

BSRLM Virtual New Researchers' Day: Abstracts

Opening keynote speech: Geoff Wake (University of Nottingham)

Case studies: from theory to reality

Case studies are often used in educational research: like many research methodologies in the social sciences "case study" as a research paradigm has only developed relatively recently and can often be considered as a 'catch all' for a range of 'messy' approaches to making sense of the complexities of educational settings. This session will explore some of the theoretical underpinnings of case study work, consider questions such as "what is your unit of analysis?", 'what are the advantages of developing multiple case studies?', and so on, as well as considering issues of context, nested cases, issues of validity etc. This session will consider both theoretical ideas and how these might play out in practice by considering how case studies are being developed as part of a large research project I direct with a focus on GCSE maths resits.



Geoff Wake is Professor of Mathematics Education at the University of Nottingham where, following a successful career teaching in schools and colleges, he leads a number of research projects and convenes the work of the Centre for Research in Mathematics Education. Currently he is researching different approaches to teaching and learning GCSE resit mathematics as part of the Centres for Excellence in Mathematics programme. He is also carrying out research with colleagues in Japan that explores conceptual development of mathematics as developed in the curriculum and in school classrooms.

Closing keynote speech: Jennie Golding

Is that OK?' Conundrums of developing as an ethical researcher

Your research project will (have) need(ed) 'ethical approval' from your institution. However, developing an ethical approach to research is far more pervasive than following guidelines to complete that form to the approver's satisfaction. It involves the development of honesty, trust, fairness, respect, responsibility, and sometimes, courage in all aspects of your research, including the related interactions - and a sensitivity to changing circumstances that might compromise those. So how can you develop an ongoing awareness of such issues? How do they change with the age, experience or circumstances of participants in your research? This session will address some related challenges by drawing on my own, students' and colleagues' ethical dilemmas via a set of 'vignettes', and will invite discussion of those.



Jennie Golding is Associate Professor of mathematics education at UCL Institute of Education, and currently Ethics Lead for her department. Her own work builds on her considerable background in 5-18 mathematics education by focusing on the policy-practice interface through classroom-close research. See <https://iris.ucl.ac.uk/iris/browse/profile?upi=JGOLD18>

Abstracts for parallel sessions

Students' Understanding of a Mathematical Concept: A focus on Metaphors

Ahn, Aehee, University of Bristol

As mathematical concepts are interrelated, students' current understanding of a concept affects their further learning. Thus, for effective teaching and learning, I aim to find a way of investigating students' understanding of mathematics.

Mathematics as a language of conceptual tools is full of representations, and students re-interpret the representations to understand mathematical concepts. A metaphor is an important aspect of learning mathematics in terms of a powerful linguistic approach for creating and extending meanings of a concept. In the contemporary theory of metaphor, every concept is metaphorical, and language students commonly use, such as the words; 'how many', 'take away', and 'smaller', implies metaphors. In order to understand students' understanding of abstract mathematical concepts, we need to interpret the metaphors students use.

Since words have meaning depending on their context, I carry out script writing tasks with primary students. In these tasks, I provide a prompt that includes a mathematical situation, and students are asked to write a script with dialogue format for the prompts, like writing a scenario for role-playing. In this session, we analyse and interpret metaphors of a fraction in the students' writings, based on other related concepts such as number, multiplication, and division.

Investigating a Potential Format Effect with Two-Column Proofs

Alarfaj, Maryam, University of Edinburgh

The current study aims to explore the impact of the two-column format in writing simple mathematical arguments.

That is to say, a structured method of presenting a mathematical proof or argument by using a tabular layout with two-columns.

The underlying goal of the research reported in this paper is to inform understanding of how to effectively assess students' proof construction, particularly online. In this study, we report the results of an experiment designed to test the hypothesis that students provide more justifications when using the two-column format in writing mathematical proofs. Participants were 80 first year undergraduate mathematics students at The University of Edinburgh who were enrolled in a calculus course. The findings supported this hypothesis: overall frequency of justification were higher in the two-column condition compared to the traditional condition. This is due to the format structure where students are expected to justify each line in the statements' column with a corresponding explanation in the justification column. However, as a side effect of increasing the amount of justifications, students in the two-column group generated more non-explanation statements which we classed as paraphrasing.

Theoretical lenses on teacher embrace of PBL

Barnecutt, Jessica, Institute of Education, UCL

In this presentation I describe the contributions of two theoretical lenses, activity theory and complexity thinking, to my interpretation of one aspect of the findings of my thesis, 'Exploring perceptions of students leading their own learning during Project Based Learning (PBL) in the secondary mathematics classroom in the UK'. First, I describe the strategies and challenges of using

multiple lenses for interpretation, then I describe each theory and detail their specific influence on my interpretation. Lastly I outline how I view the two lenses as being complementary aids to help me gain understanding of an empirical phenomenon whose complexity may have been more difficult to grasp with only one lens.

GCSE Mathematics resit students' narratives of their relationship with mathematics

Boli, Despoina; UCL - Institute of Education

A number of recent research studies have focused on the reasons behind the disengagement that Further Education (FE) Mathematics GCSE resit students often show and identifying approaches that can be used to help those students improve their mathematical understanding and improve attainment. However, few of these evidence students' prior experiences to any extent. My research gives FE students the opportunity to explore the experiences they had with mathematics through their previous schooling and understand the factors that have shaped their current engagement with the subject. Through their individual narratives, I hope to understand the factors that shaped the dispositions they hold towards mathematics and any characteristics those might share. For the purpose of this study, seven GCSE mathematics resit students were interviewed using a narrative approach. Using semi-structured prompt questions, students were able to reach back to their past experiences with mathematics and tell their stories. Early data analysis suggests that key factors in shaping students' engagement with mathematics were a) their relationship with the teachers, b) teenage class distraction and c) the ability to transfer mathematical function from classroom to exam.

Teaching students to write (and read) mathematics

Butler, Lee; Carey, Rachael; Donald, Andrew; Gunns, Jos; Walling, Lynne; University of Bristol

Students typically come to university without know how to write maths. Rather than treat it like a problem individual members of staff have to all deal with (with varying levels of success), we created half a module designed to explicitly teach students how they are expected to express mathematical concepts, ideas and proofs. By introducing this topic right at the beginning of students first year, we succeeded in creating a lasting improvement which lasted into their second year. We also discovered along the way that students don't know how to read mathematics (which is a bit of a problem given how often we tell them to read the worked solutions!), and so we are expanding our remit into 'study skills' rather than just focussing on writing well.

Pre-service Mathematics Teachers' Understanding of Geometric Concepts through Writing Jokes

Çaylan Ergene, Büşra; Sevinç, Şerife; Ergene, Özkan; Sakarya University, Middle East Technical University, Sakarya University*

In this study, it is aimed to determine how geometric concepts were integrated into jokes and which contexts were preferred in the jokes written by the pre-service elementary mathematics teachers. For this purpose, pre-service teachers were asked to write jokes related to geometry at the end of Geometry course and 41 written documents were collected as data. In the study, document analysis method as a qualitative research method was adopted. The data were analysed by content analysis method through MAXQDA (VERBI Software, 2019) that is a software for qualitative data analysis and sub-codes, codes and categories were created. As geometric concepts, pre-service teachers used polygon, line, angle, circle, point, ray, line segment, plane, diagonal, circular region and edge and the most used one was determined as polygon in the jokes. Among the polygon, triangle was the most



used one and the pre-service teachers addressed various aspects of triangle such as types consist of by angle and by side, relations, properties, auxiliary elements and concepts related to triangle in advanced Euclidean geometry. For the contexts, it can be said that the pre-service teachers mostly preferred personification by assigning human qualities and attributes to geometric concepts in the jokes.

Steam Education in elementary schools: A holistic investigation on technology enhanced teaching and learning

Haas, Ben / Lavicza, Zsolt; Johannes Kepler University Linz - School of Education

When we address the learning of mathematics in elementary school, we imagine pupils doing experiments, discoveries, and combining the different elements from arithmetics to geometry. Pupils interact with their environment and try to use their learned skills to get a deeper understanding of the world. They engage in a mathematical thinking process and try to interact with their environment. However, when you visit a classroom, you find a rather old fashioned teaching based on a deductive approach where imitations of technics play an essential role. Based on our observations, pupils learn mainly through repetitions in textbooks. Experimentation, if any, comes as additional work, it is seen as a ludic activity rather than as real learning activity. In our research, we inquired about different ways to engage pupils in an experimental approach. We used digital and physical modulation, augmented reality, and various educational technologies.

In one of our first studies, we designed a tutoring system to foster process-related skills in mathematics within the educational software MathemaTIC . We collected data on pupils in assessments on transferring mathematical thinking from instructional technology to the everyday classroom teaching. In a second study, we worked with pupils from elementary schools, kindergarten, and from the special needs section to go beyond two-dimensional representations and discover how mathematics operates in three-dimensional settings. Pupils worked on designing software and three-dimensional printing. We collected data on how pupils and parents perceived the learning and teaching and how this influences the further thinking in mathematics. In a holistic approach, we aimed to identify how pupils, teachers and parents perceive the learning through these new technologies and how it affects the learning and teaching. Our research happened in onsite and remote teaching. In this conference, we will present results from the different studies, give insights into our research, and present future experimental investigations.

The use of task-based interviews to develop and refine a framework of growth points in the development of probabilistic thinking.

Kingston, Mary; Dublin City University

Supply, Van Dooren, Lem, and Onghena (2020) highlighted the need to investigate how children's probabilistic thinking develops over time. While a small number of researchers have established frameworks to describe key stages in the development of probabilistic thinking, the nature of thinking at each stage varies (e.g. Jones, Langrall, Thornton, & Mogill, 1997; Piaget & Inhelder, 1975; Way, 2003). In 2002, Clarke et al. posited that the research base was not strong enough to develop a reliable framework for describing the development of probabilistic thinking. I argue that it may now be possible as a number of empirical studies investigating young children's responses to probabilistic situations have been conducted over the past decade (e.g. Nikiforidou & Pange, 2010; Kazak & Leavy, 2018).

In this presentation, I will provide an overview of some of the key components in the design of a



research study that aims to develop and refine a framework of growth points in the development of probabilistic thinking. The study will involve conducting repeated task-based interviews with children aged 4-8 years over an eighteen-month period. The affordances of task-based interviews will be discussed, along with decisions relating to the design of tasks used for data collection.

A teacher's mathematical and pedagogical knowledge in teaching multiplication of fractions

Machino, Natheaniel ; University of East Anglia

Fractions are notoriously difficult to learn and teach (Newton, 2008), because they have several different conceptual meanings: a part of a whole, a portion of a discrete set of objects, a measurement point on a number line, or one number divided by another (Leinhardt & Smith, 1985). In this presentation, I report findings of the analysis of a multiplication of fractions lesson taught by myself to a Further Education (FE) GCSE class. The analysis employed the Knowledge Quartet (KQ) (Rowland, Huckstep, & Thwaites, 2005) – a framework for the analysis of mathematics teaching, with focus on teacher knowledge. Data were collected during one of my lessons which I video recorded. Analysis identifies the different aspects of the KQ dimensions – foundation, transformation, connection and contingency – in relation to the teaching of multiplication of fractions in an FE college. Findings demonstrate the teacher's overt knowledge of fractions, use of terminology and the reliance on procedures. Teacher demonstration, choice of examples, connection between concepts and decision about sequencing were observed. Contingency was partially evident as the teacher showed insight during instruction by working questions on the board after seeing students' errors but seemed to brush aside student contributions. While I tried to be as objective, critical and neutral as possible, my analysis might have been clouded by the double role of being the teacher and the researcher, I will conclude my presentation with a reflection on this double role.

Mathematical definitions – what works and what doesn't?

Majewska, Dominika ; Cambridge Mathematics

The Cambridge Mathematics (CM) team has developed the CM Define It app – a survey tool which collects information about existing definitions of mathematical key words. The tool is aimed at professionals in the mathematics education community, including teachers, academics, researchers and curriculum and resource developers. Survey participants are presented with a key word and up to five definitions taken from international sources that address all learners. They select the group(s) of learners they work with the most (such as beginners) and are asked to rate how good the definitions are for the learners they work with on a five-star scale. They may optionally go further and provide justification for their ratings, including how accessible and accurate the definitions are for the learners they have in mind. The aim of the survey is to inform the CM team of what the mathematics education community perceives to make a definition of a mathematical term 'good', which will inform the glossary layer embedded in the Cambridge Mathematics Framework. This workshop will encourage discussions about what a 'good' definition may contain, allow participants to test CM Define It and provide feedback about their experience of the survey and the app itself.



The school, society and the teacher: Power dynamics and their influence on mathematical problem solving in the Egyptian classroom

Makramalla, Mariam; University of Cambridge

Being a collective culture, power dynamics strongly affect the way how Egyptian mathematics teachers perceive their own authority in the classroom. In this study, I investigate historical, social, cultural and political tensions in an attempt to untangle how teachers relate to mathematical problem solving tasks in view of their implementation in the classroom. Focus groups of teachers are invited to put together lesson plans that are devised around a pre-discussed problem solving task. The lesson plan designs are then assessed in light of the author's understanding of the Mathematical Task Analysis Guide. Results reveal a collective leaning towards procedural instruction, with few individual attempts to promote conceptual connection making activities in the classroom. This power tension and how it affects classroom choices and operations will act as the discussion platform for this session.

A Study of the Experience of Able Mathematics Students in Post-Primary Schools in Ireland

Mills, Judj; Maynooth University

The topic of my research is to investigate whether able mathematicians in Irish secondary schools feel challenged. The main aspects of my research for this will involve how to identify such students and how to design unfamiliar tasks, based on concepts in the Irish curriculum, to test out with students through a series of workshops. Through open ended tasks and multi solution tasks I hope to investigate whether the attitude of the students changes when exposed to non-routine tasks. Having considered the factors that hinder teachers, I will suggest recommendations of what could be done within a diverse classroom to challenge such students more.

In preparation, I have been reviewing literature on research into how other countries deal with high ability mathematicians. I have a particular interest in creative tasks and the effect these can have on the motivation of able mathematicians. Through visits to NRICH in Cambridge and schools in Scandanavia, who have a policy that specifically focuses on high ability students, I have been researching ideas that have worked in other countries. I am focusing on designing tasks for workshops and investigating ways to incorporate Sriraman's five principles for maximizing creativity within the workshops.

Building Mathematical Resilience: A Case Study of Grade Three Children Experiencing Mathematics Anxiety in Kenya

Njaru Mbogo, Harrison

Although over 60 years' literature confirms that mathematics anxiety is an issue in children performance in mathematics, it is difficult to find empirical evidence on building mathematical resilience in young children in Kenya. It has been established that successful mathematics outcomes are hindered due to children's mathematical anxiety experienced in classrooms. In response to this global issue, it has been identified in literature that mathematical resilience is required to achieve positive mathematics outcomes. The use of positive adaptive stance enhancing teaching approaches plays a role in building mathematical resilience leading to the reduction of mathematics anxiety. This paper investigates literature from a number of sources that recognize that although research is on-going in this area, mathematics anxiety continues to be a prominent issue with school age children. In particular, it is evident from literature that grade three children have mathematics anxiety that impacts on their school performance. In fact literature authority reveals the existence of mathematics anxiety in children as young as six years of age. Literature regarding mathematics

attainment in Kenya reveals that 61% of grade three children are identified as being unable to compute grade two level mathematics tasks. Further literature evidence reveals that 50% of grade three children's learning has fallen below 250 mean score points that are officially stipulated as the mathematics curricular attainment requirement in Kenya. It is suggested in literature that the low mathematics attainments could be due to mathematics anxiety, a lack of positive adaptive measures and development of mathematical resilience when teaching mathematics in the classroom. Unfortunately, it is difficult to find empirical evidence on building mathematical resilience among grade three children either globally or in Kenya. This is despite the literature evidence that at grade three level mathematical competences is developed. This paper will identify the literature outcomes, gaps and further research to investigate mathematics anxiety in grade three children and measures to mediate the current situation in Kenya.

An analysis of pre-service teachers' practices to teach mathematics in economically diverse settings: A Bourdieusian perspective

Sahin, Nejla Tugcem; University of Aberdeen

This study is part of a larger PhD study which explores the role of emancipatory pedagogical approaches in mathematics teacher education to disrupt (re)productive practices of social inequalities in school mathematics. Bourdieu's concepts of field, habitus and capital are mobilized to explore prospective practices of pre-service primary school teachers in the field of mathematics education. Workshops are developed as a way to elicit and discuss student teachers' (mis)recognitions in relation to mathematics teaching and learning in economically diverse settings. Findings revealed that majority of the participants conform to the dominant discourse in terms of how they construct their practice of teaching mathematics. The findings suggest that such a conformity can be transferred to the classroom as a socially reproductive practice.

Using the Growth Zone Model to limit the effect of mathematics anxiety on highly academic secondary students

Thomas, John; University of Warwick

Mathematics anxiety is an "adverse emotional reaction to math or the prospect of doing math" (Maloney and Beilock, 2012) that negatively impacts an individual's experience of mathematics. There are studies examining the impact of mathematics anxiety on highly academic people (e.g. Beilock and Carr, 2005) but fewer large-scale studies of interventions in schools. The Growth Zone Model (Lee and Johnston-Wilder, 2017) is a construct that helps students overcome the negative emotions related to mathematics anxiety. I describe a pilot study into the benefits of introducing the Growth Zone Model to groups of students in years 11 and 13 in a highly academic, selective school. Year 11 students were preparing for higher tier GCSE Mathematics and year 13 students IB Higher Level Mathematics. Time was allocated to the discussion of students' emotional reactions and using the Growth Zone Model to moderate negative responses to difficult mathematics problems. Data is presented indicating the degree to which mathematics anxiety is an issue for these students and responses to a questionnaire about the efficacy of the Growth Zone Model are analysed. A case study examining one student's response to the intervention is presented highlighting the potential of the intervention to make a positive change.



Why can't everyone teach like Claire? A theoretical approach to understanding teacher differences.

Townsend, Vivien; Manchester Metropolitan University

In this session I will share some findings from my recently completed doctoral research into the ways in which three Year 6 teachers approached the task of teaching new fractions content in the 2014 National Curriculum. Their different approaches to teaching led me to explore theoretical tools to understand why they taught as they did. The first of these tools, 'history-in-person' (Holland et al., 1998), enabled me to understand teachers' identities as both ever-forming and complex, and as informing action. And the second, 'internally persuasive discourse' (Bakhtin, 1981), brought insight into how the teachers orchestrated discourses including those of teaching and accountability. Theory led me to a sympathetic and nuanced understanding of my teacher participants and enabled me to realise why teaching like Claire is simply not an option for everyone. I will close by drawing out potential implications for anyone wanting to (in any small way) influence the work of teachers.

Crystallizing experiences in developing mathematical skills of the Polish winners of IMO international Olympiads.

Wenderlich, Maja; Academy of Special Education Warsaw, Poland

I study crystallizing experiences that have spiked the interest in mathematics, that is, experiences that "engage in a meaningful and unforgettable meeting of people with extraordinary talent or potential abilities with the material of a given field in which this talent can be manifested" (Walters, Gardner 1986). I am interested in the Polish winners of international mathematical Olympiads organized during the years 1959-2019. The history of mathematics shows that ground-breaking mathematical discoveries were made by young people (at the turn of adolescence and early adulthood). Examples are the achievements of Evarist Galois, Srinivas Aiyangar Ramanujan, Terence Tao. This, according to M. Spitzer (2012) and D. A. Kramer (2003), has a biological basis in reasoning strategy. However, some imperative for the development of talent had to appear. I plan to undertake qualitative research. The aim of the project is to capture crystallizing experiences that were related to orientating the minds of the people towards mathematics.

Developing and evaluating GeoGebra Classroom in a mathematics lesson sequence with examples of exploring positions of straight lines

Zöchbauer, Johanna; Hohenwarter, Markus; Lavicza, Zsolt; Johannes Kepler University Linz*

In our research project, we are interested in developing and evaluating a new connected classroom technology for formative assessment enabling teachers to utilize a wide variety of teaching methods. We already conducted semi-structured interviews with teachers who are highly knowledgeable in using such technologies. We found that they would need new features for formative assessment to foster classroom discussions, conveniently monitor and collect students' work, and using students' responses for follow-up activities.

Based on these findings, a new connected classroom technology, called GeoGebra Classroom was developed. To further enhance its usability and better serve teachers' needs, we study its uses in mathematics classrooms and test it with a variety of examples. Thus, we design mathematics lesson sequences for teachers and pupils to work with this new tool and prepare online worksheets for classroom explorations. One of these sequences includes the exploration of straight lines graphically together with a series of questions. This lesson sequence is currently being video recorded, teachers' dashboards screen recorded, and participants' work with the tool observed. Furthermore, we will conduct semi-structured interviews with all pupils and teachers to better understand their experiences. At the conference, we will highlight our preliminary findings of this study.