop children's sense of quantity and shape through activities embedded in play and daily life, rather than through the use of formal teaching methods. Many parents reported that their children engaged in daily life activities involving number and shape, and a higher than expected proportion reported that their child engaged in formal learning schemes from commercial educational providers. The results indicate the complexity of the landscape of maths-related activities traversed by preschool-aged children in Japan. Although suggesting that Japanese children may be well prepared for formal maths learning at school by preschool experiences, the study also indicates the need to take into account other influences from the home and educational providers, which could be linked to later inequalities.

Key words: *Curriculum; out-of-school activity; preschool; Japan; ages 4 to 6*
Session type: *Research paper*
Duration: *30 minutes*



Clark-Wilson, Alison*; Wake, Geoff*; Adams, Alison*

Building and Sustaining Active Research Collaborations with Teachers of Mathematics Working Group

This group meets periodically to share the diversity of ways in which the research community collaborates with teachers in the process of doing, and engaging with the findings, of mathematics education research. The current educational landscape in which colleges, research schools, teaching schools and Maths Hubs are being encouraged to engage with, and participate in, more 'research-informed' practices offers a range of challenges, but also opportunities to develop new collaborative ways of working. The working group meets to share and discuss experiences, current projects and initiatives with a view to developing a range of resources that might inform and support future work. Please come prepared to share your experiences and ideas that inform some principles for effective partnerships with the group.

Key words: *Collaborative research; teacher inquiry; research-informed practices*
Session type: *Working group*
Duration: *60 minutes*

Curtis, Fiona

RME reading group

This session is an opportunity for you to reflect and discuss the contents of the Janet Duffin Award lecture, and then to debate with others on the merits of the contenders for next year's award. You do not need to have read all, or even any, of the articles in RME to take part in this session, but I hope that at least some people will come prepared to argue the case for their particular favourite. There will be a "slow chat" on the BSRLM website in which this debate will also be developing.

Key words: *RME, papers, award, academic writing*
Session type: *Working group*
Duration: *30 minutes*

DeBay, Dennis

Public Data for Public good: Interdisciplinary research for data to policy

Data to Policy (D2P) is an interdisciplinary data science initiative that tasks groups of students in STEM and non-STEM disciplines to study and propose solutions to data-rich problems that impact their local community. Working together with representatives of local government, community groups and other stakeholders, D2P gives students the opportunity to learn with and from peers as they investigate real issues and work to benefit our community. This project will undertake a research study to investigate how participation in the D2P project impacts undergraduate students at various levels in both STEM and non-STEM disciplines.

To assess the impact of the program on collaboration and views on statistics, a repeated measures design will be used in which we will track students over the course of their involvement with the project. Several questions will guide this research:

1. Statistics Attitudes: How does participation in a Data to Policy course impact participating students' attitudes about statistics? How does this compare to other sections of the same course that are not integrated into Data to Policy?
2. Course Pairs effectiveness: How does participation in a collaborative course pair impact undergraduate students' willingness and ability to engage in interdisciplinary collaborations?

We are currently in early stages of the research and hoping to gain some insight from other's exploring statistical interest in students including, but not limited to, experience in the field and exploring measures for statistical interest. The talk will involve the context of the project and the importance of having statistics students explore policy and the policy students having a greater understanding of statistics. An overview of the research plan will also be discussed. The project team hypothesizes that participating in the D2P program will positively affect the undergraduate students with respect to each of the dimensions described in the research questions. The following will break down the research into quantitative and qualitative components.

Key words: *Teacher education, algebraic expressions, collaborative enquiry*
Session type: *Working group*
Duration: *30 minutes*

Despoina Boli*; Timothy Bartlett*

The use of Socratic Method to improve problems solving skills among Further Education students who retake GCSE Maths.



Students who come in Further Education and have not previously achieved a grade 4/5 in GCSE Maths are now required to continue studying maths until they reach a foundation level of mathematical knowledge. Hence, they are obliged to retake the GCSE Maths exam as many times needed to achieve a grade 4/5. The majority of those students come in FE with negative predispositions towards maths and a lot of times a cycle of exam failure follows them. This makes the teaching and learning of mathematics in FE a challenging matter. Improved teaching strategies adapted to FE students are therefore essential. The emphasis on improving learners' problem-solving skills is very clear in the recent development of mathematics curriculum and for that reason, the Socratic Method was used to enhance problem-solving ability, help learners make connections and develop their mathematical understanding. The method involves the use of a series of questions that guide students to understand the mathematical problem and find a solution through making connections on what is previously known, what is given and what is asked to be found. The main aim is to encourage learners to be less dependent on the teacher and develop their own problem solving and reasoning skills.

Key words: *GCSE Mathematics, Further Education, Problem Solving, Socratic Method*
Session type: *Research paper*
Duration: *60 minutes*

Eaves, Joanne

Knowledge of the order of operations and the use of arithmetic strategies

Knowledge of the order in which arithmetic operations can be performed is important for success with secondary-school mathematics (ages 11+) and bridging the transition from arithmetic to algebra. A correct understanding consists of knowing that multiplication and division have precedence over addition and subtraction, and that addition and subtraction have equal precedence. In countries such as the UK and USA, the order of operations is often taught with the aid of acronyms such as BODMAS (Brackets, Orders, Division, Multiplication, Addition and Subtraction).

Many children and adults have difficulty understanding the order of operations (Linchevski & Livneh, 1999; Pappanastos et al., 2002) and some have specific misconceptions of BODMAS. However, there has been no attempt to quantify individuals' understanding of the order of operations, or investigate the consequences of misconceptions on mathematics performance. In two studies, we filled this gap. First, we developed a new measure of the order of operations and quantified the prevalence of misconceptions. Second, we investigated whether knowledge of the order of operations influenced how undergraduates solved 'a + b - c' arithmetic problems. We suggest that relatively few individuals (16%) have a good understanding of operation order, and that misconceptions hinder the use of sophisticated arithmetic strategies.

Key words: *Arithmetic; BODMAS; Associativity; Strategies; Conceptual*
Session type: *Research paper*
Duration: *30 minutes*

Forsythe, Susan*

Using the Dynamic Perpendicular Quadrilateral to support students' thinking towards the concept of inclusion in geometry

In this session I will describe how a dynamic perpendicular quadrilateral (DPQ) was used as the basis for a task designed to support students in developing the concept of inclusion in geometry. I will take the particular case of the hierarchical classification of the kites and the rhombuses as special cases of the kites. The task with the DPQ was first used and refined when working with pairs of students in early secondary school. An important dragging strategy emerged where the students dragged to maintain the symmetry (DMS) of the DPQ as it morphed through the instantiations of the kite, including special cases. I then went on to embed the task into a pedagogical sequence of activities (generating shapes using geo-strips to act as the diagonals, working with the DPQ on the computer screen to generate shapes by using DMS, class discussion and watching an animation of the dynamic figure) and used these with a whole class of 31 students. In my presentation I will use the theoretical frameworks of Van Hiele (levels of geometrical thinking), and Duval (Perceptual Apprehensions) to analyse the data from the students' work on the task.

Key words: *geometric task; dynamic geometry; inclusion; dragging strategy*
Session type: *Research paper*
Duration: *60 minutes*

Gifford, Sue

BSRLM Early Years and Primary Mathematics (EYPM) Working Group

This session will examine the research case for retaining a Shape, space and measures ELG. Please bring references to research evidence which supports this case. Participants are recommended to look at relevant research on Erikson



website: <https://earlymath.erikson.edu/?s=spatial+relationships>.

We will also discuss the primary and early years implications of the new Ofsted framework, handbooks and particularly the research commentary for the consultation ending 5th April

<https://www.gov.uk/government/news/ofsted-launches-a-consultation-on-proposals-for-changes-to-the-education-inspection-framework>

<https://www.gov.uk/government/publications/ofsted-inspection-handbooks-drafts-for-consultation>

Key words: *Early years mathematics; primary mathematics; curriculum; teacher education*
Session type: *Working group*
Duration: *30 minutes*

Godfrey, Dave

Using Story as a Tool for Demonstrating and Developing Conceptual Understanding Within the Teaching of Subtraction: a literature review

In Singapore, primary aged children are regularly asked to create stories about subtraction in order to demonstrate and develop their understanding. In this session I will present the highlights of my doctoral literature review assignment which seeks to understand why the creation of story narrative (an aspect of problem posing) is so embedded in the mastery curriculum, and how it might specifically help children to develop conceptual understanding of the multiple structures found within subtraction in English primary schools. The literature review explores theoretical frameworks for demonstrating and developing conceptual understanding, with one particular framework by Wong (1999) specifically incorporating the use of story as both a means of cognitive development and application to the real world. Analysing story literature has also revealed the particular benefits of oral storytelling and the affective impact of storytelling on both the author, storyteller and the listener (Zazkis & Liljedahl, 2009). Professional literature guiding the teaching profession appears to provide a lack of clarity surrounding the teaching of subtraction, particularly with respect to the use of technical language and the multiple structures of subtraction that children in Year 1 are now being exposed to in English schools.

Key words: *Story, subtraction, conceptual understanding*
Session type: *Research paper*
Duration: *30 minutes*

Golding, Jennie*

Teacher capacity for supporting problem-solving

Problem-solving currently has a renewed, and well-supported, focus in English mathematics curricula at all levels, yet teaching for that is complex and unfamiliar to many teachers. I report on a set of longitudinal classroom-based studies evidencing the development of related teaching over the early years of new curriculum enactment. We found that classroom enactment of problem-solving varied considerably, and continues to do so. Alignment of both 'educative' curriculum materials and assessments appears to be necessary for widespread enactment consistent with curriculum intentions, but teacher capacity, including their subject-specific knowledge and pedagogical knowledge, and their affect, was a constraint on the development of such opportunities in all classroom phases. I discuss the implications across the curriculum system.

Key words: *Problem-solving; curriculum coherence; pedagogical knowledge; assessment; curriculum resources.*
Session type: *Research paper*
Duration: *30 minutes*

Horsman, Rachael*

Models of knowledge for teaching

What is deemed to be a valuable measure of a teacher's potential is not just their declarative knowledge but what they understand this knowledge to mean, its place in school mathematics, effective representations, and common misconceptions, amongst other things (Shulman, 1986, 1987, Mason and Spence, 1999, Hill et al., 2004, Thompson, 2015).

Through modelling our own understanding (for teaching) of an area of mathematics, we will consider the nature of the organisational structures of our own mathematical knowledge. We will explore, compare and contrast a selection of models of teacher knowledge developed since and including the seminal work of Lee Shulman (1986, 1987) and consider how such models could potentially support teacher reflection.



Key words: *Teacher knowledge; mathematical structure; professional development*
Session type: *Research workshop*
Duration: *30 minutes*

Jackson, Colin

Teachers introducing and maintaining all attainment mathematics: what sustains them

In this paper, I draw on the findings of my doctoral study into all attainment teaching in mathematics in English secondary schools. In this small scale research study, I was interested in finding an answer to the question How is it possible to introduce, maintain and extend all attainment teaching in mathematics in English secondary schools in the current education environment? In particular, in this paper I seek to answer the question Who are the teachers who achieve this and what sustains them? I discuss the teachers interviewed and their approach to the curriculum, an approach which marks many of them out from other teachers in the degree of creativity they exercise and the extent to which they collaborate with others. They all love mathematics, they all have an interest in the curriculum and all of them are actively engaged in developing their teaching resources both in terms of skills and materials. Interestingly almost all of the teachers are interested in either curriculum development or research in mathematics teaching or more usually in both.

Key words: *All attainment; teachers; introduce; maintain; sustain*
Session type: *Research paper*
Duration: *30 minutes*

Joubert, Marie*; Oakes, D*; Lyakhova, S

An in-depth look at students' experiences of, and thoughts about, 'flipped classrooms' in mathematics

In response to teachers' complaints about an overcrowded curriculum, FMSP in Wales initiated a research project in two phases. This presentation relates to Phase 1, which aimed to research the responses of teachers and students to the use of 'flipped classrooms' for mathematics. In a previous presentation, we reported on teachers' views, with a glimpse into students' views. This presentation provides a detailed look at the students' views. Phase 2, which is currently underway, aims to develop, trial and refine lessons which go beyond practice examination questions to build deep understandings by exploring topics in depth and making connections.

The research was set in North Wales and involved six teachers and their A-level or Further Mathematics classes. It took place between October and December 2018. Teachers used the flipped classroom approach in all their mathematics lessons with the research classes, and researchers observed two lessons for each teacher, interviewed the teachers after each observed lesson and interviewed or surveyed students.

Analysis of the data from the students suggests that overall the students liked the flipped approach, for a number of reasons such as, for example, feeling more ready for the class when they arrived in the classroom and having more time to take notes. Some students, however, appeared to prefer more traditional approaches and others reported that, while they liked the flipped approach for mathematics, they would not like it in other subject areas.

Key words: *flipped classrooms; students' views; A-level*
Session type: *Research paper*
Duration: *30 minutes*

Oakes, Dominic*; Birch, Teri*; Lyakhova, Sofya

Bringing a connected mathematics curriculum to life

Programmes of Study tend to work through specifications topic by topic. Can we improve developing mathematical thinking by looking at the connections in the material and travelling through the mathematics in a different way? FMSP Wales have written Schemes of Work for the new Mathematics & Further Mathematics A-Levels. We have mapped prior & dependent topics for every topic in the syllabi. At present this is represented in a spreadsheet and a MindMap, as presented previously.

Our MindMap is complicated - it has to be printed on A0 paper to be at all legible! We are developing a 3-D version of the MindMap using the Unreal Game Engine to allow students and teachers to travel through the curriculum. This will also allow the opportunity to develop gamification etc. In this session we will be showing progress so far.

Can we use this resource to grow our teachers' (& students') understanding of the patterns running through mathematics?



Developing the MindMap is a first step in our research, which aims to investigate whether and how teachers of A-level Mathematics could use the connections we have identified (as well as resources like Underground Mathematics) to inform their short- and long-term teaching plans.

Key words: *Connection; curriculum mapping; game engine; KS5*
Session type: *Research workshop*
Duration: *30 minutes*

Owens, Emma*; Nolan, Brien*

An investigation into the problem-solving proficiency of pre-service post-primary teachers

This study reports on the problem-solving proficiency of nine pre-service post-primary mathematics teachers on a concurrent, initial teacher education programme in an Irish university. The participants had previously received instruction through a module which involved a focus on mathematical problem-solving. The problem-solving proficiency of the participants is being investigated in this study in relation to research which states that it is a necessary component of a teachers' effectiveness in teaching of problem solving (Chapman, 2005). Each participant undertook two mathematical problems in a 'Think Aloud' manner in recorded interviews. The interviews were then analysed using two approaches; firstly, by rating responses against the interviewees' use of Mason et al.'s (1985) rubric-writing method, and then by a general inductive approach (Thomas, 2003). Themes were identified based on their recurrences across the interviews and the analysis revealed that they could be classified into seven main categories. We report on this analysis and on how it will be embedded in the ongoing research project.

Key words: *Problem-solving; education; post-primary*
Session type: *Research paper*
Duration: *30 minutes*

Papadaki, Evi

Mapping out different discourses of mathematical horizon

The term mathematical horizon was introduced as part of the Mathematical Knowledge for Teaching (MKT) framework (Ball, Thames, & Phelps, 2008). Knowledge at the mathematical horizon was first described as "an awareness of how mathematical topics are related over the span of mathematics included in the curriculum" (ibid, p.403). After its first introduction, the mathematical horizon has been used and elaborated in research. Nonetheless, "knowledge at the mathematical horizon" is still considered to be a "grey area", with different interpretations and meaning, compared to the other parts of MKT framework. In this session, I will report a preliminary commognitive analysis (Sfard, 2008) of a sample of papers about mathematical horizon attending to the use of the term in the related research. The aim of this presentation is to investigate different narratives in relation to mathematical horizon and how these narratives might be linked to how mathematical horizon is conceptualized and operationalized into research. To conclude, I am arguing that a discursive approach might provide better insight about the nature and use of mathematical horizon in research and set the scene for further development of these ideas as part of mathematics teachers' discourse.

Key words: *mathematical horizon; teachers' knowledge; commognitive analysis; research as discourse; literature*
Session type: *Research paper*
Duration: *30 minutes*

Povey, Hilary*; Demissie, Fufy* & Adams, G*

What are the affordances and limitations of the Philosophy for Children (P4C) pedagogy for teaching and learning mathematics?

The increased emphasis on pupils' reasoning capabilities in primary mathematics education foregrounds pupils' conceptual understanding and the associated skills and dispositions (such as critical thinking, conjecturing, evaluating and evidencing). In the absence of pedagogical approaches to support this curriculum change, P4C offers an approach that can enable teachers to support pupils' reasoning and conceptual understanding. In this workshop, we reflect on the use of the P4C pedagogy in a PiCaM, a European Erasmus project in global citizenship and mathematics education. The project involves teachers and curriculum developers from Germany, Romania, Greece, Portugal and the UK. In particular, we explore the affordances and limitations of the P4C pedagogy in addressing global learning and mathematics education that also reflects ongoing debates within the P4C community and raise questions about the extent to which it may support either a neo-liberal interpretation of citizenship and global competence and / or a critical citizenship linked to affirmative politics. We consider the implications of



this approach for social justice.

Key words: *conceptual understanding; critical citizenship;*
Session type: *Research workshop*
Duration: *60 minutes*

Redmond, Ben* Golding, Jennie* & Grima, Grace

Assessing mathematics education for intelligent use of big data

Underpinning intelligent and purposeful harnessing of the affordances of 'big data' is a robust conceptual understanding of 'large data sets' - those which are susceptible to analysis through spreadsheets or other data processing software.

English 5-18 education until recently offered limited scope to develop increasingly important concepts related to data sets or associated data handling, representation and interpretation skills. We report on a study which evaluates emerging opportunities to support and assess such learning within one A-level (post-16 calculus-rich) course. For examination from summer 2018, A-level Mathematics students are required to engage with a 'large data set' using appropriate software. Their learning is summatively assessed drawing on pre-release material.

This area of teaching and learning, and the mode of summative assessment for this high-stakes qualification, is new to many teachers and students involved. We report on the challenges they faced, and their perceptions of the nature and extent of the support provided, during the first year of operation. We show that for teachers and students there are tensions between education for appropriate use of software and a focus on the underpinning conceptual understanding. There are also challenges for teachers and students in formative assessment of the related learning.

Key words: *Pre-university mathematics; large data set; data processing application software; formative assessment; summative assessment.*
Session type: *Research paper*
Duration: *30 minutes*

Saralar, Ipek*; Ainsworth, Shaaron; Wake, Geoff*

A design study on improving spatial thinking of middle school children

Spatial thinking and geometry are interrelated to each other. This relation can be described as two sets having an intersection which shows the common parts of them. Our current work is on improving middle school children's two-dimensional geometrical drawings of shapes constructed from unit cubes that belong to this intersection. For this purpose, a set of lessons were designed by the researchers and tested with initial samples of 8 and 30 students (Saralar, Ainsworth, Wake, 2018). The lessons based on the RETA principles which support realistic, exploratory, technology-enhanced and active teaching and learning environments. This approach was found to be an effective and engaging way of teaching two-dimensional drawings. Consequently, we scaled this approach to include more teachers and students to be able to report how this approach works in mainstream contexts. This study with over 200 students in two middle schools was the final cycle of our design-based research. The findings confirmed the results of previous cycles and showed that RETA-designed lessons provided more effective instruction than traditional methods.

Saralar, İ., Ainsworth, S., & Wake, G. (2018). How to help middle school children's learning of polycubical shapes. Proceedings of the British Society for Research into Learning Mathematics, 38(3), 1-6.

Key words: *Spatial thinking; geometry; two-dimensional drawings; middle school children; design-based research*
Session type: *Research paper*
Duration: *30 minutes*

Saunders, Piers

Learning from Scratch: an evolution of Teachers' mathematical knowledge.

This session is part of my ongoing doctoral work researching teachers engaging with a specially designed mathematics curriculum in Scratch, ScratchMaths and their developing teacher knowledge. My research aims to trace the development of teachers' mathematical reasoning as well as to focus on the core mathematical ideas of place value, variable and proportion and how these are mediated by engagement with the ScratchMaths curriculum.

In this session I will share part of my initial analysis of the data of two primary teachers as they learn to program with Scratch, initially in a CPD setting and then teaching programming with mathematics in a classroom setting over a period of 16 months.



The design based research methodological approach uses task based interviews and lesson observations to explore the teachers engagement with curriculum materials designed to be a window on their mathematical knowledge for teaching.

Key words: *Computational thinking, KS2, Curriculum, Mathematical knowledge for teaching*
Session type: *Research paper*
Duration: *30 minutes*

Sawyer, Robert

How the use of Task Design supports the development of teacher subject knowledge and pedagogy.

Task design refers to a process of a deep analysis and potential augmentation of a mathematical task or activity that considers what mathematics will be learned by engaging in the task, how the learner will interact with the task and the teaching methods and strategies that will be used. The initial proposal hypothesises that engagement in task design can impact on teachers practices and enacted beliefs, a process that Furinghetti (2007) has called "reorientation".

Further there is little doubt that the use of task design can not only influence teacher beliefs but also can have a significant impact on teacher subject knowledge and pedagogy Wilson and Cooney (2002); Watson et al (2015).

This workshop will explore how the process of task design can support the development of a pedagogy hereafter known as 'orchestrating the learning' so that it impacts on the attitudes and beliefs of teachers of mathematics in such a way that it:

1. Leads to improvements in subject knowledge;
2. Enhances the ability of the teacher to incorporate the pedagogy of 'orchestrating the learning' into their practice;
3. Becomes a permanent and regular feature of their practice

Key words: *Task Design; Orchestrating Learning/ Anticipating Responses*
Session type: *Research workshop*
Duration: *60 minutes*

Smith, Cathy

Discursive roles of time and maturity in constructing oneself as a further mathematics and/or mathematics student

Previous studies suggest that choosing to study A-level mathematics at age 16 is discursively constructed as a performance of masculinity, of self-belief and of dependability, and that such constructions have traction within institutional cultures of schooling. This paper focuses on language associated with 'time' and 'maturity' in the accounts of adolescents choosing to study mathematics and further mathematics. Drawing on interview data from a 2- year study, the paper identifies differences in the discursive patterns that structure the intelligibility of their participation: 'moving/improving' is associated with mathematics, while 'getting ahead' is associated with further mathematics. Two case studies show the inclusions and exclusions created and maintained by these discursive alignments.

Key words: *Participation; A-level; discourse*
Session type: *Research paper*
Duration: *60 minutes*

Tiflis, Ozdemir* & Ineson, Gwen*

Ratio and Proportion: An Analysis of GCSE resit Students' Errors

My PhD thesis will compare the types of errors that students, retaking their GCSE examination in colleges of further education, make in the topic of ratio and proportion in the UK and Turkey. In this presentation, I will share the findings of the first part of my data collection, which has been collected in the UK.

A total of 32 GCSE mathematics resit students were selected from one FE College in London. The Newman Error Hierarchy Model (Newman, 1977) was utilised to analyse data using descriptive statistics. This includes reading errors, comprehension errors, transformation errors, process skill errors, and encoding errors. The most common types of error were in transformation and process skills. However, although Newman allows us to identify these errors, it is not possible to identify the conceptual difficulty within the topic and something further is necessary. I will share the types of transformation and process errors students made to prompt discussion about possible support mechanisms to address these difficulties.

Key words: *Newman error hierarchy model; ratio and proportion; students' errors; GCSE; FE college; resits*
Session type: *Research paper*
Duration: *30 minutes*



Wake, Geoff and Foster, Colin

Didactical tools and their potential role in supporting curriculum coherence

An aim of many, if not all, mathematics curricula is to structure and support students' learning in ways that lead to understanding that is both mathematically coherent and connected. However, there is much transposition work to be done, particularly in the day-to-day work of teachers before this can be experienced by students in their classroom learning. In this presentation we will present some of our initial considerations of the potential of didactical tools to support this transposition work so that mathematics learning might be both coherent and connected.

We will draw on initial stages of our research with partners in Japan with whom we are exploring their approach to, and understanding of, the use of didactical tools through their ongoing curriculum design work as explored by teacher research groups through lesson study. We will draw on both resource (text book) analysis and research lesson accounts to illustrate our thinking to date.

Key words: *Teacher education, algebraic expressions, collaborative enquiry*
Session type: *Research paper*
Duration: *30 minutes*

Webb, Charlotte*, Oldroyd, Jenny* and Calvert, C

The impact of taking a study break on part-time distance-learning students: a three part study.

Students who engage with higher education through part-time learning are usually the most disadvantaged (ARC, 2013) and common progression barriers include cost, time constraints (work, caring commitments), and (in)flexibility of study (Butcher, 2015). Many undergraduate mathematics students become disengaged from their studies and student enjoyment decreases as they progress through undergraduate study (Croft, T. and Grove, M., 2015).

In the presentation I will discuss the findings from a small research study of part-time distance learning students of mathematics who have taken a study-break. In a two-year period we have found that mathematics students who had taken a study-break were at risk of not returning to study, with 13% of the student cohort not returning after a study-break. In response, an intervention was implemented to support these students, including revision and preparation tutorials, as well as discussions about qualification aims and employment. Semi-structured interviews were conducted with participating students and common themes were identified. One of the most significant of the student concerns about returning to study after a break, is "forgetting all the mathematics" from previous modules. This suggests that, along with the strategies we have already implemented, these students need extra support to refresh their mathematics.

Key words: *Undergraduate mathematics; distance-learning; retention; intervention*
Session type: *Research paper*
Duration: *30 minutes*

Wright, Pete*

The potential of participatory action research to promote critical reflection and transformations in mathematics classroom practice

In this workshop I will explore the potential of participatory action research (PAR) to bring about transformations in mathematics teaching through developing a critical understanding of existing classroom practice. A recent BERA study of 'close-to-practice' research (Wyse, et al., 2018) highlights the potential of action research to bring about changes in practice that address locally-identified problems. At the same time, it acknowledges how a lack of explicit focus on methodology can limit the potential for bringing about wider-scale change and contributing to knowledge in an academic field. I will present for discussion research approaches, such as 'video-stimulated reflection' and genuine collaboration between teacher researchers and academic researchers. These methods are currently being employed in the 'Visible Maths Pedagogy' project, a PAR project aiming to challenge inequitable outcomes in school mathematics through making pedagogy more visible to learners. Further information about the project can be found at <https://visiblemathspedagogy.wordpress.com/>

Reference:

Wyse, D., Brown, C., Oliver, S. & Poblete, X. (2018). The BERA close-to-practice research project: Research report. London: BERA.

Key words: *Participatory action research, school mathematics, visible pedagogy, video-stimulated reflection*
Session type: *Workshop paper*
Duration: *30 minutes*