



## Plenary lecture 1

**Sofya Lyakhova**, Swansea University

*What does mathematics as a discipline tell us about how to teach it, how to research it and how to do research in mathematics education?*

I will talk about my personal experience of being a teacher, mathematics researcher and a researcher in mathematics education and will attempt to draw a comparison between these activities.

Based on the opinions of mathematics researchers (both historical and contemporary) I will share my views on how these activities and methods they employ are influenced by the nature of the discipline itself.

## Plenary lecture 2

**Jane Waters**, University of Wales Trinity St Davids

*Research writing or 'dissemination': Know your purpose, know your audience and know your message!*

This presentation encourages the audience to carefully consider the *why* element of dissemination and publication. We consider various purposes for these activities and the implications of the *why* for the nature of the product. By reviewing some examples of dissemination and publication products we are able to determine when purpose, audience and message have been successfully aligned ... and when they have been misaligned. We are reminded that misalignment is associated with wasted time and effort, and working 'smartly' means avoiding such pitfalls!

**Baker, Emma** NNEM Practitioner Researcher and Caldicot School, Monmouthshire

*"I've done this before, but I can't remember how to do it!": Improving retention of learning in mathematics.*

A frequent complaint of mathematics teachers is that students cannot recall their prior learning, thus hindering efforts to build on this, to make further progress. This session reports on an action research project that aims to improve Year 7 students' retention of mathematical learning and memory through recall and application of knowledge and skills. The research draws on the work of pioneering psychologist, Ebbinghaus. His work [1] in memory included the discovery of the forgetting curve, demonstrating how newly gained information is lost from memory over time when no attempt is made to retain it. This research involves a study of two similar ability Year 7 classes over two academic terms, implementing retrieval practice strategies through carefully designed homework tasks. Initial findings indicate that it is not only the act of retrieval that is important but also the associated feedback.



[1] Memory: A Contribution to Experimental Psychology Ebbinghaus, H. (1913).. (H. Ruger, & C. Bussenius, Trans.) New York, NY: Teachers College

Key words: retrieval practice, task design, memory

Session type: Research paper

Time: 30 minutes

**Bishop, Emma** NNEM Practitioner Researcher and Ysgol Bryn Elian

*Does regular exposure to mathematical methods and formulae in the form of a visual aid and self-questioning model ('Numeracy Mats') positively impact pupils' retention and self-regulation strategies when solving problems under exam conditions?*

This strand of design research is part of a larger, on-going study that aims to evaluate the impact of domain specific self-questioning prompts and regular exposure to common mathematical methods and formulae in the form of 'Numeracy Mats'. The motivation for this study came from the observation of a Year 10 Set 1 Class tackling GCSE Numeracy problems. Although seemingly mathematically able and with strong literacy skills, they initially struggled to make the mathematical connections and on occasions recall the necessary methods or formulae.

The concept of the mats are based on the theory of metacognition and it's influence on problem solving. Metacognition is 'active mental participation' (Flavell, 1979) and has been defined as 'actively attending to one's thinking' (Pate and Miller, 2011). Ozsoy and Ataman (2009) identified self-questioning as a strategy for developing metacognition within the framework of constructivist learning. Therefore important mathematical information was connected on the mats by questions that model a self-regulatory approach to arriving at the methods or formulae needed to calculate solutions. The design and visual element of the mats was deeply considered, particularly the colour and font as these have been found to influence the recall of learnt information.

The mats are now permanently in place with adhesive clear film on all tables in the classroom and their use has been modelled in a lesson. Pupils continue to use and refer to them whenever they need. Pre-quantitative data has been collected from a pre-test and questionnaire that was constructed especially for this study to measure any changes in metacognitive awareness over the course of six months. However, initial in-class observations are that pupils are becoming more conscious of their approach to solving mathematical problems and are able to better recall the necessary information.

Key words: Problem solving; numeracy GCSE; metacognition; self-questioning; mathematics

Session type: Research paper

Time: 30 minutes

**Bustang, Bustang** University of Leicester

*Designing a learning trajectory that connects proportional reasoning and probability: An initial design framework*

There has been a considerable amount of research on students' misconceptions about probability as well as the heuristics that may lie behind them, both by psychologists (e.g. Piaget & Inhelder, 1975;



Tversky & Kahneman, 1974) and mathematics and statistics education researchers (e.g. Fischbein, 1975; Fischbein & Schnarch, 1997; Green, 1983; Jones, Langrall & Mooney, 2007; Shaughnessy, 2003). However, research exploring whether some misconceptions in probability are caused by misapplication of proportional reasoning is limited (e.g. Van Dooren et al, 2003). Furthermore, Jones et al (2007) in his review of research in probability highlighted the need of research on developing hypothetical learning trajectories along with instructional theory for teaching and learning probability at all age levels. The work of Van Dooren and research review of Jones call for further research on development and evaluation of instructional programs that provide a rich setting for the convergence of proportional reasoning and probability. In this presentation, I will present the initial design framework that tries to connect proportional reasoning and probability, aiming to help students improve their probabilistic reasoning and prevent misconceptions.

Key words: proportional reasoning; probabilistic reasoning; probability misconceptions

Session type: Research paper

Time: 30 minutes

**Cascella, Clelia and Giorgio Bolondi** University of Manchester, Freie Universitat of Bozen

*How much does Math item phrasing matter? Empirical evidences from an "experimental" study*

The existence of a remarkable relationship between item phrasing and its psychometrical functionality is well recognized as well as the impact of this relationship on information quality about estimated student's abilities in Mathematics.

More or less glaring factors can explain such relationship. The probability to provide a correct answer obviously depends on student's ability to understand question's literal meaning but also (and maybe less clearly) on further factors, such as the relationship between some item phrasing and the activation of specific cognitive processes since they implicitly activate/stimulate in student's mind some cognitive strategies to solve an item in place of other ones.

Our research is aimed at studying these relationships by administering four alternative and anchored Math tests. Each of our forms contains theoretically supported variations in item phrasing in an effort to not modify item's question intent. Our tests were administered to a probabilistic sample (2040 14-years old students), stratified by Region and students' socio-cultural background.

Our preliminary results confirm some relevant theoretical hypotheses regarding the relationship between item phrasing and its psychometrical functionality and they suggest the concrete possibility to list these associations in order to use them in future items construction process.

**Cosgrove, Fay** NNEM Practitioner Researcher and St Joseph's Cathedral Primary School

*Using the Knowledge Quartet as a starting point in professional development of teachers of mathematics*

This presentation concerns research about the mathematics professional development of primary teachers. The research aimed to develop an intervention to reduce anxiety felt by teachers when teaching maths in turn aiming to reduce the anxiety passed on by teachers to their pupils. A related



aim was to improve teaching efficacy for maths. The design of the professional development intervention was based on the theoretical ideas of The Knowledge Quartet (Rowland et al 2005) which focuses teachers on the subject-specific skills for teaching maths. The research took place over three months in the academic year 2017-18 and involved four teachers in primary schools in Swansea. Teachers video recorded their own lessons and in pairs discussed critical incidents captured linking to the 20 codes of the Knowledge Quartet. Emerging findings suggest that maths anxiety is slightly reduced and teaching efficacy slightly improved. Implications for my own practice and future school priorities are discussed.

Key words: professional development; primary; maths anxiety  
Session type: Research paper  
Time: 30 minutes

**Dunne Imogen** NNEM Practitioner Researcher and Cathays High School

*Improving mathematical retention in preparation for the new GCSE Numeracy exams, with the use of daily 'sprint' tests*

My presentation discusses the impact of a newly-created retention resource on students' GCSE Numeracy outcomes. Many students currently struggle to access the new GCSE Numeracy exam due to them not being able to retain key information, work under time pressure and understand the long, worded problems presented within the exams. Having researched the GCSE Numeracy Intermediate specification in depth, along with theories in memory and retention, I have created a new resource which aims to support students in retaining the maximum amount of information needed, to access the GCSE Numeracy exam. The research, which aimed to investigate student mathematical achievement related to topics in the GCSE Numeracy exam, was carried out with a Year 10 class, Target Grades of C-E, in a comprehensive high school in Cardiff with a high percentage of EAL pupils. My presentation will discuss the positive impact this resource has had and next steps in ensuring all students can better access the new GCSE Numeracy exams.

Key words: memory; retention; numeracy; GCSE  
Session type: Research paper  
Time: 30 minutes

**Eastwood, Kathryn** NNEM Practitioner Researcher and Ysgol Dinas Bran

*Can multiple visual representations of fraction models support learners to progress through the enactive and iconic, to solve more abstract fraction problems? Fraction Mastery : Entering into symbols*

This presentation is about research with year 9 students on Fractions. In particular it focuses on low attainment students who constantly find routine fraction problems very difficult or impossible to do. It looks at how conceptual understanding can be deepened through use of physical and diagrammatic representations. It looks at methods used for solving abstract fraction problems in the classroom and uses Bruner's (1961) theory of learning, where mathematical concepts are represented in three different ways: enactive (concrete), iconic (pictorial) and symbolic (abstract).



The particular concern of this research is how well visual and iconic methods support students in being able to progress on to solve abstract problems that they would not normally be expected to solve.

My research examines pupils' perceptions of the usefulness of visual models and applets as tools to help them make sense of routine fraction problems.

I carried out my research with 24 students in 2 classes in North Wales. Both groups follow the same scheme of work at Key Stage 3 and have comparable attainment levels. Fraction kits were made and used to support mastery as a 'bridge' between solving visual problems with concrete manipulatives and solving problems using symbolic representations once they had started to 'master' fractions on the Fraction Applet. This research includes a critical reflection of my teaching practice and a systematic evaluation of the impact of fraction kits and Applets on pupils' personal perceptions of solving fraction problems.

Emerging findings show that student confidence does increase with the use of visual concrete manipulatives and this varies between students. It has also identified the importance of basic fraction language and teacher questioning to build student confidence. Implications for my teaching and changes in future schemes of work will be discussed.

Key words: fractions; mastery; multiple representations, iconic, abstract

Session type: Research paper

Time: 30 minutes

**Hendy, Theresa** NNEM Practitioner Researcher and Gower College Swansea

*How does the use of structured discussion in mathematics change the students' experience of A level and GCSE mathematics?*

This presentation sets out to explore the changes in students' experience through the use of structured discussion in mathematics. Previous research has emphasised the importance of talk as a pivotal factor in the richness of the student learning experience but often there is a lack of opportunity for this to take place particularly at A level. I look at the issues of creating an environment, in both my own classroom and colleagues', to catalyse dialogic teaching and describe my methodology, asserting throughout that this is a simple and effective way of promoting a move towards dialogic pedagogy in day to day teaching practice. The student response to this initiative is considered, comparing it to more traditional forms of teaching and this intervention is recommended as a valuable, straight forward, teaching tool for discursive learning.

Key words: mathematical discussion ;group work ;A level;

Session type: Research paper

Time: 30 minutes

**Heshmati, Holly** University of Warwick,

*Learners creating video revision resources to promote mathematics self-efficacy*

This paper reports on action research aimed at improving pupils' self-efficacy in mathematics. Relationships between learners' self-efficacy and achievement have been well-researched. However,



less is known about practical pedagogical strategies teachers can use to strengthen learners' self-efficacy.

There are four factors influencing learners' appraisal of their self-efficacy: learner' past attainment, their vicarious experiences, their experiences of being 'persuaded', and their physiological reactions. The action research was designed to develop features of mathematical self-efficacy amongst pupils in one school through their participation in creating VLE resources. During 28 lessons, various approaches were explored through addressing the aforementioned factors. Data was collected by observations, learning journals and questionnaires.

The results confirmed that pupils' engagement in creating VLE resources exposed pupils to various sources of experience in developing self-efficacy. Pupils' collaboration and teachers' feedback improved pupils' subject mastery along with their experiences of vicarious success and persuasion, and positive physiological reactions.

Key words: mathematical self-efficacy; VLE resources; achievement; collaborative learning

Session type: Research paper

Time: 30 minutes

**Kinnear, George** University of Edinburgh

### *Measuring learning from two-stage collaborative exams in mathematics*

In a two-stage exam, students complete a normal exam individually before working in small groups to answer the exam questions again. This style of assessment is gaining in popularity; for instance, they are now widely used at the University of British Columbia, including 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 several existing studies which have explored the effect of two-stage exams on learning in a variety of (non-mathematics) disciplines. We will also report on some preliminary findings from studies into the effect of two-stage exams in three university mathematics courses, and discuss possible future directions for this work.

Key words: assessment; examinations; group work

Session type: Research paper

Time: 30 minutes

**Mulu, Hildegardis** University College London

### *Encouraging social justice in mathematics learning – can it be achieved in setted classrooms?*

Promoting social justice in mathematics education has been commenced since the emergence of notion 'critical mathematics education'. Since then there is an increasing number of research focusing in addressing the link of mathematics education and social justice. On the one hand, there is also growing interest in the research about homogenous grouping in mathematics classrooms which is mainly based on results of standardised tests which is assumed to portray so-called



students' ability. One of its most prevalent forms in England and Wales is setting. However, this grouping is presumably unjust and seemed to hinder the promotion of social justice. In this essay I analyse how the development of students' awareness of social justice might be achieved in a setted classroom. This literature review paper, drawing on pertinent corpus of research will address the issue. The paper analyse the concept of social justice in mathematics learning: how to incorporate social justice issues in learning and what constitutes a socially just learning, then how setting might affect students' perception of social justice.

Key words: social justice; setting; mathematics classrooms; ability grouping; students' perception of social justice

Session type: Research paper

Time: 30 minutes

**Sahin, Nejla Tugcem**, University of Aberdeen

*Teachers' Attitudes towards Children with Special Educational Needs: A Comparative Case Study with Pre-service and In-service Mathematics Teachers*

According to National Statistics, the proportion of children with Special Educational Needs (SEN) in England is 14.4%. Teachers are encouraged to be aware of diversity in schools, as well as the problems that might arise in inclusive settings. Some research studies have pointed that successful inclusion depends on teachers having a positive attitude towards inclusive education and children with SEN (Avramidis, et al., 2000; Delaney, 2016; Secer, 2010). The question this study asks: "what might be the probable reasons behind teachers' positive/negative attitude towards children with SEN?". To answer this question, the attitude of in-service and pre-service secondary school mathematics teachers towards children with SEN is examined in a comparative way, considering years of teaching experience. For the purpose of the study, ten participants (five in-service and five pre-service teachers) were interviewed, using semi-structured interviews. The data was analysed, using thematic analysis, and categorised into themes. The results indicate that in-service teachers hold more positive views about children with SEN in comparison to pre-service teachers. Interestingly, teachers with personal, non-teaching experience of SEN have highly positive attitudes compared to other participants.

Key words: Special Educational Needs; teacher attitudes; inclusive education

Session type: Research paper

Time: 30 minutes

**Wells, Rachel** NNEM Practitioner Researcher and Milton Primary School

*Is children's understanding of mathematically related vocabulary the obstacle when problem-solving?*

Research indicates that a key part to understanding mathematics is learning the vocabulary. One of the obstacles to this can be the lack of opportunities provided.

This presentation will focus initially on an investigation into whether following a systematic approach to the teaching of mathematically related vocabulary in order to deepen pupils'



understanding, would consequently improve their ability to problem solve? The intervention targets a group of Year 2 more able pupils.

The methodology adopted is one that combines direct teaching alongside meaningful contexts.

Initial findings recognised that more time than originally planned was required on the direct teaching of each key word. However, it also became evident very quickly that the pupils did not know where to begin when problem solving and they were reluctant to 'jot'.

Unfortunately, due to circumstances beyond my control, the focus of this intervention had to change and I was unable to complete the research as planned.

Whilst I will be able to provide some details of my findings, part of the presentation will explore how things can go wrong with action research.

Key words: problem-solving; vocabulary; deepen understanding; Year 2

Session type: Research paper

Time: 30 minutes

**Williams, Ross** NNEM Practitioner Researcher and Hakin Community School

### *Making the Most of Manipulatives in Upper Key Stage Two*

This research explores the use of the Concrete, Pictorial, Abstract approach, sometimes known as 'Singapore Maths'. The approach is supported by a wealth of academic research.

Concrete mathematical resources are generally much less common in upper Key Stage Two classes than in lower years. However, I believe they still have an important role and in this action research project within my own classroom, I designed an intervention to promote the use of concrete resources. My planning for the use of concrete resources is meticulous and learning focuses on developing understanding of key concepts as opposed to mathematical processes. After spending time experimenting with manipulatives such as Cuisenaire rods, number counters, bead bars and numicon, learners are moved towards a pictorial representation, commonly the bar model. Although the approach has been adopted with all children, the research has focused upon the progress of four children. The research triangulates video analysis, summative assessment and pupil voice.

The findings are still at the emerging stage, but it appears that learners use concrete and pictorial approaches consistently to support them to solve problem in a variety of different contexts. Further, there has been a significant change in my pedagogy.

Key words: manipulatives; bar modelling; CPA; upper Key Stage Two

Session type: Research paper

Time: 30 minutes