

Research papers and workshops

Baker, Janet
University of Warwick

Title of session: **“The question is ... are feelings as important as learning?”: Assessing mathematics anxiety in young learners.**

Session Abstract: Mathematics Anxiety is a prevalent, distressing and debilitating problem across the UK which increases through secondary education. Whilst the causes of mathematics anxiety are well researched, and the implications for teaching are widely discussed, the age at which it becomes debilitating is less clear. I report on the first stage of my doctoral research, where I assessed the level of mathematics anxiety in pupils beginning their education at a large secondary school in the English Midlands. Maths anxiety was measured through a paper-based questionnaire in two parts. The first part gathered contextual information such as gender, age and Key Stage 2 Standard Assessment Test score. The second part was adapted for upper primary and lower secondary pupils (10 to 12-year olds) from the Betz Mathematics Anxiety Scale (MAS). This part asked the students to report their feelings in various mathematical situations. 223 year 7 students took part. The data was analysed using SPSS software. This research develops knowledge of the extent to which year 7 students are affected by mathematics anxiety, including issues related to prior mathematics achievement, gender, and teaching group.

Type: Research paper

Key Words: mathematics anxiety; pupil support; KS2, KS3, KS4

Baldry, Fay*
University of Leicester

Title of session: **Teaching high and low attaining sets: What changed for three teachers, and it was not more ‘drill and practice’**

Session Abstract: Drawing on findings from a classroom-based video study of three teachers, this presentation explores the teachers’ practice when they taught sets with different attainment profiles. The Orchestration of Mathematics Framework (OMF), developed as part of the study, was used to orientate the data collection and analysis. Differences in practices were found when sets were compared, such as tighter control over classroom talk in lower attaining sets, which mirrored prior research. However, there were no discernible differences regarding the levels ‘drill and practice’. Indeed, many of the teachers’ pedagogical characteristics were stable across lessons and classes. With research indicating that allocation to a low attaining set has a detrimental impact on attainment, implications for practice are considered.

Type: Research paper

Key Words: setting; lesson observation frameworks; pedagogical practice

Brown, Martin; Gibson, Kevin & Pope, Sue*
Scottish Qualifications Authority

Title of session: **Higher in Applications of Mathematics - developing a new qualification in Scotland to increase participation and achievement**

Session Abstract: At almost 50%, Scotland's participation in post-compulsory school mathematics is in sharp contrast to participation rates in the rest of the UK. The current Higher in Mathematics is valued as a highly effective component in preparation for STEM related further study and employment. However, there is an increasing need for mathematical and statistical literacy across an increasingly wide range of academic disciplines, in life and in work. Drawing on the work in England on Free Standing Mathematics Qualifications, AS and A level Use of Mathematics and Core Maths; and by the OECD on Mathematical Literacy in PISA, SQA is developing a new distinctive Higher in Applications of Mathematics to meet this need.

Type: Research paper

Key Words: qualifications development; assessment design; mathematical and statistical literacy

Curtis, Fiona

University of Reading

Title of session: **Money: The manipulative in your pocket**

Session Abstract: Research has shown that manipulatives are very helpful for conceptual understanding, allowing children to access their intuitive reasoning, providing a clear manifestation of ideas that facilitates teacher intervention, and offering the benefits of multiple representations. Yet manipulatives are very rarely used in the secondary classroom, for reasons of teacher perceptions as irrelevant at secondary level, or too problematic, and student resistance to 'childish' resources. This session advocates the use of money as a manipulative, drawing on students' knowledge of how money is used to demonstrate ideas of place value, operations, directed number, algebraic substitution, equation solving, sequences and data handling. I argue that students' familiarity with the way that money operates allows scaffolding for abstract concepts without the need to work with coins and notes.

Type: Research paper

Key Words: manipulatives; KS3 scaffolding; algebra

Foster, Colin

Loughborough University

Title of session: **Confidence Assessment to Support the Learning of Mathematics**

Session Abstract: Most research into mathematics confidence examines students' broad, general attitudes to mathematics. In this session, I will describe a finer-grained approach, called Confidence Assessment, in which students give a confidence rating alongside each of their responses to low-stakes, in-class tests to indicate how sure they are that each of their answers is correct. Their total mark is then weighted by their confidence ratings, rewarding them for accurate confidence ratings and penalising them for over-confidence or under-confidence.

There are several possible benefits of using Confidence Assessment as a regular feature of classroom formative assessment, including improving students' 'calibration', meaning that their confidence and competence are better correlated, which could enhance future learning; discouraging guessing, which adds 'noise' to formative assessments; and promoting self-checking.

I will summarise findings from my pilot study across five secondary schools, which suggested that the approach was easy for teachers to implement and for students to understand. I will then outline my current, larger study, exploring what happens when students use Confidence Assessment over a term or more.

Type: Research paper

Key Words: confidence assessment; formative assessment; negative marking; secondary

Godfrey, Alison

University of Leicester

Title of session: **Early career primary teachers' perceptions of the influences on their teaching of mathematics – a new theoretical model**

Session Abstract: Newly qualified primary teachers enter a varied environment in terms of schools' approaches to the learning and teaching of mathematics and provision for their ongoing learning and development as teachers of the subject. The literature suggests that in addition to factors related to their school context, potential influences on their evolving practice relate to their beliefs about the learning and teaching of mathematics; their background, including the interrelated aspects of subject knowledge, attitudes to mathematics and emotions; and their proactivity in response to their own reflection on practice.

This qualitative longitudinal study extends the existing literature by exploring these influences from the perspectives of teachers themselves. Eight early career primary teachers with a range of mathematical backgrounds are followed through their first two years as qualified teachers, with detailed evidence gained from five interviews with each teacher, including through the use of participant generated visual data collection techniques. Through their narratives, teachers' perspectives on the personal and complex nature of these influences are highlighted and deeper insights are provided into how these interrelate.

The focus of this presentation is on the model of the interacting influences on early career primary teachers' teaching of mathematics developed from this research.

Type: Research paper

Key Words: teacher characteristics; professional development; primary school mathematics

Helme, Rachel*
University of Bristol

Title of session: **What are the implications for identity positioning of forefronting the low attaining student's own narrative data?**

Session Abstract: Mathematical identity is described as the saying, doing and relating in the context of mathematics as well as the positioning by oneself and others (Bishop, 2012; Grootenboer & Edwards-Groves, 2019). A review of literature suggests that the mathematical identity of low prior attaining (LPA) students in mathematics can be negatively positioned and hence seen as deficient when compared to both other students, and the discipline of mathematics. However, the voices of either student or teacher participants seem less prevalent in these discussions than that of the researcher. As part of a study into the experiences of low prior attaining (LPA) students in mathematics I am considering the impact of forefronting student voice into discussions about their own identity enactments.

In this workshop we will review the statements by the LPA student themselves, and those of the teacher and other students about the LPA student as presented in literature. In particular, I seek to answer the questions How is the LPA student both directly, and indirectly, positioned by these statements? ; and, What themes emerge through the inclusion of the LPA student's own positioning statements?

Type: Research workshop

Key Words: Low prior attainment; positioning; identity

Kinnear, George*
University of Edinburgh

Title of session: **Reliable classification of classroom practices using lecture recordings**

Session Abstract: Numerous classroom observation protocols have been developed across school and higher education. Within higher education, an important application of these is to characterise and better understand "active learning" approaches, which have been identified as more effective than traditional lecturing. The Framework for Interactive Learning in Lectures (FILL) was developed to characterise the activities taking place in undergraduate physics lectures, and to analyse the levels of interactivity. I will report on recent collaborative work to develop a refined observation protocol, FILL+, which was designed to be more widely applicable across STEM lectures. I will present results from applying FILL+ to recordings of 220 STEM lectures, including 94 in mathematics. A key finding was that the FILL+ protocol can be applied reliably by novice coders, following training. The rich data set that we have produced presents several opportunities for further work, which we will discuss.

Type: Research paper

Key Words: classroom observation; active learning; interactivity

McGill, Shauna
Ulster University

Title of session: **Primary Mathematics Technological Anxiety: a mixed methods exploratory case study of primary pre-service teachers.**

Session Abstract: Using the Technological Pedagogical Content Knowledge (TPACK) survey and an Abbreviated Mathematics Rating Scale (AMARS) to quantitatively measure Technological Knowledge and Mathematics Anxiety among Post Graduate Primary student teachers, the exploratory case study quantitative and qualitatively investigates some of the inflammatory indicators of Mathematics Technological Anxiety. Based on the SPSS analyses of the quantitative data, although pre-service teachers' mathematics anxiety levels significantly decreased by the end of the course technological knowledge did not significantly improve. Moreover it can be concluded from the qualitative thematic analysis that the pre-service primary teachers felt the pressure to use technological devices in mathematics resulted in increased mathematical and technological anxiety levels.

Type: Research paper

Key Words: maths anxiety; technological knowledge; preservice teachers.

Medrano Moya, Ana*, Xolocotzin, Ulises* and Inglis, Matthew*

Mathematics Education Department, Cinvestav; Mathematics Education Department, Cinvestav; Mathematics Education Centre, Loughborough University

Title of session: **Promoting children's functional thinking with diagrams**

Session Abstract: Functional thinking is the ability to understand relations between number sets using concepts like covariation, generalization, unknowns, and symbolic expressions. This study explores the potential of diagrams to nurture functional thinking in elementary grades. 1145 students in Year 4, Year 5 and Year 6 resolved functional tasks with data represented with diagrams and tables, with or without a concrete context. Across grades, diagrams facilitated functional thinking more than tables, but only when the data was embedded in a concrete context such as shadows cast. We conclude that the use of diagrams might enrich the design of instructional materials to introduce algebraic ideas in elementary school.

Research paper

Key Words: Functional thinking, early algebra, diagrams, tables, visual representations

Nyama, Joyce

University of Warwick

Title of session: **Bouncebackability: Getting back from maths setbacks: Subjectivity and Educational Interventions to develop Mathematical Resilience - a study carried out at a girls' school.**

Session Abstract: The UK mathematics education landscape is increasingly focusing on equipping students to 'solve problems by applying their mathematics to a variety of routine and non-routine problems with increasing sophistication, including breaking down problems into a series of simpler steps and persevering in seeking solutions' (GOV.UK, n.d). This study explores the construct of mathematical resilience as one of the vehicles that could be used not only to deliver the goal of UK government but also to enable students to manage their learning safely. This research draws together two major areas of research, Q Methodology and especially its subjectivity attribute and Interventions, to highlight the role subjectivity can play in intervention programmes that could support the development of mathematical resilience. The association between subjectivity and intervention has been lacking in mathematical resilience intervention literature so far. From this study, subjectivity emerged as an advantageous selection criterion for intervention candidates. intervention candidates are part of their own 'selection' and when interventions are matched to subjective views, they make more sense to the students and ultimately are better received and therefore likely to have added effectiveness.

Type: Research paper

Key Words: Q Methodology, intervention, mathematical resilience

Portter, Andrew and Golding Gerry*

Open University

Title of session: **Developing "use value" mindsets to combat undergraduates' negative perceptions of learning mathematics in a first-year service mathematics environment**

Session Abstract: Do students fully appreciate the relevance of first year undergraduate study? Anecdotally, it would appear that many students focus on just “doing enough to pass”. When first year involves mathematics in a service mathematics environment, students’ perceptions of the “usefulness of mathematics” can exacerbate the problem.

This session will introduce ongoing scholarship work at the Open University aimed at better understanding perceptions of first-year mathematics students on the introductory service mathematics module “Discovering mathematics”.

We define a “use value” mindset as the perception of studying mathematics being inherently useful to future study and career goals – in contrast to the perception of studying mathematics as having a tangible “exchange value”, where passing grades are exchanged for progression and accreditation. A use value mindset promotes engagement with deep conceptual learning, rather than a strategic focus on imminent assessment.

Using data from tutors’ reflective journals leading to selected student interviews, we will analyse perceptions of students in relation to their mathematical studies at two key assessment stages, and their reaction to a range of context-based activities in the learning environment. An initial goal is to develop student personas representative of students who study this module to facilitate more targeted support interventions.

Type: Research paper

Key Words: support interventions; student engagement; services mathematics; assessment; instructional resources

Predergast, Mark and Howie, Jackie *
University College Cork; Learning Link Scotland

Title of session: **Teaching problem solving in mathematics in technology rich environments**

Session Abstract: In recent years, many countries have been implementing comprehensive curricula reform and are prioritising the development of problem solving in mathematics. However, it is now generally accepted that success in problem solving is affected by factors beyond simply the knowledge that a person holds (Mason, 2003). Stacey (2005) identified students’ beliefs as one of seven contributing factors to successful problem solving. As part of an Erasmus+ funded European project, this research sought to identify mathematics learners beliefs towards problem solving in five countries, namely; Denmark, Finland, Northern Ireland, Republic of Ireland, and Scotland. A quantitative measure of these beliefs was attained through the use of the Indiana Mathematical Belief Scale, an existing thirty item (five scale) self-report questionnaire. Participants (n = 1723) were selected using a convenience sampling method across a range of different education sectors (e.g. secondary, vocational and adult education). An analysis of the data across all five countries revealed issues with regard to ‘solving problems using steps’ and the ‘importance of word problems’. A series of follow on interviews with mathematics/ numeracy practitioners in each of the five countries was used to supplement the data.

Type: Research workshop

Key Words: problem solving; technology; students' beliefs

[Rodd, Melissa](#)
UCL Institute of Education

Title of session: **Art in maths**

Session Abstract: This ‘research workshop’ will be set up in three parts: (1) a short presentation on what ‘art in maths’ might mean - with examples from recent work with masters students on aesthetics and mathematics; (2) a discussion, with illustrations from mathematical practice, on such questions as: What are interfaces between visual art and mathematical practices? How can we employ art to engage with mathematics when unsure (for instance, when learning) or curious (for instance, when researching)? Can there be new interfaces that can be used in teaching?; (3) an opportunity to contribute to designing a newly funded project in which graduate students in mathematics are the research participants; an aim of the project is to produce art work that will give insight into being a working mathematician.

Type: Research workshop

Key Words: visual art; working mathematician; interfaces between practices

Rumbelow, Michael

University of Bristol

Title of session: **Musical bar-modelling: using Cuisenaire rods to reconnect mathematics with music**

Session Abstract: For thousands of years music was central to the Western European mathematics curriculum, and the single-stringed monochord was used by teachers as an 'audible diagram' to demonstrate relationships between whole-number ratios of plucked string lengths and harmonious notes. However, recently music has been reported as in decline and at risk of being dropped altogether as a subject in many schools in England.

This presentation focuses on a design experiment in adapting Cuisenaire rods to support cross-curricular teaching of music and mathematics in primary schools. Georges Cuisenaire (1891-1975) was a Belgian conservatoire-trained violinist and music teacher, who in the mid-twentieth century developed coloured wooden rods for his primary school students as a 'keyboard' on which to play mathematical concepts. Accounts suggest that Cuisenaire encoded musical ratios in the colouring of his rods, such as giving rods of twice the length similar hues, just as octave notes of twice the pitch are given the same syllable in 'Do-Re-Mi' singing, which Cuisenaire taught.

At the session participants will be invited to explore the musicality of Cuisenaire rods and their potential cross-curricular application to both mathematical bar-modelling and music teaching.

Type: Research paper

Key Words: bar-modelling; manipulatives; Cuisenaire rods; cross-curricular; music

Simms, Victoria; McKeaveney, Clare; Sloan, Seaneen; Gilmore, Camilla

Ulster University, Queen's University Belfast, University College Dublin, Loughborough University

Title of session: **Evidence-based primary mathematics interventions: A systematic review**

Session Abstract: Mathematical achievement is important for children's future educational success, employment opportunities and health outcomes. However, it is recognised that there is substantial underachievement in this subject. This review investigated the outcomes of classroom-based mathematical interventions that were targeted at primary school-aged children. The review assessed whether the interventions had an effect on mathematical achievement or related attitudinal or affective constructs. The review summarises eighty studies of varying quality. Therefore, we suggest that teachers and policy makers make any decisions for their practice or policy with caution. The lack of replication studies or studies that compare the effectiveness of different interventions is striking. This review highlights the necessity for further, rigorous studies that assess the efficacy and effectiveness of interventions to improve mathematical achievement. In addition, due to the varied nature of the interventions and use of outcome measures (with a high prevalence of author-generated measures) the authors suggest that a Core Outcome Set (an agreed set of outcome measures) should be developed by researchers working in collaboration with educational professionals to aid comparison across studies.

Type: Research paper

Key Words: primary-school; interventions; systematic review

Thouless, Helen*; Ruttenberg-Rozen, Robyn

UCL-Institute of Education, Ontario Tech

Title of session: **A metasyntesis of mathematics education research into mathematics learning difficulties**

Session Abstract: In this session I will explain our metasyntesis of articles on mathematics learning difficulties published in the top mathematics education journals. The analysis of the articles is based on Confrey's (2018) framework for analysing journal articles: Inform, Deform, and Reform. On the basis of this analysis we will discuss the types of research questions that should be addressed in future articles in order to attain equity for students with mathematics difficulties.

Type: Research paper

Key Words: mathematical difficulties; metasynthesis; special education

Tope, Clare

Open University

Title of session: **What do beginner teachers notice about examples presented in textbooks?**

Session Abstract: This session reports on a research project which examined learner teacher responses to the study of examples presented in textbooks. The research project was underpinned by a line of argument presented by Watson and Mason (2005:5) which concluded that careful choice of examples might be seen as central in the learning and teaching of mathematics. Textbooks were chosen as a source of examples as the outcomes of a wide-ranging analysis of textbooks from around the world suggested that textbooks can play a key role in the improvement of educational arrangements (Cambridge Assessment 2014 and 2016).

The study explored three research questions:

- What do students notice about sets of examples?
- How does this change over time?
- What are the implications for practice?

The key conclusion of the project was that the careful study of examples presented in textbooks can be justified as part of a programme of initial teacher education because over time students became increasingly critically aware of some of the complexities involved in the choice of examples. I also conclude that emphasis needed to be given to opportunities to explore the pedagogy of textbook use and the professional decision making that is necessary to use textbooks effectively.

Type: Research paper

Key Words: primary; beginner teachers; textbooks; notice

Wright, Pete

UCL Institute of Education

Title of session: **Metacognition and visible mathematics pedagogy**

Session Abstract: During this session I will facilitate a discussion around the question: Just how visible should mathematics pedagogy be? It is well established that developing students' metacognitive skills can impact positively on students' mathematical attainment and engagement (Smith and Mancy, 2018). Metacognition generally involves students developing a greater awareness of, and self-regulation over, their own learning through discussion, questioning, justification and reflection. A less-well established body of research suggests that students, particularly those from disadvantaged backgrounds, often misinterpret the intentions of the teacher in the mathematics classroom, particularly when the learning is less teacher-led (Lubienski, 2004). The question is to what extent can the benefits of metacognition be enhanced through students developing a greater understanding of the rationale behind the teacher's pedagogy? How might making pedagogy more visible, and discussing its rationale with learners, enable a wider range of students to make the most of opportunities provided in lessons with a greater focus on metacognitive skills. In facilitating this discussion, I will draw on findings from two action research projects, The Teaching Maths for Social Justice project - <https://maths-socialjustice.weebly.com/> - and the Visible Maths Pedagogy project - <https://visiblemathspedagogy.wordpress.com/>

Type: Research workshop

Key Words: metacognition; school mathematics; visible pedagogy

Zhang, Chengkang

University of Bristol

Title of session: **A Comparative Analysis of Examples Used in Textbooks between the United Kingdom and China**

Session Abstract: This research is devoted to analysing the examples used in textbooks from two countries. The aim is to give suggestions for teachers who work in the bilingual schools, to choose the advantages of an aspect of each of the two types of textbooks to increase teaching efficiency.

Six criteria are included in the analysing framework for comparing five topics selected from two countries' textbooks. Five bilingual teachers are invited in the interviews to express their attitudes for the two textbooks after they read the comparison results.

By comparison, the UK's textbooks are more straightforward and clearer in terms of knowledge structure, which supports an effective scaffolding for learners, while Chinese textbooks usually link theory and real-life together to teach students which mention the basics briefly, includes more information in an example and imply to explore mathematics with students together in language. Finally, I suggest that except from using extra examples to strengthen students' exam questions-solving ability, the UK's textbooks can be used as mainstream textbooks due to the final exam, whereas the Chinese ones could be a supplement for learners in early ages and for quick learning of high-ability students or as an expanding of leading students to appreciate mathematics.

Type: Research paper

Key Words: comparing mathematics textbooks; examples; the United Kingdom and China; 13 to 18 years old

Working groups (all 60 minutes)

Ineson, Gwen*; Gifford, Sue*; Marks, Rachel*

Brunel University London, University of Roehampton, University of Brighton

Title of session: **Early Years and Primary Mathematics (EYPM) Working Group – 7th meeting**

Session Abstract: In this seventh meeting of the Early Years and Primary Mathematics (EYPM) Working Group, we will continue to build on the networks that are developing within the group, but we also welcome new members with an interest in EYPM – please do feel welcome to join us.

As this conference will be held in Northern Ireland, part of the meeting will focus on similarities and differences between the English, Republic of Ireland and Northern Ireland's EYFS and primary mathematics curriculum and assessment frameworks. Participants of the working group will be invited to share their perspectives.

Sue Gifford will share some interesting results from a preliminary survey about geometry in ITE courses in England. Rachel Marks will share some early highlights on the EEF funded review of evidence on early years and key stage one mathematics teaching.

Finally, we will discuss possible research opportunities for members of the group to collaborate on between conferences.

Key Words: early years mathematics; primary mathematics; geometry; collaboration

Jones, Ian*; Kinnear, George*

Loughborough University; University of Edinburgh

Title of session: **Online assessment working group**

Session Abstract: This is a new working group proposed in response to the proliferation of the use of online assessment in mathematics, and a corresponding need for research into automated assessment, scoring and feedback. Advantages of moving assessments online are that they can be completed remotely, scoring and feedback can be automated, and large cohorts can be assessed reliably and efficiently. The main disadvantage is the limitation imposed by requiring students to input their responses in a way that can be processed by a machine, be it multiple-choice options or text-box entry. The working group will aspire to contributing research-driven critique and design principles for the development of online tests.

This first session will focus on the STACK system (see tinyurl.com/aboutSTACK) and will comprise of four main sections.

1. Introduction to the STACK system led by the working group chairs.
2. Participants will have a go with the STACK system (please bring a laptop or iPad).
3. Discussion on how best to provide feedback using an automated tool such as STACK.
4. Brief brainstorming of ideas for future meetings of the online assessment working group.

Key Words: assessment; technology; feedback

Wake, Geoff* & Foster, Colin*
University of Nottingham, Loughborough University

Title of session: **Didactics working group**

Session Abstract: In the first meeting of this working group participants briefly explored the meaning of the term 'didactics' in the European tradition. There was also discussion about the potential of didactical design in resources for teaching in Shanghai and Japan. This discussion suggested that we might look at resources closer to home that might exhibit careful design in terms of curriculum coherence supported by didactical devices. In this second session of the working group our intention, therefore, is to consider didactical approaches taken in a series of classic UK textbooks (the SMP lettered books) and consider their potential for curriculum coherence.

Key Words: didactics; curriculum; task design