

British Society for Research into Learning Mathematics

BSRLM SUMMER DAY CONFERENCE 2022 SESSION HANDBOOK Saturday 11<sup>th</sup> June 2022

# Plenary



Dr. Ian Jones, Reader in Education Assessment, Department of Mathematics, Loughborough University

Ian was a winner of the Janet Duffin Award in 2021; his paper "Teaching using contextualised and decontextualised representations: examining the case of differential calculus through a comparative judgement technique", written with colleagues Matthew Inglis, Camilla Gilmore and Marie-Josee Bisson, was judged by BSRLM members to be the most significant contribution to the Research in Mathematics Education Journal.

# Measuring conceptual understanding: how comparative judgement can help

A challenge for mathematics education research is obtaining reliable measurements of students' understanding of a given mathematical concept. At Loughborough we have developed an approach based on administering open-ended tests and assessing students' responses using comparative judgement. We demonstrated this approach in the context of two teaching experiments conducted in England that introduced (i) differential calculus to Year 11 students, and (ii) algebra to Year 5 students. I will present the findings from these and other studies to demonstrate how comparative judgement can be used to measure students' understanding of a range of mathematical concepts across different educational contexts.

## Research papers, workshops and working groups

[Where there are multiple authors, \* Is used to identify presenters]

Aantjes, Max\* (Canterbury Christ Church University); Yardley, Fiona\* [PRESENTATION] Embedding social justice in everyday lessons: An analysis of implicit conceptualisations in mathematics education

Teaching mathematics for social justice is like motherhood and apple pie. No-one is against it: everyone wants social justice for our learners. But do we all want the same thing, and why aren't we doing it already? We are embarking on a major piece of research which aims to embed teaching mathematics for social justice in everyday lessons. Our starting point is to consider what has already been done and in what different ways teaching mathematics for social justice is conceptualised. Social justice educators often propose an explicit definition of the term in their volumes and books. If Foucault has taught us anything, however, it is that discourses are guided more by what is implicit than explicit. To discern the rules that constitute the framing of social justice by mathematics educators, researchers have already started analysing both theory and live teaching practice (e.g., two 2009 issues by the Journal of Mathematics Teacher Education). Less attention has been paid to the implicit design choices in the process that bridges theory and teaching practice, that is, the design of lesson plans and projects. For this reason, we present a pilot textual thematic analysis of implicit conceptualisations of social justice in the works of Gutstein, Stocker and Wright. We hope this will generate a discussion about our methodology and assumptions, as well as contributing to our emerging understanding of how teaching mathematics for social justice is conceptualised.

## Alcock, Lara\* (Loughborough University); Attridge, Nina

[PRESENTATION]

## **Refutation in Undergraduate Mathematics**

This presentation concerns undergraduate mathematics students' understandings of refutation and performance on an abstract conditional reasoning task. It reports on 173 responses to a refutation instrument that asked participants to: 1) state 'true' or 'false' for three statements, providing counterexamples or reasons if they thought these false (all three were false); 2) evaluate counterexamples and reasons a student might give, where reasons were 'corrected' versions of the statements but not valid refutations; and 3) choose which of the counterexamples and the corrected statements were better answers, explaining why. The data show that students reliably understood the logic of counterexamples but not the broader logic of refutations. Many endorsed the corrected statements as valid and chose these as better refutations, and we analyse their explanations using Toulmin's model of argumentation.

#### Awortwe, Peter Kwamina (University of Nottingham)

[PRESENTATION]



Understanding how beginning teachers co-construct and learn appropriate content, pedagogical, technological knowledge to teach geometric constructions with technology.

This paper reports research aiming to understand how beginning teachers co-construct and learn appropriate content, pedagogical, and technological knowledge to teach geometric constructions with technology, with the eventual aim of understanding how we might improve teacher education in this area. The research investigates how dialogic inquiry tasks and dialogic learning support beginning teachers to co-construct and learn appropriate content, pedagogical, and technological knowledge to teach geometric constructions with technology. The research adopts a design-based research approach. Following a pilot study, twelve beginning teachers, who were about to finish a one-year post-graduate university-based secondary course, worked in pairs, remote from each other, in a Microsoft Teams environment. Each participant of each pair worked collaboratively but remotely with one other on a shared screen working on tasks within GeoGebra. Data comprises video recordings of all the tasks they worked on and discussed. Thematic analysis was developed in the NVivo software, primarily drawing on the principles of dialogic teaching in terms of categorising what kinds of talk took place in their knowledge building. We present data that provides evidence and insight into how the approaches used are potentially successful in realising our aims.

#### Birkhead, Amy (Sheffield Hallam University)

[PRESENTATION]



*Identity tensions: Analysing one early career teacher's stories of navigating the school context* 

Recent policy interventions, such as the Early Career Framework, have focused on improving the retention of early career teachers, those in their first five years of teaching, who are some of the most likely to leave the profession. While this attrition has largely been conceptualised as either a problem with the individual teacher or the context in which they work, this study recognises that it is the complex interaction between individual and contextual factors which are important when deciding whether to remain in teaching or not. The aim of this study is to explore early career mathematics teachers' struggles with these factors, or identity work, in which identity construction is understood to be a dynamic and ongoing process of sense making in relation to other colleagues and to the contexts in which teachers work. Such interactions within schools are likely to cause both identity shifts and tensions as teachers experience conflicts between their own values and those of others. In this presentation, I share some initial analysis of stories elicited from one participant, Bree. By exploring linguistic features of her personal written reflections and interview, such as the emotive language she uses, it becomes possible to expose tensions and turning points in her stories. As Bree makes sense of these tensions, early analysis reveals that the ways in which she chooses to navigate tensions are drawn from several past experiences, both as a teacher and learner of mathematics.



Clark-Wilson, Alison\* (University College London Institute of [PRESENTATION] Education); Noyes, Andrew\* Surveying UK teachers of mathematics on their uses, goals, and perceptions of digital technology for teaching and learning

The Joint Mathematical Council of the United Kingdom (www.jmc.org) is currently revisiting the topic of digital technology within the context of mathematics education in the four nations. One strand of this work concerns the design, implementation and subsequent analysis of a national survey of teachers of mathematics in early-years, primary, secondary, vocational and adult learning settings. In this workshop, we will present and discuss the survey objectives and design principles, with a view to discussing some of the methodological challenges and limitations, whilst encouraging wide engagement within the BSRLM community. The survey will be open to all current teachers of mathematics in the UK during June and July 2022.

Hewitt, Dave\* (Loughborough University), Jones. Ian.

[PRESENTATION]

From additive to multiplicative thinking: a journey using the Stick and Split App

The App Stick and Split is designed in a way where the mathematics of multiplication and division is an integral part of the gameplay. Through the framework of subordination, we look at the journey one student made when first playing with the App and how her thinking seemed to shift from additive to multiplicative thinking. We also consider some of the design features of the software and how the feedback experienced by those features might assist or distract from mathematical learning.

Jacob, Seibu Mary\* (Teesside University); Hare, Charlotte\* [PRESENTATION]

The research study focussed on KS4 mathematics curriculum and based in a local school in North-East England. The research questions addressed were: (1) How do the current mathematics resources allow students to make connections to real world contexts? (2) Are current mathematics resources and assessments relevant to students? (3) Is digital technology present in the current secondary mathematics curriculum? (4) What is the impact of digitalised mathematics assessments in KS4 mathematics education? (5) Does students' interest in mathematics and their views towards the relevance of mathematics affect their achievement? The findings indicated that the majority of topics within the curriculum demonstrated their applications to the real-world. However, the students' ability to recognise the relevance varied, depending on academic ability and career aspirations. The use of digital technology currently, was lacking and used only for homework. A digital assessment was implemented, and the impact evaluated. The instant, formative feedback was the most sought-after feature, quite different to the current written assessment methods. Finally, regarding the connection between students' interest in maths, their views on the relevance of it, and their achievement, to an extent, it could be concluded that the more interested a student is in mathematics and able to recognise the relevance of mathematics, the better their academic performance.



#### Jaffer, Adil (Amsterdam International Community School)

[PRESENTATION]

[WORKING GROUP]

Teaching a whole concept of number: tasks from the Grade 1 El'konin Davydov Curriculum. Should we do away with a counting first curriculum?

A discussion of tasks from the El'konin Davydov Grade 1 Curriculum, taught last year in a research study in a primary class in Amsterdam. The curriculum was translated from the original Russian material for teaching, instead of working from the more frequently found notes from Jean Schmittau. From the outset, the curriculum aims to teach a fully generalised concept of number (real numbers), relational understanding of quantities and mathematical structure and generalised arithmetic. The study found impacts on these fronts and raises questions whether movements can be found in education to commit to a curriculum which doesn't begin with counting.

Kathotia, Vinay (The Open University) Critical Mathematics Education (CME) Working Group

Discussion on certain tensions and challenges in implementing critical mathematics education

The CME Working Group (launched in November 2015) is open to all and aims to promote research that brings about positive social change through mathematics education. CME aims to identify and challenge ways in which mathematics is commonly used to maintain the status quo and reproduce inequities in society. It proposes an alternative and empowering conceptualisation of mathematics, which enables people to better understand their social, political and economic situations, and to advocate and bring about changes leading to a more just and equitable society. Using examples from the UK and the US, we will discuss some tensions and challenges in implementing CME. Learner activity and agency: Despite the desire to ground mathematics in learners' experiences and give them greater voice, how much ownership, agency and choice is afforded to students? And how feasible are such goals, given curricular constraints in compulsory schooling? Curriculum and professional development: What preparation or dispositions do teachers need (for example, the capacity to mediate sensitive discussions or the commitment to an equitable society) to deliver CME interventions? How much background knowledge do teachers need about topics that may arise in such curricula? Please join us to discuss these issues, and potential ways of addressing them.



Lee, Stephen\* (MEI); Hussain, Iram\*; Deko, Joanna

[PRESENTATION]

Breaking down the barriers to offering Level 3 Core Maths: Findings from interviews with Further Education Colleges.

More than 12,000 students in over 650 state schools/colleges now study Level 3 Core Maths. Entries have grown steadily from 2900 in the first year (2016), but there remain barriers for some institutions to offering the post-16 qualification. As part of the work of the Advanced Mathematics Support Programme, a study was conducted into Further Education Colleges that didn't have A level Maths entries to consider their Core Maths provision. Phase one of the work involve the 15 FE Colleges who did have Core Maths, with phase two involving the 85 FE Colleges who didn't have Core Maths. This paper reports on feedback from interviews with 18 institutions and 4 survey responses. Findings from phase one were used in the discussions with phase two FE Colleges. Student recruitment, timetabling and student retention, along with a lack of teacher expertise, familiarity and awareness of Core Maths were the main barriers identified.

## Lee, Stephen\* (MEI) Lord, Kevin; Stripp, Charlie

[PRESENTATION]

Analysis of the uptake in AS and A level Mathematics and Further Mathematics since their reform in 2017's changes in the availability of these qualifications in schools and colleges in England.

The AS and A level Mathematics and Further Mathematics qualifications were reformed in England for first teaching in September 2017 as part of reforms to all A level qualifications. Changes to the assessment, content and educational philosophy to emphasise problem solving and the use of technology were made. AS and A level Mathematics and Further Mathematics became linear courses, rather than modular, and achievement at AS no longer counted towards the awarding of an A level grade. As part of the work of the Advanced Mathematics Support Programme, analysis has been conducted into both the uptake and availability of AS and A level Mathematics and Further Mathematics in schools and colleges in England. Although A level entries for mathematics subjects fell in the year following the reforms, they have been recovering. There has been a large decrease in entries for AS Mathematics, like for all other subjects, although AS Further Mathematics has done relatively well in both uptake and provision within schools. An analysis of year-on-year provision at an institutional level since 2017 shows consistency for many schools and colleges, but an 'in-out' pattern for others.

#### Machino, Natheaniel (University of East Anglia)

[PRESENTATION]

Mentors' views on the role of e-mentoring in the development of student teachers' mathematical and pedagogical knowledge in further education (FE).

The education systems globally went into a panic mode when COVID 19 struck and there was no choice but to go online in teaching and initial teacher education (ITE). Mentoring had to go online as well and became what could be referred to as COVID 19 triggered e-mentoring. E-mentoring has always been in practice and, as such, it is well organised and planned, but the COVID 19 triggered e-mentoring, which is of interest to my study, has not been as well organised; it was a reaction to unprecedented situation. In this presentation, I report findings of the analysis of data collected through online anonymous questionnaire completed by mentors and follow up interviews on key issues which emerged from questionnaire responses. In an attempt to capture mentors' views, thematic analysis was employed as the analytic tool. Findings show that mentors view e-mentoring as a practice that could play a significant role in the development of mathematical and pedagogical knowledge of FE mathematics student teachers. Key themes which emerged from the analysis are discussing mathematical issues and working questions with the student teachers; explaining how to teach specific topics to the student teacher; addressing student teachers' issues with teaching; and student teachers observing experienced teachers. Keywords: COVID 19 triggered e-mentoring, pedagogical and mathematical development.

Nardi, Elena\* (University of East Anglia); Stylianidou, Angeliki; Kayali, [PRESENTATION]

Hearing the signers: BSL interpreters' experiences in the mathematics classroom and implications for inclusion

Imagine for a moment that you need to describe a mathematical problem to someone else in another language. Let this language be one that you feel reasonably comfortable in for everyday conversations but a little less so for mathematical ones. And then, imagine that your own experiences in mathematics date back to your school days and that, since then, you have had only the occasional opportunity to have a conversation that involves several mathematical terms and processes. What may the challenges be in this occasion? And, if any, how can these be overcome? These are some of the questions that we, the team behind the CAPTeaM

(https://www.uea.ac.uk/groups-and-centres/capteam) project, found ourselves asking when the project's workshops for teachers of mathematics brought us in close collaboration with British Sign Language (BSL) interpreters assisting hard-of-hearing (HoH) and D/deaf learners in the mathematics classroom. Our exchanges with BSL interpreters took the form of a focussed group discussion that revolved around each of the mathematical problems designed for one CAPTeaM workshop (Platonic Solids, Bridges of Königsberg) and zoomed out to broader issues regarding their preparedness for supporting the mathematical learning of HoH & D/deaf students. We see sharing these insights as having additional topicality within mathematics lessons and beyond, given that significant steps are 'at last' in progress towards recognising BSL's official status across the UK.

Oakes, Dominic (Further Mathematics Support Programme Wales, Swansea University) [PRESENTATION]

#### Action Research Post Covid: A Fool's Errand?

Following Action Research projects aborted in February 2020 due to the Covid pandemic, FMSPW tentatively contacted the participating teachers in the spring of 2021 but despite a wish to start up again, school circumstances made this impossible. Gluttons for punishment, we tried again in the summer of 2021 and one school signed up. We held an initial meeting with four teachers from the Mathematics department in October 2021 and all were keen on the proposed areas: a focus on explicit planning for connection within the KS5 curriculum and the use of a flipped classroom teaching approach in mathematics. The research period was planned for November 2021 to April 2022. It did not go as hoped. However, the department agreed to move to a consideration of the difficulties of Action Research during times of stress. This, in turn, led to a more wide-ranging consideration of the challenges of working with students who have experienced the disruption due to Covid. This session will report on teachers' experience of and views around returning to a normal timetable. What lessons can we learn towards planning for future disruptions?

Riding, Katie<sup>\*</sup> (University College of London); Ibrahim, Maryam: Du, [WORKSHOP] Wenfei; Li, Shuhui (Sophie); Liu, Bohan; O'Brien, Dan

A workshop examining mobile augmented reality mathematics applications: exploring a framework through the lens of student authorship

Over the past two decades, an extensive body of research has emerged examining all aspects of teaching and learning with digital mathematics education applications. Researchers have proposed frameworks to categorise these applications through a variety of theoretical lenses; be it instructional roles, operational issues, or learners' autonomy. Since 2017, most modern mobile devices are now 'AR-enabled', meaning additional hardware is no longer needed to create or access augmented reality (AR) environments; this has stimulated a rapid surge in mobile AR mathematics applications. However, research into teaching and learning with these AR-enabled mathematics apps is in its infancy. At the start of 2022, we established a reading group dedicated to Mathematics Education in Extended Reality (XR). A central theme we have observed from much of the literature, that enables educators to differentiate between mobile AR mathematics apps for their practical needs, is the level of authorship they afford to the user. In this workshop, we will invite attendees to take part in some 'hands-on' activities using GeoGebra's 3D Calculator with AR and we will present an emerging framework we are developing to categorise mobile AR mathematics apps through the lens of student authorship.

## Rowlandson, Paul (Durham University)

[PRESENTATION]

Applying Research about Interleaving to Mathematical Category Learning

'Interleaving' and 'blocking' are strategies for sequencing study content, which are often described as being opposites of each other. Blocking refers to when content from different categories is grouped together by type (e.g., AAAABBBBCCCCDDDD), while interleaving refers when content from different categories is mixed together (ABCDABCDABCD). Some research about interleaving has investigated its potential benefits for mathematics practice assignments; other research has investigated its effects on inductively learning to classify images into categories. The aim of Paul's doctoral thesis has been to investigate whether interleaving effects found in the latter strand of research also apply to category learning in secondary school mathematics, while also comparing blocking and interleaving with a third alternative strategy: learning through exposition. The empirical research for this thesis took the form of three randomised controlled trials involving secondary school students learning to classify mathematical images into categories. The results for these experiments have led to considerations about differences between mathematical categories and natural categories, along with the mental processes that are used during classification tasks. This presentation will discuss seminal studies from interleaving research, unpack the nuances behind interleaving effects and share findings from his ongoing doctoral thesis.

Rumbelow, Michael (University of Bristol)

[WORKSHOP]

Connecting mathematical block play with nature through crystallography

Friedrich Froebel (1782-1852), the inventor of Kindergarten, devoted almost twenty pages of his seminal book The Education of Man to the mathematics of crystallography, which he had learned and been inspired by as assistant to a professor of crystallography in Berlin. Froebel believed that in building structures with blocks children were imitating the Earth's formation of crystals, which he understood as natural forms alive with meaning, and he saw philosophical significance in the mathematical two- and three-symmetries of the cube - the basic unit form of crystal structures - which informed the designs of his Kindergarten building blocks. Building blocks continue to be popular in pre-school settings as well as in primary classrooms as mathematical manipulatives, and in play activities such as Lego and Minecraft. In this session, based on early work-in-progress research in my doctoral study, I revisit Froebel's crystallographic theoretical perspective on block play through the lens of post-human new materialist philosophy, in a tentative attempt to connect block play with ecological concerns in pre-school and primary mathematics education.

#### Shah, Safdar (Loughborough University)

[PRESENTATION]

#### Student Conceptions relating to Mathematical Intuition and Rigour

Very little is known about what students' conceptions of intuition and rigour are, although there is research on how these constructs are perceived by mathematicians and philosophers of mathematics (e.g., Tatton-Brown, 2021). It is important to consider students' conceptions of these constructs as they give a window into how these conceptions may impact their learning. For example, the view that rigour is purely formal may have a negative impact on student motivation since there is ample research evidence that students find mathematical rigour difficult (Curtis, 2017). The aim of the study is to investigate such perceptions when they start their mathematics degrees. The data collected were short narratives that first year students wrote in response to a questionnaire asking about their perceptions of rigour and intuition in mathematics. The narratives were coded through two cycles. The first adopted 'in vivo' coding and in the second cycle these initial codes were grouped into overarching themes. The findings suggest that student perceive rigour to be either a property of the mathematics or of the person producing the mathematics, while for intuition students highlighted aspects of reasoning related to previous experience, understanding a problem, logical thinking and being 'instinctive'. In the I discuss how the findings relate to the existing literature which corroborates constructivist perspectives in defining intuition and a formal understanding for rigour.

#### Sharpe, Fiona (University of Bristol)

## [PRESENTATION]

From 'this is just dreams. It's not a reality.' to a 'what's happening?! That's not how I imagined or thought about it!': A teacher's shifting perspective of mathematics.

For the last two years, I have been working with non-specialist teachers of mathematics, starting with experiential workshops. Putting before them something unfinished in the form of mathematical ideas and inquiries - giving them something to play with - we have improvised together a more dynamic relationship to mathematics. Moving from fragmentation to connecting has required listening and paying attention to ourselves, and to the group. An enactive approach recognises life as ever-changing and precarious. In a co-determining, co-creating world we emerge in, and of, the world in every moment. Varela (1999) speaks of a virtual self- emerging anew in each moment - if we look for this self, we cannot find it. What does research, and mathematics, look like from this perspective? Does it involve attempting to cultivate an in-the-moment awareness of this unfindable self? Working with experience and reflection and using contemplative practices myself, I aim to create a space into which knowing can emerge. A liminal space of unknowing. For one teacher, a shifting of perspective seems to be emerging. Responding to his request to introduce this more dynamic relationship to mathematics to his students, I have been working alongside him in the classroom. He appears to now be experiencing in the classroom, with his students, what was unimaginable for him in the experiential workshops.

Skilling, Karen\* (University of Oxford); Friesen, Marita

[PRESENTATION]

Using vignettes to elicit pre-service teachers' problem solving beliefs

Vignettes are short stories or scenarios that are particularly effective for representing classroom situations and aspects of teacher practices. Vignettes are highly appropriate for use in teacher training courses to explore subject matter knowledge and/or pedagogical knowledge. Vignettes are usually accompanied by questions, from which observations, and reflections on classroom situations and theory can be made. Similarly, questions can elicit beliefs, values and understandings, making these visible and available for discussion. This presentation reports on a study, where a cartoon-based vignette was designed as a method for eliciting the beliefs of trainee teachers about problem solving at the beginning of a relevant university course. Problem solving is often endorsed as an important skill, yet not prominently used in mathematics lessons. Although factors such as time might inhibit using problem solving, less visible factors such as teacher beliefs may also be influential, and important to understand because these shape teacher practices and students' learning experiences. In this study, pre-service teachers from a UK and German initial teacher training course were asked to report their beliefs in response to several statements presented in the vignette that reflected the affordances, but also challenges of using problem solving in the mathematics classroom.

Stacey, Jennifer (Sheffield Hallam University/Chesterfield College)

[WORKING GROUP]

Further Education Working Group

This is an introductory session to establish whether there is enough interest in a working group for Further Education within the BSRLM. All those involved in the delivery to FE students (16-18) or learners (19+), or teacher education within FE, are cordially invited! There will be short introductions by all attendees, to explain their involvement with FE and their research interests, including titles of current research projects. The long term objective is to coordinate sufficient interest to generate publications of research outcomes both for a special issue of the RME journal and to a wider FE audience.

Syyeda, Farhat\* (University of Leicester); Woodhouse; Joan

[PRESENTATION]

*Re-constructing life stories using the Three-Dimensional Space Narrative Structure (3DSNS) to study adult learners' experiences of re-engagement with Mathematics.* 

We draw in this presentation on some of the data and findings from a wider, narrative-ethnographic study, of which the focus was a group of mature learners enrolled on Mathematics courses in an adult education college in England. The aim of the wider study was to understand learners' perceptions and experiences of re-engaging with Mathematics as adult learners. By eliciting participants' life story narratives, we were able to map and make sense of their mathematical learning journeys, using an analytical framework adapted from Clandinin and Connelly's (2000) three-dimensional space narrative structure (3DSNS).

Clandinin and Connelly (2000) draw on Dewey's (1938) philosophy of experience to propose their 3DSNS framework for the reconstruction of life stories. Dewey (1938) argues that experience arises on the bases of two principles: interaction and continuity. He conceptualises experience as personal as well as social, occurring through interaction with other people, and related to the situational impact of the experience. Continuity implies that each experience leads to another experience, and every experience that a person encountered in the past has a bearing on their life at present and will have an influence on the future. The 3DSNS approach examines three aspects of the narrative, namely interaction, continuity and situation, to reconstruct life stories (Clandinin and Connelly, 2000).

In this presentation, we discuss a single case study from our study to illustrate how we used a modified version of the 3DSNS to explore the impact of 'situation' (e.g. school and home environment), 'interaction' with other people (e.g. tutors, peers) and 'continuity' (past, present and perceived future) on the development of a learner's relationship with Mathematics.

Thoma, Athina\* (University of Southampton); Bokhove, Christian\*; [PRESENTATION] Gammack, David Proof by induction in Calculus - Investigating first-year students' examination scripts

Students' transition from secondary to university mathematics and the difficulties they face are at the forefront of mathematics education research. This study explores one of the areas that students have difficulties with, namely proof by induction. The presentation focuses on first-year undergraduate mathematics students' difficulties when solving a proof by induction task. This task comes from a final-year Calculus examination paper and combines proof by induction and differentiation. Our data consist of 197 students' Calculus solutions to this task and the corresponding module materials, specifically lecture notes and coursework exercises. Using coding and theming, we explore what solution processes arise when solving the task. In the presentation, we present and discuss the relevant teaching materials and then focus on students' difficulties when engaging with the examination task. The findings illustrate that students have difficulties with the proof by induction processes, and issues related to both. We present student work from all three categories and conclude that combining both induction and differentiation principles in one task, poses additional challenges for students. We also discuss the implications of our work.

WORKING GROUP

[PRESENTATION

Thouless, Helen\* (St Mary's University, Twickenham) Hilton, Caroline\*; Ipek Saralar; Esmeralda Zerafa

SEND and Maths' Working group

This SEND and Maths Working Group is open to all and aims to promote research that looks at the intersection of SEND and mathematics. This working group has four goals: 1) to connect researchers who have an interest in this topic; 2) raise awareness of the topic; 3) bridging the gap between theory and practice; and 4) bridging the gap between the fields of mathematics education, psychology, and special education. This session we will continue to consider what we offer our initial teacher trainees on the topic of SEND and Maths, how we could improve this offering, and what resources would help implement this improvement.

Voutsina, Charis\* (University of Southampton); Stott, Debbie

A phenomenographic study on preschool children's interpretations of the uses of written numerals in everyday life

Written numerals observed in everyday environments may have quantitative or nonquantitative purposes and their use is underpinned by social knowledge. While a significant body of research exists on the development of preschool children's early mathematics knowledge and computational skills within the family environment, there is a dearth of research examining preschool children's experience and understanding of the social and cultural meanings of written numbers outside preschool, and with a focus beyond the context of arithmetic. We will present findings from a study that examined 3-5-year-old children's understandings of the meanings that written numerals have in everyday contexts. The research included a volunteer sample of 37 preschool children and their families. The children participated in individual, video-recorded interviews with a photo-elicitation element. A phenomenographic analysis of the data revealed the qualitatively varied ways in which children conceive and interpret the meanings of written numerals in everyday life, as well as the structure that underpins children's awareness about written numbers in their environments. The study provides significant insights into the varied patterns of awareness and the social and cultural knowledge about numerals that children develop before formal schooling and can help educators engage in purposeful classroom conversations that connect this knowledge with what children learn about written numbers at school.

Watson, Steve (University of Cambridge)

Mathematics education as a social system

I will begin with a seemingly simple question 'what is mathematics education?' This, expectedly, can lead to a range of answers and which are likely to depend on the respondent's perspective. Differing accounts of mathematics education would be expected from researchers from diverse paradigms and approaches, from teachers, learners, policymakers, mathematicians, or even from perspectives completely outside of mathematics education. It might then be reasonable to accept the 'whole' that is mathematics education is internally diverse and pluralistic and characterised by its complexity in terms of both research and practice. We might then consider the whole as an indeterminate conglomeration of heterogeneous parts and that any attempt to conceptualise mathematics education as a thing 'in and of itself' is not possible. On the other hand, there appears to be increasing interest, in the last 40 years, in characterising mathematics education as a whole. The most notable of these are the historical accounts developed by Howson (1982) and Kilpatrick (1992) and more recently Inglis and Foster's (2018) examination of five decades of mathematics education research journal content. Philosophy of mathematics education has also emerged during this time. There have been attempts to survey the scope of mathematics education research in various international handbooks and in an edited volume scoping the use of theory and concepts (Sriraman & English, 2010). There is also rich, vibrant and sometimes combative discourse about mathematics education practice and research on social media. It might be concluded there is imperative for mathematics education to observe itself as a whole, but why? In order to address this, I use social systems theory (Luhmann, 1995) to provide analytic tools to go beyond the first-order observation of mathematics education i.e. as viewed from the perspective of the observer to a second-order observation which attempts to observe observers. From this, I present mathematics education as a social system of society and consider how this might help us understand the relationships and possibilities between its components e.g. between research paradigms and between research and practice and what this might contribute to conceptualising mathematics education.

[PRESENTATION]