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Plenary address

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Scotland's Curriculum for Excellence – where are we now?
The Curriculum for Excellence was introduced after a National Education debate in 2002. The Scottish Curriculum had to be transformed to provide Scotland's children and young people with the knowledge, skills and attributes needed for life in the 21st century through a coherent, more flexible and enriched curriculum from 3 to 18.
Practitioners were involved and consulted during each phase of implementation and the Curriculum for Excellence officially started in August 2010. The Programme continues until 2016 when the implementation of the new qualifications, which are being developed by SQA, is completed.
The Curriculum for Excellence aims for children to become:

- Successful learners
- Confident individuals
- Responsible citizens
- Effective contributors

The curriculum includes all of the experiences that are planned for children and young people through their education, wherever they are being educated. These experiences are grouped into four categories: *Curriculum areas and subjects*, *Interdisciplinary learning*, *Ethos and life of the school* and *Opportunities for personal achievement*.
We share our experiences of the Curriculum for Excellence from different perspectives:

- Primary mathematics – changes in pedagogy
- Transition Primary to Secondary 'the broad general education'
- The new qualifications

Research presentations

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Cultures of disadvantage in learning mathematics: A comparison between Penang and Nottingham
For many years there has been a concern internationally that socio-economic class remains the most significant predictor of students' academic outcomes in mathematics. A child's academic performance is often largely dependent on family income and level of parental education. Consequently the influence of pupils' socio-economic backgrounds remains a major challenge to those of us in the field concerned with achieving equitable education. However, the ways in which socio-economic factors (such as demography, geographic location, social background, school systems, curriculum, ethnicity structures and cultures) play out in different parts of the world subject to different political systems and structures, remains unclear. This is largely due to the intellectual dominance of western capitalist economies in structuring research agendas. In this paper we present a descriptive analysis of Malaysian and UK education systems, outlining key issues and contributory sources of low achievement among students and highlighting some of the similarities and differences in the two systems. The nature of different data and its validity is explored to offer a more localized perspective to try to understand the ways in which socio-economic status effects students' achievement. Our bottom line is to bring about an improvement in educational outcomes for disadvantaged and poor children.

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Examining Identity through Story Telling
This paper focuses on the notion of identity and how it is formed through stories. Many researchers equate identity with the construction of stories (e.g. Rodgers and Scott, 2008). This case study examines a prospective mathematics teacher's professional identity by interpreting stories which come out of an interview with her. The prospective teacher was enrolled in a teacher education program which will award her a certificate for teaching mathematics at primary level. She was interviewed during her school placement. The interview data was analysed using content analysis (Strauss and

Corbin, 1990). Themes which describe prospective teacher's identity and how it is constructed through her stories will be discussed.

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How young children view mathematical representations: A study using eye-tracking technology
Representations of mathematical concepts play an important role in understanding, helping students grasp the mathematical ideas required (Greeno & Hall, 1997). However, representations themselves do not necessarily convey the mathematical concepts and so children are not guaranteed to extract the required mathematical knowledge (Cobb, Yackel, & Wood, 1992; Pape & Tchoshanov, 2001). That is, the ways in which children access and interpret mathematical representations can be problematic (Vosniadou, 2010). Eye-tracking technology can help in this respect because it allows data to be gathered concerning children's focus of attention and so indicate how children might be interpreting the representations. Eye-tracking studies having a mathematics focus include investigations of students' approaches to arithmetic, the comprehension of word problems, dyscalculia and geometry. There have been some recent eye-tracking studies examining the role of representations in mathematical learning (DeWolf, Van Dooren, Hermens, & Verschaffel, 2013; Shvarts & Cumachenko, 2013). However, research on eye-tracking involving mathematical representations is still very limited, and research in the field of primary mathematics education is sparser still. This presentation will outline the results of an eye-tracking study with nine Year 5 primary pupils exploring how they 'looked at' representations of multiplication.

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Investigating first year mathematics teacher education students' knowledge of the angle concept
In this study, the researchers investigated first year mathematics teacher education students' knowledge of the angle concept through an instrument comprising open-ended items. The participants' were first year students in the mathematics teacher education program of a public university in Turkey. At the beginning of the 2011 spring semester, the data collection instrument was given to 151 students who were enrolled in the first year geometry course. In this study, only the participants' responses to the item about the angle concept were investigated via content analysis. The findings indicate that most of the participants could partly define the angle concept. Additionally, their drawings of the shape of an angle were sometimes incorrect and showed misunderstandings. The findings in general showed that the participants' drawings were much better than their definitions. They sometimes used incorrect concepts and use incorrect language. For example, about one third of the participants indicated that the interior of the angle is the angle itself. Also, fifty participants defined that angle is the measure of the angle. Similarly, the investigation of the drawings indicated that about half of the participants marked the interior and the measure of the angle as the angle.

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Pre-service middle school mathematics teachers' beliefs about mathematical problem solving
The purpose of this study was to identify pre-service middle school mathematics teachers' beliefs about mathematical problem solving and the effect of a problem solving course on these beliefs. In order to collect data we used a Turkish translation of the 'Beliefs about mathematical problem solving' instrument developed by Kloosterman and Stage (1992). Data was collected during autumn 2012 from 91 senior pre-service middle school mathematics teachers at the Primary Mathematics Teacher Education Department of Atatürk Education Faculty at Marmara University in İstanbul. Results revealed that middle school mathematics teachers' level of epistemological beliefs about mathematical problem solving was generally high. Additionally, results showed that the problem solving course had a significant effect on pre-service middle school mathematics teachers' beliefs about mathematical problem solving.

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"It's not a sausage factory!" Primary teaching assistants' experiences on a short intensive block of study on mathematics
This presentation will report on the initial study for my EdD thesis, which aims to investigate and evaluate the learning experiences of teaching assistants studying a four week block on mathematics as part of the Open University module: Subject knowledge and professional practice in primary schools. In particular the presentation will focus on the design and management of the evaluation, and summarise some of the key findings to date and how they will inform the main study to follow. Findings from the initial study suggest that the impact of such a course of study on pupils' learning and behaviour may be considerably more extensive than students realise and that this is related to the way in which their wider background and experience contribute to their learning.

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An alternative destination for post-16 mathematics: views from the perspective of vocational students
Raising the school leaving age and introducing a requirement for those without a grade C in GCSE mathematics to repeat the examination are significant changes affecting the place of mathematics in post-16 education. Although alternative curricula have enjoyed brief seasons of favour over the last few decades they have failed to achieve the credibility and recognition afforded to GCSE mathematics. The current lack of an alternative to GCSE implies an acceptance that a single mathematics curriculum is a suitable preparation for all students, despite their widely differing destinations. In this session several case studies of vocational student groups in Further Education will be used to explore students' views of the relative merits of GCSE mathematics compared to a functional mathematics curriculum, in the context of their experiences in school and college. The evidence suggests that these students respond more positively to a curriculum that is related to their expected use of mathematics in the future rather than repetition of a subject they associate with school. The reasons for these views may provide a useful contribution to the discussion about an alternative curriculum.

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Surface area to volume ratio and metabolism: Analysing small group-task as Vygotskian activity
Three students Dan, Levi and Thor, attempt a group-task containing worksheets A and B. While worksheet A asks students to calculate and compare surface area to volume ratio of a sphere for six successive units, worksheet B asks them to consider the metabolism of living cells and the impact the ratio has on their functioning and size. While Levi and Thor own the group-task, follow its instructions and deliberate on its questions, Dan declares his intention of observing Levi and Thor and takes a free ride. Based on students' inscriptions and transcript of audio-recordings, I show how Levi and Thor work through calculations required in worksheet A with ease, even coming up with conjectures. In attempting worksheet B they are able to correlate better metabolism in cells with a smaller radius, yet question if that model is indeed borne out in reality. The concept of activity in Vygostkian theory is used to study students' attempts at the group-task. An effort is made to examine how social interaction, cultural tools mediating the group-task and ZPD so formed, together enabled students' mastery of scientific concepts relating surface area to volume ratio as well as metabolism, making their development contingent on such learning.

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Mathematics education research and cultural imperialism
English is the main medium of communication within the international research community and therefore the language through which mathematics education research is largely mediated. At the same time in various parts of the world there is a developing academic research culture which is not dependent on English. National politics as well as national culture play a big part in constructing the research priorities. In countries with developing economies there is a need to have a focus on enhancing performance and improving learning if the country is to become and remain economically

competitive. Currently, mathematics education research in Malaysia does not appear significantly in the international literature, perhaps because articles are either rejected or not even submitted. We are interested in exploring what effect this has upon the communication of research internationally, given the current dominant view of Europe/USA/Australia as the World. We are planning to survey Malaysian mathematics education academics and a systematic review of literature from Malaysia published locally and internationally. Our intention is to look at cultural and intellectual imperialism in the academic community. We are in particularly interested in the position of disadvantaged learners within these discourses within the field of mathematics education for social justice.

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Prospective Pre-School Teachers' opinions about Realistic Mathematics Education (RME)
The aim of this study is to investigate the responses of prospective pre-school teachers to Realistic Mathematics Education (RME) activities.
Data was collected through a semi-structured interview comprising ten open-ended questions about perceived strengths and weaknesses of RME. 25 students volunteered to participate in the study. The collected data is going to be analysed using content analysis.
In the light of emerging results, some suggestions can be made about preparing more effective and efficient approaches to planning lessons for pre-school teachers.

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Relating student meaning-making in mathematics to the aims for and design of teaching in a small group tutorial at university level
The question of the meanings students make of the mathematics they encounter in teaching sessions (and beyond) and how this relates to the intentions of the teacher and approaches to teaching has been concerning me for some time. In recent years I have been looking into a range of issues relating university students' perspectives of their learning to the intentions of those teaching them. Most recently, I have been collecting data from my small group tutorial with first year university mathematics students (n=5) and started a preliminary analysis.
In this session, I will ask participants to look at some data and consider what we can learn according to a set of research questions. It will be an interactive session.
The data consists of an abbreviated transcript of activity in the tutorial, indicating the progress of events and episodes of dialogue. The focus is on concepts in Linear Algebra which first year students encounter in their lectures and a related problem sheet.
I will explain teaching design and my approach to implementing it, and we can explore the issues that arise in practice and how these are related (or not) to students' meaning-making of the mathematics in question.

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Why parents can't always get what they want
We report on work from the Everyday Maths Project. The overarching aim of the project is to empower parents to support their children's mathematics learning. To help us understand how this could best be achieved, we conducted focus groups with parents of year 3 children in 15 Bristol primary schools. We used these sessions to find out about parents' attitudes to mathematics and their own mathematics learning, as well as to explore parents' feelings about their involvement in their children's mathematics learning. Our analysis of these focus groups revealed a wide range of responses from parents, including a number of anxieties about their ability to help their children. Parents also often talked about these anxieties leading them to want much more communication from school about children's mathematics learning and progress. We will discuss the way in which these data demonstrate shortcomings in a school-centred approach, and point to a need for a parent-centred approach to parental engagement in children's mathematics learning.

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Yes it is fair, no it is not fair: What leads to a shift in young students' probabilistic reasoning about the fairness of a chance game?
Games of chance provide a rich context for children to explore random situations, notice the unpredictability of outcomes and see the need for probability (Cañizares, Batanero, Serrano, & Ortiz, 2003). When it comes to thinking about whether or not a chance game is fair, students however tend to rely on their intuitive ideas. Common intuitive strategies, like equi-probability bias (Lecoutre, 1992) and outcome approach (Konold, 1991), often lead them to an incorrect decision about the fairness of a game, particularly games involving combined events (e.g. Pratt, 2000). Thus an important question to explore is "How do students make a shift from using (often misleading) intuitive reasoning to probabilistic reasoning?" This presentation will examine the use of TinkerPlots software and dialogic interactions in small groups to foster Year-6 students' probabilistic reasoning when they explore whether the Wink-Blink-Stare Game is fair in the course of making predictions, playing the actual game, and modelling it in TinkerPlots. Drawing on multiple theoretical perspectives on conceptual development in mathematics, such as constructivism, a socio-cultural approach, and dialogic theory, this session will offer examples of the shifts in students' reasoning in their joint work for discussion of the possible mechanisms behind them.

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Investigating the effect of using dynamic geometry environments and physical instructional materials on first year pre-service mathematics teachers' explanations and justifications
In this study, the researchers investigated the effects of dynamic geometry learning environments and physical instructional materials on first year middle school mathematics pre-service teachers' explanations of and justifications for their solutions of geometry problems. 151 first-year pre-service teachers who were enrolled in an introduction level geometry course at a public university in Turkey participated in the study. Prior to the ten-week instructional treatment, all participants were given a six-item test as a pre-test and post-test to determine the participants' level of explanations and justifications. Out of 151 participants, responses of 139 of them were analysed as 12 of the participants did not take either the pre- or post-test. Qualitative and quantitative data analysis techniques were used. It was found out that there was no statistically significant difference between the treatment groups. In general, the findings indicate that most of the participants struggled in explaining how they solved the geometry problems and justifying their solution methods. Additionally, the number of mathematically convincing justifications significantly increased at the end of the treatments. The study shows that in geometry and mathematics courses students should be given more opportunities to engage in geometric thinking via geometry tasks demanding high level thinking.

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Professional Learning for Collaborative Mathematics Teachers
In the spirit of equitable teaching and the Common Core State Standards for Mathematical Practice, state-based professional learning leaders worked with university-based mathematics teacher educators to plan and implement a series of professional mathematics learning opportunities for collaborative pairs of general education and special education teachers. The professional learning opportunities spanned an entire academic year and included content and pedagogy workshops, participant presentations, teaching observations, and reflective writing and sharing. This session will focus on the professional development strategies that guided this project, examples of activities that were used to engage the participants, transformations seen in participants' teaching, and lessons learned by all involved.

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Interaction and Learning: What gesture research can tell us about the role of physical actions in learning mathematics
The everyday use of physical materials in mathematics education, and the development of new forms of interaction with digital materials, demand greater understanding of how physical actions influence conceptual development. Gesture studies present a novel approach to this area, where evidence suggests that gestures illuminate our manipulation of internal imagery. Some gestures reflect previous actions with physical materials, suggesting that physical actions may be fundamental in cognitive development. Yet a causal relationship between physical action and gesture remains unclear, certainly sufficiently enough to evaluate the impact of altering children's actions (e.g. through digital interaction).
This talk will share early video data from a study examining student teachers' hand actions when asked to explain certain numerical relationships (e.g. why 1+8=2+7) with, and without, physical materials. Preliminary examination of hand movements suggests a flow between actions with materials and gestures relating to these materials: an interplay between internal and external imagery. This work informs a framework to subsequently examine young children's interactions when learning about these number concepts using different materials. As well as helping evaluate the role of new forms of interaction with digital materials, this work aims to contribute to our understanding of the role of action in cognition.

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Using history of mathematics in the classroom: Babylonian number system
This work builds on recent research on integrating history of mathematics into the teaching and learning process. We prepared a worksheet which included pictures of a Babylonian clay tablet in order that students might discover for themselves the Babylonian number system. The worksheet was used with twenty one students who worked individually. After completing the worksheet, student opinions about the task and lessons that include the history of mathematics were elicited. Data was obtained through a questionnaire comprising seven open-ended questions. Our evidence suggests that such activities are motivating and well suited to the mathematics curriculum.

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Using the iPad as a tool for reflection in primary teacher education
I report on an intervention with a group of students doing a one year PGCE course at MMU, all of whom have chosen to take the Early Years route, which focuses on the education of children aged 3- 7. Students have been loaned an i-PAD for the duration of their course. In my teaching sessions the students have used these to collect and analyse photographic and video evidence. The purpose being to nurture students' reflection on teaching and learning in mathematics in line with Mason's (2002) 'discipline of noticing'.
The use of photographic and video evidence is particularly important in Early Years practice as support for practitioner judgements about a child's level of achievement and as a basis for discussion of what the next steps in learning might be.
I will report on the work done so far and emerging implications for both the tutor and the students.

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Prospective middle grade mathematics teachers' teaching approaches for the greatest common divisor concept
This study explores how prospective middle school mathematics teachers integrate problem-solving in teaching the greatest common divisor concept. Thirty prospective teachers studying the middle school mathematics teaching programme participated in this study. They were asked to prepare a lesson plan as part of the content analysis assessment. Most of the participants used a 'teaching for problem solving' approach, in which students are first taught the requisite knowledge and skills and only then

they are asked to solve problems by using these knowledge and skills. On the other hand, some participants prepared their lesson plans using a 'teaching through problem solving' approach. In this latter approach, real life examples underpin the teaching of the lesson. Real life problems are presented from the outset and the knowledge and skills to solve them develop during the problem solving process itself. The study also includes semi-structured interviews with five participants that aim to reveal how participants design the teaching process and what they care about in their lesson plans. For most participants, the chief reason for prioritising the teaching of the relevant knowledge and skills in relation to a concept is that they believe it better facilitates students' learning.

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Mathematical Thinking: How does the perspective of pre-service mathematics specialists on mathematical thinking impact on their teaching of mathematics in the primary classroom?
In a "deeply mathematical" world (Ginsburg & Seo, 1999, p. 115) there exists a possible tension between the various definitions of what constitutes the nature and structure of mathematical thinking (Breen & O' Shea, 2010). The construct 'Mathematical Thinking' remains ill-defined (Schoenfeld, 1992) despite the ubiquitous and sometimes arbitrary use of the term. This study aims to highlight why this research is important to mathematics education and to practitioners in addressing this "messy" (Greener, 2011) construct. Research into children's mathematical thinking presents a mêlée of attempts to define the concept. Some extant classifications lie in two areas: conceptual understanding (Krutetskii, 1976; Tall, 1991) and problem-solving heuristics (Mason, Burton & Stacey, 2010, Polya, 1962, Schoenfeld, 1985). In aiming to address this tension, Sternberg offers that "there is no consensus on what mathematical thinking is … [with] typically no defining features at all" (p. 316).In contrast, Mason, Burton and Stacey (2010) posit that there are at least two fundamental processes, namely specialising and generalising, involved in thinking mathematically (p. 22). As such, this study will present preliminary findings regarding pre-service teachers' perspectives on mathematical thinking (n=20) and aims to clarify these problematic interchangeable terms (Mason, Burton & Stacey, 1982; 2010; Schoenfeld, 1992).

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Teacher visualisation loss mid explanation: an issue when teaching geometry
From several years of teaching an in-service masters course 'Learning geometry for teaching', a set of teacher self-report data has been accumulated that records incidences of teachers not being able to 'see' the theorem or geometrical relationship that they were in the middle of explaining or discussing.
This presentation will give examples of these incidents and will use neuroscientific understanding of the processing pathways in the brain as a theoretical lens for understanding this phenomenon and explain that in some contexts, like geometry teaching, speaking disrupts seeing. A consequence of this tension between doing geometry and teaching a geometrical theorem interactively, is that in order to defend against the discomfort of loss of geometrical insight a teacher might avoid geometrical practice in the classroom. It will also be argued that 'visualisation loss mid explanation' need not be due to lack of teacher mathematical knowledge.
After a presentation, participants will be invited to work in small groups on geometrical tasks which may stimulate the phenomenon under consideration. This will be followed by discussion including: the applicability of the proposed theoretical lens, challenges in teaching of geometry interactively and the nature of teacher mathematical knowledge.

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Understanding Mathematics in Depth: an investigation into the conceptions of secondary mathematics teachers on two UK subject knowledge enhancement courses
I report on an investigation into conceptions of 'understanding mathematics in depth', as articulated by two specific groups of novice secondary mathematics teachers in the UK. Most participants in the sample have completed one of two government funded mathematics subject knowledge enhancement courses, which were devised to strengthen students' understanding of fundamental mathematics. Qualitative data was drawn from semi-structured interviews with 21 subjects and more in-depth case studies of two of the sample. The data reveals some key themes common to both groups, and also

some clear differences. The data also brings to light some new emergent theory which is particularly relevant in novice teachers' contexts.
Quantitative data on pre-service mathematics Postgraduate Certificate in Education (PGCE) students is also presented, and it is shown that, at the university in the study, there is no relationship between degree classification on entry to PGCE, and effectiveness as a teacher as measured on exit from the course. The data also shows that there are no significant differences in subject knowledge and overall performance on exit from PGCE, between students who have previously followed a subject knowledge enhancement course, and those who have followed more traditional degree routes.

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Extended teacher professional development courses – feedback on the impact of undertaking MEI's Teaching Advanced Mathematics (TAM) and Teaching Further Mathematics (TFM) courses
Mathematics in Education and Industry (MEI) provides extensive opportunity for teachers to undertake professional development. Great value is placed on the feedback from those undertaking the courses to establish the impact of them and how they might be improved.
In summer 2013 feedback was sought from the participants in the 2012/13 cohorts of the extended professional development courses of TAM and TFM. Two online surveys were designed using two different pieces of online software – a 15-question instrument that considered various elements of the TAM course and a more in-depth multi-sectioned 50-question instrument for TFM. The in-built analysis tools for each piece of software were utilised for initial analysis.
In the session, an outline of the TAM and TFM course structures will be given, along with discussion of the design of the two questionnaires, their administration and reflection on participants' feedback. Included will be consideration of how a 65% response rate was obtained for the extensive TFM survey, using a small incentive and how this contrasted to a high 85% response rate for the TAM survey which wasn't incentivised. Finally the session will reflect on the impact of these extended courses on teachers' attitudes and developing practice through the feedback provided.

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The problem posing ability of pre-service mathematics teachers
The purpose of this research is to investigate the problem posing ability of pre-service mathematics teachers. Data was collected through a problem posing ability test comprising ten questions. The test was prepared by the researchers and examines the ability of problem posing in middle school mathematics. The pre-service mathematics teachers had to pose problems that were assessed by the researchers using various criteria: quality of mathematics, potential relevance for middle school mathematics, quality of written expression, accessibility of the posed problem, the extent to which data is needed, the range of possible solutions, originality and overall impression. The result of this research is an analysis of the problems posed by pre-service mathematics teachers.