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Retaining heads of mathematics in a performative culture: A case study

This study explores the experiences and perspectives of heads of mathematics (HoM) departments in English secondary schools. The aim is to identify the conditions under which retention of those in the role is likely. The current crisis (NFER, 2016) in the recruitment and retention of mathematics leaders in schools is not a new one, but despite this there exists a very small body of research into the issues affecting those in this key role. Taking as a theoretical background Foucault's work on power, governmentality and discourse, the study considers the way in which school leaders' interpretations of a performative culture (Ball, 2003, 2013) affect the work of HoMs. Taking a case study approach and employing data collection techniques including focus groups, one-to-one interviews, audio diaries and observations, the study focuses on the perspective of the HoMs. In this presentation, I give a brief overview of the role of the HoM and how it has changed, before focusing on two of my research questions: 1) *What influences do HoMs experience?* and 2) *How do they manage those influences?* The study is being undertaken as an EdD thesis to be submitted in October 2017.

Key words: *secondary; departmental leadership; performativity; power; 11-18*

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Partial knowledge of understandings needed for proportional reasoning

Improving the function of multiple-choice items could be achieved by giving credit when an individual selects an option which, while incorrect, indicates that the person has some knowledge of the tested concept. The skills and understandings necessary for the development of sound proportional reasoning were chosen as the context for the identification and investigation of partial knowledge. To assist with the identification of what might constitute partial knowledge, Rasch Measurement Theory was applied to students' responses in tests of ratios and fractions given in 2008 and 2009 as part of the ICCAMS project. Based on earlier research findings, the answers to individual parts of constructed response questions (items) were classified as being fully correct, partly correct or incorrect and scored accordingly. An examination of the category probability curves produced by the RUMM2030 software during the Rasch analysis indicated for which items the award of partial credit was justified. This study indicates that the identification of items for which partial credit is warranted requires both a qualitative as well as an analytical approach.

Key words: *partial knowledge; proportional reasoning; item difficulty*

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Putting mastery in practice, the importance of using precise mathematical language: an appraisal from a range of perspectives

The term *mastery* is one that has recently gained traction in discussions about mathematics pedagogy in England. The use of precise mathematical language by teacher pupils was striking when we observed a visiting



Chinese teacher in Hampshire as part of the Chinese teacher exchange. This prompted a discussion about the importance of using mathematical terms correctly, what is meant by fluency, what is achievable, what the outcomes of doing so could be in terms of developing and demonstrating mastery. It also led to a consideration of the implications of this adaptation of pedagogy to initial teacher training (ITT). Working in partnership, a lecturer and a Key Stage (KS) 1 teacher worked on how children could learn to use mathematical terminology and what the impact of that was on developing children's mastery of mathematics. This work was enhanced and developed by groups of teacher training students working at master's levels who also researched aspects of mastery pedagogy within the KS1 setting as well as on school experience as part of their course. Data was collected through observations of the children in class and the class teacher's assessment procedures. Initial findings suggest that when developed through a Concrete Pictorial Abstract (CPA) approach, children in Years 1 and 2 could incorporate precise mathematical terms into their explanations of the mathematics they were doing.

Key words: *mastery; language; teacher training; developing practice*

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Teaching undergraduate mathematics in the United States and the United Kingdom: Four comparative observations

Increased global mobility has given students and faculty unprecedented opportunities to study and work in different countries. This leads to new challenges for faculty in adapting to classrooms that are more international than ever before. This paper looks at the author's experience in teaching mathematics in the United States and the United Kingdom, and to students with very different cultural and academic traditions. Four broad themes are used as the basis for comparison, chosen on the basis of their relevance to contemporary issues, with previous literature blended with personal observations, along with qualitative data gained through individual interviews.

Key words: *United States; United Kingdom; undergraduate teaching; student engagement; textbooks; technology; assessment*

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Features influencing teachers' engagement in a research project: A discussion about data analysis

Three secondary mathematics teachers embark on a project to teach fractions differently for low achieving students. As a member of the research team implementing the project, my interest was in how these teachers conciliated the project lessons with their regular practice in the classroom and what were the most prominent aspects influencing this conciliation. The focus of my PhD study is to identify the features that constrained or fostered teachers' engagement in the project. In this presentation, I want to discuss the ongoing process of data analysis. The data came from a one-year period in the school, during which I conducted interviews, observed lessons and meetings and had informal talks with the participant teachers. I will present the different methods I have been using to analyse the data – line by line coding, word search and memos – and what they have provided so far. Tentatively, I would say that the project being aligned with teachers' practices and the support offered during it were the most prominent features that fostered engagement and created opportunities for the teachers to learn.

Key words: *mathematics teachers; data analysis; qualitative data*



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Learning to apply variation theory to the design of mathematical tasks in English primary classrooms

Mathematics teaching in primary schools in England is currently undergoing significant reform; influenced, in part, by the practices of international jurisdictions such as Shanghai. The use of variation theory in task design is one such pedagogical feature, however this is not something that English primary teachers are necessarily familiar with. Over the last 18 months, a pilot mathematics professional development program has been shaped with the intention of following the professional learning journeys of some primary teachers as they learn how to design and teach with tasks that make use of procedural and conceptual variation. Early findings suggest that variation theory may be more challenging to apply effectively than might be expected to task design.

Key words: *professional learning; task design; variation theory; primary education; learning/lesson study*

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Designing for designers: Bootstrapping a tool for knowledge representation in framework development

This paper describes work in progress building and refining a knowledge representation toolset to assist in the development of the Cambridge Mathematics Framework. The design project involves multiple overlapping but distinct goals: to create a tool that framework designers can use to structure theory and evidence for connected understanding in mathematics, a tool that curriculum developers can use to make decisions for their own designs by using that structure as a reference, and a tool that teachers and students can leverage for the purposes of formative assessment and metacognition. Feedback is very welcome on the design and design process leading into the second major cycle of design.

Key words: *mathematics; knowledge representation; design; curriculum*

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How mathematics anxiety levels of adolescent girls influence the use of self-regulation strategies?

This study focuses on effect and self-regulated learning (SRL) in order to address whether level mathematics anxiety (MA) influences learners' use of self-regulated learning strategies. As research shows MA has a detrimental effect on attainment, and as SRL increases attainment, there appears to be a connection between these two domains. MA tends to be more prevalent in girls, and increases with age, so there is a focus on female adolescent. Mixed methods are used, with quantitative data being collected using questionnaires and analysed using statistical methods, and qualitative data being collected using semi-structured interviews and then transcribed and coded. Post-coding methods elicit themes from the interviews. Observations are used to triangulate the data and verify findings. The findings indicate that use of SRL strategies are dependent on MA. Moreover, high levels of MA correlate with low proficiency in seeking and learning information strategies and higher levels of maladaptive strategies. Reasons these findings stem from teachers, peers, exams, self, family and school systems. Overall, the study shows that mathematics anxiety levels in girls in secondary school do influence the use of self-regulated learning, however exactly how certain types of MA impact on particular SRL strategies is still unclear.

Key words: *mathematics anxiety; self regulated learning; self regulation strategies; females; adolescent*



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Undergraduates' difficulties with the concept of extreme point

When students start their first semester in mathematics at university in Germany, many fail their first analysis course. One reason for this is an insufficient understanding of basic concepts like monotonicity or differentiability. In our study, we focused on the concept of extreme points which has strong connections to both monotonicity and differentiability. Regarding this concept, we analysed students' difficulties, as well as some of the possible reasons for these difficulties. We did so by using three distinct theoretical frameworks: the German framework of Grundvorstellungen (vom Hofe, 1995), the concept image/concept definition (Tall & Vinner, 1981) and the conceptual change theory (Posner et al., 1982). Data consists of 10 semi-structured interviews with first year mathematics university students on tasks involving extreme points. The interview transcripts were analysed using qualitative content analysis. Our analysis found both categories of re-occurring difficulties and inferred reasons for the occurrence of such categories from the standpoint of the three theoretical frameworks mentioned. In this presentation, we discuss preliminary results of the analysis and focus on examples of how knowledge from high school could influence the understanding of extreme points at university level.

Key words: *concepts in analysis; extreme point; university students*

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Portrait of a mathematics teacher

In this session, I show how the social and cultural capital of a mathematics teacher informs a preparation programme aimed at students applying to study mathematics at elite universities. This is based on a research project which investigated how independent schools might give their students an advantage when they apply to elite universities. The project found that the social networks of the teachers provide valuable information/knowledge i.e. social capital, and the project specifically finds that the teachers draw on this to inform the activities used in the programme. In addition, the teachers' cultural capital informs the curricula and pedagogy of the programme. As an insider researcher and mathematics teacher on the programme, I was able to examine my own case in detail and, in this session, I share my own social network and associated capital, showing how it informed the mathematics sessions of the preparation programme.

Key words: *capital; Bourdieu; elite universities; independent schools; advantage*

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Students' conceptions of the equals sign as predictors of their algebra performance

Students' conceptions of the equals sign are related to algebraic success. In most research, students' conceptions of the equals sign (=) have been conceptualised in two ways: as an operator indicating the result of an arithmetic operation, and as a relational symbol indicating that the same value is on both sides of the equals sign. The latter has been widely viewed as sameness, but Jones, Inglis, Gilmore and Dowens (2012) argued that the notion of substitution is also an important and distinct part of a sophisticated understanding of mathematical equivalence. Despite the vast literature investigating the role of the sameness and operational conceptions of the equals sign in learning algebra, the role of substitution on students' algebra performance is yet unclear. In this study, we investigated whether students' endorsement of a substitution definition of the equals sign is a unique predictor of their algebra performance. Secondary school students were asked to rate the 'cleverness' of operational, sameness, and substitution definitions of the equals sign and completed an algebra test. Our findings



demonstrated that endorsement of substitution played a unique role in explaining secondary school students' algebra performance above and beyond school year and the other definitions.

Key words: *algebra; equals sign; equivalence; substitution; secondary school students*

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Mathematics and examination anxiety in adult learners: The findings of surveys of GCSE Mathematics students in a Further Education college

I teach adult learners in a Further Education (FE) college in the Midlands of the UK. As part of my work at the college, I run a survey at the start of each academic year on the attitudes of adult learners around mathematics and exams. This helps inform my teaching: once I know the learners' confidence or anxiety levels, it helps me to target their needs. Out of a cohort of approximately 70 learners (20% of whom are not first language English speakers), usually around a third of the learners each year describe themselves as anxious or very anxious about mathematics, and up to a half have the same responses for exams. In this paper, I share the results of a further survey to investigate whether there are any patterns in confidence levels around age, gender, or nationality, and whether learners identify any key moments or events that shaped their opinions. Finally, I look at why and how learners' views are changing as a result of their experience in an adult classroom.

Key words: *adult learners; mathematics anxiety; exam anxiety; GCSE Mathematics*

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Commognitive approach in the analysis of a teacher's mathematical discourse on the derivative

This presentation is part of a doctoral study investigating how teachers of mathematics teach calculus, with a focus on differential calculus. Research on the teaching of the derivative (and limit) is not as extensive as the research on students' learning of calculus. It examines the discourses of one teacher and his Year 12 class through a communicational approach presented in Sfard (2008), the commognitive framework. It is built on the premise that thinking is a form of communication, and communication with oneself; thus, cognition + communication (interpersonal exchanges) = commognition. Discourse is the core unit of analysis. Mathematics is seen as a form of discourse, which is made distinctive by four commognitive constructs of word use (vocabulary and syntax), visual mediators, endorsed narratives and routines. These commognitive constructs are the key components of the discursive lens for the analysis of mathematical discourse. This is a case study investigating the discourse of an introductory lesson about tangents, gradient and differentiation to a Year 12 class in England. Data sets included two audio-recorded interviews with the teacher and one video-recorded lesson observation. The teacher was interviewed first, prior to teaching the observed lesson on differential calculus and secondly, after teaching the lesson.

Key words: *commognitive; discourse; visual mediators; endorsed narratives; routines*

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Mathematical problem solving and autism: Negotiating the journey towards an inclusive curriculum

According to Baron-Cohen (Baron-Cohen et al., 2009), approximately 1% of the population could be affected by autism spectrum disorder (ASD) and as educational practitioners, we have a responsibility to ensure that the



provision within our schools ensures a fully accessible curriculum for these students. Contrary to Baron-Cohen's (2009) prediction, between 6% and 22% of autistic children and adolescents are reported to struggle with number and calculation, to an extent where their mathematical difficulties are incommensurate with their intellectual functioning (Aagten-Murphy et al., 2015). When it comes to solving mathematical word problems, Jitendra et al. (2007 as cited in Bae et al., 2015) point out that there is a requirement for the integration of several cognitive processes. As the primary school curriculum evolves, and the government draw on international best practice, the bar model approach is becoming a more prominent tool in the teaching of mathematics. Coupled with the rise in numbers of students with autism in mainstream primary schools, the question is: *Is this evolving curriculum inclusive to the needs of autistic learners?* This session will draw upon findings from a pilot study in preparation to use qualitative comparative analysis (QCA), as an evolving research design, to investigate whether the bar model

Key words: *autism; problem solving; bar model*

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Policy enactment in primary mathematics

In this presentation, I report on the analysis of one interview conducted in 2016, and how the teacher positions herself in relation to a number of policy discourses. My PhD is set in the context of the UCL Institute of Education Key Stage (KS) 2 Mathematics Test Preparation Project, which involved interviews with 30 Year 6 teachers from 24 schools in 2015, and interviews with Year 6 teachers from the same schools in 2016. I begin this presentation by setting out some theory in relation to policy implementation and how this, with theory from the mathematics education community, has influenced the way I analysed the interview transcript. I explain how I went about the analysis, drawing up a 'coding book' and coding the transcript in NVivo, then drawing out the main themes. I present some findings from the analysis, and conclude that there are four main areas of influence on this teacher's practice: The National Curriculum, other guidance such as that produced by the NCETM, her desire to ensure mathematical understanding, and the KS2 SATs (Standard Attainment Tests). I conclude with an evaluation of the approach to analysis, with some recommendation for aspects of the coding book which should be retained and some which might be discarded or amended.

Key words: *policy enactment; curriculum; calculation; Key Stage 2*