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SESSION HANDBOOK

UNIVERSITY OF SOUTHAMPTON

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Research papers, workshops and working groups

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

Alcock, Lara

[PRESENTATION]

Diagrams for 'if-then' statements in mathematics

Mathematicians use Venn diagrams to represent the logical constructs 'A(x) and B(x)' and 'A(x) or B(x)', using interlocking circles to represent the x-values for which A(x) and/or B(x) are true, and shading relevant parts of the resulting diagram. They could also use Venn diagrams to represent the conditional 'if A(x) then B(x)' (alternatively, 'A(x) implies B(x)'), again shading according to the relevant truth table. However, based on a survey of 17 commonly recommended introduction-to-proof textbooks, they seem not to do that: only two of these books use a diagram, and neither uses a Venn diagram shaded in the usual way. This presentation will report two small studies designed to ascertain whether this is a general phenomenon. When asked to draw a diagram for 'if A(x) then B(x)' or 'A(x) implies B(x)', what do mathematicians draw? I will discuss implications for teaching and learning about conditionals.

Alcock, Lara*; Thoma, Athina*; Jones, Ian*

[WORKING GROUP]

HE Mathematics Education

This new working group will bring together researchers who work in HE mathematics education, studying issues in undergraduate learning and teaching, broadly conceived. In this session, we will have short presentations from two colleagues (one from Loughborough, one from Southampton) with plenty of time for discussion. The group currently comprises researchers from Edinburgh, Loughborough, Southampton and UEA (plus visitors); we plan to meet several times per year, primarily online, and we welcome new members from elsewhere.

Aziza, Mela*; Sangwin, Chris

[PRESENTATION]

Key topics and concepts of school algebra

Reviewing school algebra was done as a preliminary stage before identifying key algebraic concepts at the transition to higher education. This study aimed to identify key topics and key concepts of school algebra across diverse grade levels and ages. A comprehensive literature review was conducted on four mathematics curricula (Scotland, Indonesia, the United States, and the International Baccalaureate). Although the four mathematics curricula revealed a few differences in grade and age of students in learning algebra topics, students were taught common key algebra topics and concepts at school. The curricula

highlighted five key topics of algebraic schools: (1) variables, (2) algebraic expressions, (3) equations, (4) inequalities, and (5) functions and graphs. These five key topics covered key concepts: the meaning and the use of variables; formulating algebraic expressions; solving algebraic operations; transforming algebraic expressions to a standard/shorter form; expanding algebraic expressions; solving algebraic operations; linear equations; quadratic equations; discriminant; factoring; the solutions of linear equation systems; exponents; logarithms; linear inequalities; quadratic inequalities; the solutions of inequalities; the definition of a function; domains and ranges; the definition of a slope; graphing a function; odd and even functions; composite and inverse functions; and function transformations.

Bokhove, Christian

[PRESENTATION]

Help-seeking in an online maths environment

Many online mathematics environments provide feedback to help students make progress. However, the extent to which students make use of such feedback, so-called ‘help-seeking’, depends on numerous instructional variables, including the design of the online platform and individual student characteristics. Furthermore, student activities in such platforms are not independent events: the order in which tasks are completed matters, and the order says something about students’ help-seeking behaviour. To gain insights, we have to study sequences of events. This study used student data from UK students in primary schools with at least 100 lesson records in the academic year ‘18-’19 (N=1,799), totalling more than a million records from an online mathematics platform. Sequence analysis was applied to the data to uncover patterns of help-seeking. The results showed that help-seeking, task difficulty and proficiency interact. Well-tailored help is subject to a Goldilocks ‘sweet spot’: help-seeking does not contribute to precision if the learning content is too difficult or the student too proficient. Help is not needed if the learning content is too easy, while help-seeking is not productive if a student is not proficient enough yet. The findings have implications for instructional design and show how sequence analysis can provide useful insights of students’ behaviour in an online mathematics environment.

Borthwick, Alison*; Trundle, Ruth*; Parkinson, Andy*; Tynemouth, Andy; Burke; Stefanie; Edginton, Helen; Farran, Emily; Smith, Felicity

[PRESENTATION]

The impact of teaching the multiplication tables: a comparative study

The Multiplication Tables Check (MTC) for year 4 pupils in England was announced by the DfE in 2017. This assessment was intended to determine whether pupils can fluently recall their multiplication tables. In comparison, while The Government of Jersey mandate the use of the KS2 National Curriculum Tests, they do not currently use the MTC with their year 4 pupils. This study is a research project between England and Jersey to investigate pupils’ understanding of multiplicative relationships. In particular, we were keen to understand if the inclusion of the MTC had a positive impact on those pupils who take it in England compared to pupils in Jersey who do not. Our main research question was: • Do children in

England perform better/make use of their understanding of multiplication more than children in Jersey, because of the focus on the MTC? We have collected both qualitative and quantitative data. Early analysis shows that children from England did not perform better than children in Jersey. It also shows concerning trends across both countries, for example, children not connecting responses to multiplication and division questions. It has also prompted us as researchers to reflect on and refine our original questions.

Davies, Ben* ; Perisic, Vesna

[PRESENTATION]

Assessing Proof Comprehension in Undergraduate Real Analysis

We explore the dimensionality of proof comprehension using a collection of eight proof multiple-choice proof comprehension tests. These tests were administered as low-stakes formative assessment, in an undergraduate module introducing Real Analysis. We first analysis the reliability of each test in isolation, before exploring the relationships between them. Our results build on previous literature, suggesting that proof comprehension is in fact a singular entity and that students develop this skill through the 10-week semester. This analysis fits into a wider on-going research project involving a suite of other (formative) assessment tools for this context and will shed light on the dynamics of assessing undergraduate real analysis from a variety of perspectives.

Dowker, Ann* ; Sigley, Graham

[PRESENTATION]

The Catch Up Early Years project: adapting Catch Up Numeracy to Reception class children

Catch Up® is a not-for-profit charity working to address literacy and numeracy difficulties that contribute to underachievement. Children receiving either the Catch Up Numeracy or Catch Up Literacy intervention, have two 15-minute individual sessions per week from trained teachers or teaching assistants. In Catch Up Numeracy, they are assessed on ten components of numeracy (e.g. counting verbally; word problems; ordinal numbers) and are provided with mathematical games and activities targeted to their specific levels in specific components. From 2020 to 2023, Catch Up carried out a 3-year action research project, funded by the Mercers' Company, to adapt these interventions to help Teaching Assistants to support Reception-age pupils who were dropping behind in reading and numeracy. Due to the Covid pandemic, initial research plans had to be somewhat scaled down. Staff in six schools gave qualitative feedback concerning the numeracy intervention, and case studies were returned for nine children. Staff reported improvement in both performance and attitudes. Though the sample was small, data from the Hodder Basic Number Screening test and a researcher-devised attitude test also suggested improvement. Educational implications and plans for further research are discussed.

Fu, Arya

[PRESENTATION]

Exploring the Application of Generative Artificial Intelligence in High School Mathematics Teaching: An Action Research on A-Level Calculus Learning

With the development of generative artificial intelligence, its impact and potential application scenarios in the field of education have increasingly become the focus of attention among educational researchers and practitioners. The exploration of how to apply generative artificial intelligence, such as ChatGPT, more rationally and ethically in mathematics teaching and learning has become a research direction that educational researchers are pursuing. This study conducted semi-structured interviews with mathematics teachers and students to gain an understanding of their utilization of artificial intelligence tools in daily mathematics teaching and learning. Additionally, a literature review was conducted to analyse the current research status and progress of generative artificial intelligence in mathematics education. Based on the results of this interview, action research was carried out to explore the potential applications of artificial intelligence in the teaching of calculus in A-level mathematics, which aimed to find how artificial intelligence can be integrated into the teaching process to enhance students' learning experiences and improve their mastery of calculus. It also sought to find any challenges and opportunities that may arise from the use of such technologies in mathematics education.

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

[WORKING GROUP]

Early Years and Primary

We would like to reconvene the Early Years and Primary Working Group, which aims to provide a forum and meeting place for those concerned with research about maths education in the early and primary years. In particular, we would like to focus on providing research-based advice for the government's current curriculum and assessment review (<https://consult.education.gov.uk/curriculum-and-assessment-team/curriculum-and-assessment-review-call-for-evidence/>). Suggested curricula and key messages for key stages 1&2 (ages 5 to 11) have been drafted by the Early Childhood Maths Group and the ATM/MA Primary Group. We aim to consider the research basis for these proposals and provide further relevant advice. This group will continue across the year, initially to develop key messages and then to consider curriculum aspects in more depth.

Gifford, Sue*; Thouless, Helen*; Ockelford, Adam; Kirk, Sharon; McCarthy, Sarah

[PRESENTATION]

Pattern and music with children with SEND

This project builds on the development of a learning trajectory for patterning with young children (Borthwick et al., 2021). It aims to discover whether this is similar to the development of children's awareness of pattern in music. Ockelford's Sol music trajectory was based on research with non-neurotypical as well as neurotypical children and provides a detailed sequence of stages from birth. A second aim was to discover whether children

found musical or object patterns easier to copy and identify. Patterning activities with objects were mapped onto the Sol's order of difficulty of musical pattern structures (e.g. AA, AB, ABC patterns, and also 'getting louder' or 'getting faster' patterns). 20 children with learning and additional needs were asked by their teacher and a researcher to copy patterns, played on a musical instrument or made with objects, or presented both ways simultaneously. Provisional findings indicate that there is a correspondence in the relative difficulty of musical and object patterns. There are interesting complexities with handling instruments, choice of objects and issues such as individuals' varying perceptions of gaps in time and space. Findings suggest that most children find object patterns easier to copy than musical patterns, but that most find both modes together the easiest. This suggests that a range of children may find that music makes mathematical patterning more accessible.

Hewitt, Dave

[PRESENTATION]

Number, algebra, symbols and notation: What is the pedagogic challenge?

During the session, I will invite you to explore your own relationship with certain familiar symbols and notation. I will then share some stories from the literature, and from classrooms, which say something about students' relationship with the mathematical notation they engaged with. I will finish off by sharing some data from a current research project I am undertaking, which have the potential to reveal the ways in which students struggle to make sense of notation, and raise the question of what is the pedagogic challenge we face.

Hilton Caroline*; Thouless, Helen*

[WORKING GROUP]

Maths and SEND working group

We will begin the working group with a presentation of some of the findings from the Teaching Maths and Social Justice project. This will be followed up by a discussion of how we take the group forward and what participants would find useful for future conferences. The Teaching Maths and Social Justice project took place in two primary schools in London. The project used participatory action research, with teachers and academic researchers working collaboratively. In both schools and across all ages, a key finding, was that the lessons focusing on maths and social justice issues were more engaging and more inclusive. Teachers reported that they were often surprised with the level of participation and engagement in mathematical dialogue demonstrated by some of their more 'reluctant' learners. We will discuss the possible reasons for this and consider how we can take these findings forward to impact more of our classrooms.

Huang, Liying*; Fujita, Taro

[PRESENTATION]

Fostering students' spatial reasoning skills in geometry using duo of digital and tangible artefacts

Spatial reasoning is an essential part of the geometry of students' at all levels of mathematical education and is considered a basic mathematical skill. Given the importance of spatial reasoning skills, this study aims to contribute to the successful development of students' spatial reasoning skills through a combination of digital and tangible objects. This study aims to describe and analyse the spatial skills in geometry teaching and learning with the multi-duo of artefact framework in this paper. To achieve this goal, we used duo of digital and tangible tools (Virtual Reality, GeoGebra and traditional tangible artefacts) for design-based research. We analysed data from our pilot study of experimental learning activities in spatial geometry carried out by Chinese students in grades 7-10. We identified moments of development in the use of spatial skills as students engaged in 3D geometry problems using VR, GeoGebra and tangible artefacts. The analysis also showed that students' spatial skills are effectively trained through the use of multiple duo artefacts.

Hyde, Rosalyn*; Bokhove, Christian*; Peleg, Ran

[PRESENTATION]

Secondary school students' understanding of Verbal Probability Expressions

The probability or likelihood of an event occurring can be communicated numerically or by using a verbal probability expression (VPE) such as possibly, certain, or likely. VPEs are 'adjectives (often qualified by adverbs) that express risk or uncertainty' (Collins & Hahn, 2018, p. 68). In this study we examine data collected from approximately 200 secondary school students via an online survey. Students were asked to use a slider to indicate a numerical equivalent for 29 expressions taken from Willems et al. (2020) combining a VPE and a context, for example, 'it is generally the case that everything fits in the suitcase'. We will share our findings indicating the levels of agreement and variability in students' interpretations of these expressions, as well as their relationship to age. We discuss some of the implications for the teaching and learning of probability, as well as wider implications.

Jacques, Laurie; Küchemann, Dietmar

[PRESENTATION]

Comparing Uncommon Fractions: Y6 Pupils' Strategies

Previous research that has considered strategies for comparing fractions has revealed many different ways of determining which of two fractions is larger or smaller but has mainly involved older students or adults. We are curious to see whether younger learners who are developing their understanding of fractions make use of similar or other strategies. We conjecture that by offering pupils pairs of fractions formed using values for numerators and denominators that are atypical ('uncommon' fractions), pupils might be provoked to use a wider repertoire of strategies and/or reveal something about their fraction knowledge. Drawing on previous research, we share an instrument that we used to explore pupils'

strategies for comparing uncommon fractions. We will discuss some emerging findings from recent interviews with Y6 pupils that revealed their preference for finding common denominators, the difficulties of keeping track of the residues, the use of benchmarks and a potentially novel strategy involving temporarily substituting the denominator for 1 on the number line.

Kastberg, Signe*; Helliwell, Tracy

[PRESENTATION]

Certainty and Uncertainty in Curricular Design for Teaching Mathematics Teaching

Curricular design in mathematics teacher education has highlighted the need for opportunities to wrestle with mathematics teaching and mathematics content. Models of curricular development highlight technical rationality such as backwards design and competency-based views of teaching such as core teaching practices. Descriptions of mathematics teacher educators' (MTE) design of whole class instructional activity for teaching mathematics teaching have identified diversity in approaches but commonalities such as use of examples, discussions, and opportunities for task design. In this presentation we report on the self-study of one MTEs' experience developing an instructional activity designed to support prospective teachers' development of learning from teaching. Data sources include recordings of critical friend conversations and MTE reflective journals. Findings include the role of voice of mathematics teacher education, voice of the prospective teachers, voice of the institution, and voice of the MTE. We argue that MTEs' experiences of uncertainty and certainty inform instructional activity design and implementation in supporting prospective teachers' learning to teach mathematics.

Kireeva, Maria

[WORKSHOP]

Offering startup equity as compensation in participatory EdTech research involving parents

There is little doubt that "involving individuals with a stake in the project who are not researchers can enhance the quality of the research and help it to bring about positive change for society and the economy" (UKRI, 2024). However, it seems that such research is more widespread in the healthcare sector as patients are literally given the opportunity to take matters into their own hands. When it comes to education overall and EdTech in particular, I think that parents' voices should be heard and their experiences should also be shaping the development of services that they use. Although participatory research is an effective way to provide research impact, the question of ethical compensation is one of the first things that comes to a researcher's mind. If the process and the result of said research project are also conceived as an EdTech business, such considerations become even more pressing. It is a widespread practice for startup investors to receive equity in return for their investment, but it is unclear whether with this participatory research such an approach would "blur the lines between the researcher and the participant" (UKRI, 2024) even

further. This workshop welcomes suggestions on conducting participatory research with parents for solution-focused EdTech and encourages insights into the issue of power that arises from equity-based participant compensation.

Larbi, Ernest

[PRESENTATION]

Pre-service Mathematics Teachers' Understanding of Completing the Square of Quadratic Functions

Knowledge of completing the square plays a significant role in learning several topics in mathematics. Pre-service mathematics teachers content knowledge is crucial for teaching effectiveness. The study investigated pre-service mathematics teachers' understanding of completing the square for given quadratic functions and it was guided by three objectives. Simple random sampling was used to sample about 90 pre-service mathematics teachers to participate in the study. Participation in the study was voluntary. Using a sequential explanatory design, data will be collected using a test of three questions on quadratic functions followed by interviews and focus group discussions. The findings of the study will be discussed, and appropriate recommendation will be made.

Makri, Depy*; Jones, Ian; Foster, Colin

[PRESENTATION]

Conceptualness and Proceduralness of Mathematical Questions: Independent Properties or Opposite Ends of a Spectrum?

Classifying a mathematical question as conceptual or procedural can be tricky. The distinction between these types of knowledge is complex, and students may use procedural knowledge for conceptual questions—and vice versa. By considering proceduralness and conceptualness as coexisting properties of a mathematical question, we investigated whether these properties are separate or are opposite ends of a spectrum. We also investigated the role of question difficulty in this relationship. To do this, the first author developed 21 multiple-choice questions, which were evaluated pairwise by 126 experts in undergraduate mathematics teaching or mathematics research. Experts were randomly assigned to judge the questions based on either conceptualness, proceduralness, or difficulty. We fitted a statistical model to the pairwise judgement data in order to produce a unique score for each question within each property. A correlational analysis suggested that conceptualness and proceduralness lie on opposite ends of the same spectrum rather than being independent properties. Furthermore, when a question is perceived as difficult, it is more likely to also have been perceived as conceptual rather than procedural.

Meangru, Matthew

[WORKSHOP]

Mathematising through the Curriculum: The Implementation of AI-technology in School Mathematics

There is a need in mathematics education to provide current and future teachers with the ability to '[leverage] AI as a tool to enhance their teaching and support student learning' (Engelbrecht & Borba, 2024, p. 286). The National Council of Teachers of Mathematics (NCTM) released a statement emphasising a need for maths teachers' awareness of and competency in the use of AI tools such as ChatGPT (NCTM, 2024). Botoana et al. (2024) investigated using GeoGebra and ChatGPT for Geometric Discovery, but little else has been done to prepare maths teachers for next generation mathematics education.

Mathematising through the curriculum refers to the effort to understand how primary and secondary educators can teach the mathematical content in the English National Curriculum using AI technology. This workshop aims to engage its audience with AI learning tools such as GeoGebra and ChatGPT and explore these in relation to school mathematics in the UK. The activity consists of five tasks comparing questions and answers on GeoGebra with responses that ChatGPT gives to resolve the same mathematical problems. This activity has been conducted with in-service and prospective teachers enrolled in master's mathematics education courses that are aligned with New York State Next Generation Learning Standards for Mathematics. The objective of the session is to inform mathematics educators and researchers about the potential impact AI-learning technology has on in-service teachers in the UK.

Pomeroy, David

[PRESENTATION]

The racial politics of mathematics attainment grouping in Aotearoa New Zealand

Decades of research has raised concerns about attainment grouping and equity, with researchers arguing that attainment grouping exacerbates inequities related to class, race, and gender. I build on such scholarship by arguing that attainment grouping in secondary mathematics is a form of systemic racism in the settler colonial context of Aotearoa New Zealand. Firstly, based on a recent quantitative study, I argue that attainment grouping reinforces racialised class inequalities in education and employment. Secondly, based on a recent qualitative study, I argue that attainment grouping systematically produces the emotions of shame and entitlement, in racialised ways. The claim the attainment grouping is systemically racist is both empirical and political, arguably like all discussions about mathematics education and equity. I invite participants to discuss the politics of attainment grouping research in their respective educational contexts.

Pratt, Nick*; Alderton, Julie*

[PRESENTATION]

Mathematical reasoning in primary school: how mathematical is 'it'?

We consider mathematical reasoning in English primary schools and ask what 'it' is and how mathematical 'it' is. Literature identifies many types of reasoning – algebraic, geometric etc. – and a focus on pedagogy, often rooted in psychology. Our approach is sociological (Foucault/Bernstein) making sense of what reasoning 'becomes' in policy texts and in teachers' reported practices. We examine the discourses inherent in a range of policy texts related to primary mathematics, focusing on reasoning and how they construct 'it' as a curriculum object; and how this construction potentially positions teachers and pupils. We then use data from a small-scale interview study which asked mathematics mastery specialists (as a particular, but highly-informed group) about classroom practice. Data relating to reasoning is analysed and presented, drawing comparisons with the previous text analysis. By examining policy as both text and discourse we draw inferences for practice, noting Popkewitz's (1987) claim that all curriculum decisions involve philosophical, political and ethical choices. In particular we consider how mathematical reasoning is affected by the socio-political conditions of primary classrooms i.e.: - To what extent reasoning is a socially situated activity, not (just?) a mathematical one. - How the classroom experience of reasoning is connected to management and control, as well as to mathematics. - How teaching reasoning might produce in/equitable opportunities for pupils.

Shah, Rehan

[WORKSHOP]

Identifying and recognising the implications of threshold concepts in the teaching of undergraduate mathematics

The notion of 'threshold concepts' coined by Meyer and Land [1] can be considered akin to a portal, opening a new and previously inaccessible view of a topic without which students would be unable to progress intellectually. Threshold concepts are also particularly 'troublesome' for students due to their being conceptually difficult, alien or counter-intuitive and intellectually absurd. There is therefore a strong need for HE mathematics educators to understand, identify and recognise what key threshold concepts exist in their mathematics modules. This will sensitise them to the challenges these concepts present to students and enable them to facilitate their students' learning and understanding. In this workshop, participants will be presented with some commonly identified examples of threshold concepts from literature. Through interactive mapping exercises and focused discussion groups, they will be asked to classify and provide their perspectives on sample topics from an undergraduate mathematics module. By actively engaging several UK mathematics education researchers and practitioners, this workshop will provide a valuable opportunity for exchanging ideas and sharing cross-institutional good practices about teaching and learning in mathematics.

[1] Meyer, J.H.F. and R. Land (2003). Threshold concepts and troublesome knowledge 1 - linkages to ways of thinking and practising. In C. Rust(Ed.), *Improving Student Learning - Ten Years On* (pp. 412–424).Oxford, UK: OCSLD.

Simeonov, Emil

[PRESENTATION]

The 10-omat and the 100-Net - a new approach to place-value and initial arithmetic

The 10-omat and the 100-Net are new low-tech hands-on tools for mathematics in primary school. Based on ideas from modular arithmetic and polar coordinates these new tools give a mathematically sound representation of natural numbers, wrapped up in a spiral shape. The 10-omat might be considered as the simplest version of Schickard’s calculator. In the 100-Net the number sequence is made visible without discontinuities. Place value representing emerges naturally as a consequence of the specific shape. The important patterns (rounds, rays, steps, jumps, symmetries) and the imposed specific code (the decimal representation) are directly visible. The tools have been successfully tested in primary schools in Austria and the UK (in the framework of a project funded by the EEF). The underlying issue is the importance of stressing the ordinal (sequential) aspect of numbers in their initial acquisition. The talk will highlight some interesting mathematical issues which arose from the writing of support materials for these tools: - necessary prerequisites for learning a place value system - a possible interpretation of Zero as an ordinal number - a recursive construction of traditional number representation without assigning the traditional place value - a structure which is something like an incomplete discrete one-dimensional affine space.

Skilling, Karen*; Puttick, Steve

[PRESENTATION]

GEM project: interdisciplinary learning opportunities for pre-service mathematics and geography teachers

The critical importance for developing skills and knowledge in science, technology, engineering and mathematics (STEM), have led to frameworks identifying particular characteristics conducive to integrated STEM learning. However, connections to other subjects also offer meaningful contributions for developing STEM literacy, such as climate change education. The GEM Project (Geography and Mathematics) was initiated to connect mathematics and geography curricular knowledge and skills in purposeful ways to understand issues surrounding sustainability and environmental crises. Such understandings are critical for pre-service teachers entering the teaching profession and for addressing young peoples’ concerns about multiple and intersecting environmental crises. We report how the characteristics of integrated STEM framings were applied to the integrated GEM Project.

Tatters, Genevieve

[PRESENTATION]

Supporting Children's Reasoning and Understanding in Mathematics at Key Stage 1 through Patterning and Talk

Mathematical reasoning is influential in reconstructing prior mathematical knowledge. Herbert and Williams' (2021) study focused on teacher's employment of open questioning with children working on tasks where there is not one specific solution and children are encouraged to grapple and explore ideas through discussions and the transference of learning from one context to another. By accepting different ways of students communicating their thinking enabled children to make connections between verbal, diagrammatic and symbolic representations and to increase their understanding of reasoning. The use of their own methods beyond mathematical procedures encouraged children to combine mathematics in unfamiliar ways as they made connections with prior knowledge which in turn led to better explanations and discussions behind their solutions. The challenge for mathematical teachers is to identify ways of thinking mathematically that are characteristic of understanding but also to support children in reasoning and exploring mathematics in their own ways allowing them to experience 'wow' moments and the enjoyment that mathematics can bring. This research proposes a teaching and learning framework to develop greater understanding and reasoning skills through open-ended investigative activities focused on pattern, a growing awareness of the relationship between focused talk and teacher questioning, children's own graphics and concrete representations.

Thoma, Athina*; Iannone, Paola

[PRESENTATION]

Using Lean in teaching proofs: Exploring lecturers' perspectives

Interactive Theorem Provers (ITPs) like Lean are used in mathematics research, and recently, they are also being used within university teaching. Existing empirical evidence has primarily focused on students' experiences, revealing that Lean users tend to write more structured proofs and show greater precision in symbol usage (Thoma & Iannone, 2022). However, students also report challenges particularly in relation to Lean's syntax (Iannone & Thoma, 2023). This presentation shares findings from a study that explores lecturers' perspectives on teaching with Lean. We will focus on the experiences of two lecturers, who integrated Lean into their undergraduate proof course that combined both Lean proofs and traditional hand-written proofs. We discuss adjustments they made to their teaching approach, as well as the challenges and limitations they encountered. This study aims to offer insights into the benefits and constraints of teaching proof with Lean and provides a foundation for further exploration of lecturer perspectives on using ITPs in their teaching.

Voutsina, Charis*; Stott, Debbie

[PRESENTATION]

Children's notations for representing quantity and ordinal position: a longitudinal study

We present findings from a longitudinal study that examined the notations that 3-5-year-old children produced to communicate the ordinal position of an object in a sequence and quantity. 33 preschool children participated in three individual, task-based interviews, over one year. Children's individual notational pathways varied over one year and did not always portray gradual moves towards conventional notations. The frequency of conventional numeral use in the quantity task was almost double the frequency of conventional numerals used in the ordinal task. Qualitative data show that notational choices can be influenced by various factors, including children's awareness of their own numeral knowledge constraints, and do not necessarily reflect limited awareness of the affordances of numerals as communicative-referential symbols. The findings can inform early mathematics pedagogy that can best support connections between children's informal knowledge about written numbers and formal learning at school.

Wallis, Rachel

[PRESENTATION]

Developing multiplicative reasoning in Year 2 through measures contexts: some findings

In the UK, multiplicative reasoning is typically developed through ideas such as repeated addition, repeated subtraction, grouping and sharing and through using representations such as arrays. In this session, I will present an overview of my PhD design-based research project which focused on the use of measures contexts to develop multiplicative reasoning with Year 2 pupils in a school in South Wales. Using measurement contexts with continuous quantities to develop learning of number concepts is an approach developed by Davydov and Elkonin in Russia in the 1960s; they developed a whole mathematics curriculum based on this. In such a curriculum, pupils would learn about number through measures contexts with continuous quantities from the very start of schooling. The research discussed in this presentation focuses on the development of multiplicative reasoning in a context where learners are typically introduced to number using discrete objects and through counting, and in which their experiences of measures focus on how to measure. In the presentation I will give an overview of tasks used, learner and teacher responses and the themes that developed from the data collected.

Heshmati, Holly*; Wang, Linda*; Barmby, Patrick*

[PRESENTATION]

Making sense of teaching for mastery: A preliminary study on pre-service teachers' understanding using comparative judgement

Teaching for mastery has been developing in England for over a decade. An important factor in its prominence is the perceived need to assess pre-service teachers' understanding. We report on a preliminary study that tested an alternative approach to assessment of understanding, one called comparative judgement. Twenty-seven pre-service from PGCE

Secondary Maths courses at two research-intensive universities drew mind maps to show their understanding of their most recent university session. Their work was then assessed by 14 ITT Maths course leads. We report two main findings. First, what the assessors perceived as the best and worst examples of pre-service teachers' understanding reveals the level of their understanding. Second, the comparative judgement approach to assessing their work proved successful, in terms of inter-rater reliability. The results facilitate ECT (Early Career Teachers) mentors to support noticing and implementing of mastery approach further in their practice.

Woollacott, Bethany*; Guy, Natasha; Lortie-Forgues, Hugues

[PRESENTATION]

Understanding the challenges that Early Years and Primary practitioners face when interacting with research

As part of the increased interest in addressing the gap between research and practice, researchers have considered the barriers which prevent education research from being effectively communicated to practitioners or implemented in practice. However, the majority of research focusses on primary and secondary education, with little understanding of how early years practitioners interact with research – a unique community due to the diverse skills, experiences and backgrounds of these practitioners and their settings. We designed a questionnaire which compiled all known barriers to interacting with research from the literature, aiming to capture the experiences of early years' practitioners. To contextualise these responses, we also gave the questionnaire to Key Stage 1 and 2 practitioners so that we could understand whether these two communities of practitioners face different barriers when interacting with research. We adopted a randomised sampling approach across England, aiming to capture views of practitioners with varying levels of interest in research. In our session, we present which barriers to interacting with research are most and least problematic for both groups of practitioners, highlighting the differences and similarities. Importantly, we explain how these findings will support us in communicating research to practitioners more effectively in the future.

Zhang, Jingyun*; Alderton, Julie

[PRESENTATION]

Forgetting/reinserting meaning as self-technologies: Chinese children's mathematical subjectivities across transition from Anji Play to primary school

Most literature on the transition between kindergarten and primary school mathematics relies on a continuity/discontinuity framework, assuming a chronological developmental trajectory. Drawing on Walkerdine (1988), the transition is not about accumulating mathematical knowledge, but about how children's subjectivities are reconstituted and repositioned through 'meaning-forgetting' as they shift from informal to formal mathematical discourses. I view 'meaning-forgetting' as a self-technology, where children master a metonymic axis of logico-mathematical principles to construct a rational self, at the cost of eliminating the metaphoric axis tied to life meaning (Walkerdine, 1988). Following on this, I propose 'meaning-reinserting' as another self-technology, where

children reintroduce the metaphoric axis by crafting embodied narratives to forge emotional connections with the metonymic axis. Thus, I argue that meaning-forgetting and meaning-reinserting function as self-technologies across informal and formal mathematical discourses, fashioning how children experience themselves through normalized and divided learning capacities (what constitutes 'good' mathematical ability) and learner statuses (what defines a 'good' mathematics learner). Qualitative data were collected using participatory methods from 10 kindergarten children adopting the Anji Play pedagogy and 11 primary school children receiving exam-oriented education, all from a disadvantaged county in southwestern China.

Zhang, Meng Yan

[PRESENTATION]

Investigating the Impact of Demographic and Classroom Factors on Maths Anxiety in Secondary Students: A Mixed-Methods Study

This study investigates the prevalence and factors contributing to maths anxiety among secondary school students, focusing on gender, year group, English as an Additional Language (EAL) status, academic performance, and classroom experiences. A mixed-methods approach was employed, incorporating quantitative analysis from 800 students across Years 7 to 10 and qualitative responses to open-ended survey questions. The research aimed to explore both the statistical relationships between these demographic factors and maths anxiety, as well as the personal experiences that shape students' attitudes towards mathematics. The findings revealed that female students in Years 7 and 8 experience higher levels of maths anxiety compared to their male peers, although this difference diminishes in later years. Additionally, EAL students demonstrated varied levels of anxiety, suggesting the influence of language barriers on their mathematical learning experiences. The study identified four key contributors to maths anxiety: cognitive challenges in understanding mathematical concepts, fear of making mistakes in front of peers, disengagement from the subject, and pressure from teachers.