Boundaries and Bridges: adults learning mathematics in a fractured world

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ALM25 Long abstracts for parallel sessions

This document contains the long abstracts from contributors arranged in alphabetical order by last name of author (or first author). This has more details than the short abstracts which may help delegates in their choices of sessions and provide more information post conference.

Contents

Tanya Aas and Susan Easton

Managing Money: using an app to help adults develop financial literacy

Financial literacy, or how to manage money, is a subject most adults find interesting, even if they do not find math or numeracy interesting. Managing Money is an EU-project focusing on financial literacy and adults. The project started up in 2015 with the aim to develop an app that users can use whenever and wherever to get a better understanding in managing their own money.

There were eight partners from seven different countries participating: ESPC Europe (Germany), Skills Norway (Norway), CVO Antwerpen (Belgium), Roc-Brabant (the Netherlands), Ljudska Univerza Velenje (Slovenia), SVEB (Switzerland) and Learning and Work Institute (UK). Modern English (UK) is the creator of the app, based on their earlier work: the app ""Math Everywhere"".

The initial focus of the project was to do a needs analysis report focusing on financial literacy and adults. Each partner focused on its own country, firstly looking at existing resources and financial literacy in the school systems as well interviewing different stakeholders to identify needs. The different partner countries show large differences in how financial literacy is already included in the schools. In the process, resources focusing on children were looked at to see if there could be made any adaptions to make them useful for adults. This is all included in the needs analysis report.

Next came the development of the curriculum. This was partially based on the ""Competence goals for numeracy"" and ""the Basic skills profile for financial literacy"" developed by Skills Norway. Included in the curriculum are skills, learning outcomes, actions/tasks and examples of what the actions/tasks may entail. There are four areas covered in the curriculum; budgeting, banking, loans & credit cards and shopping.

Based on the curriculum and needs analysis, the development of the app became an avatar game. The app consists of four different avatars with different age groups, backgrounds and goals they want to achieve. The user of the app has to make various decisions on behalf of the avatar to help them achieve their goals. Through the game, you can either save money and achieve the goal or spend too much money causing the avatar to fail to reach their goal. Once you have completed an avatar, you can either try again for a better result, or switch avatar.

Alongside the app, the project also will provide learners and teachers with a learning guide, a resource for the teachers and a guide to the app. The resource for teachers consists of the curriculum as well as different classroom activities suited for adults. The classroom activities and the app can be used together or by themselves. The app is geared toward a wider audience, anyone can access it and use it whenever, wherever.

Participants in the Netherlands and Slovenia have piloted the different activities and resources while the different partner countries, including a multiplying event in Belgium, with practitioners tried out the app.

Most, if not all the material will be translated into Slovenian, German, Dutch and Norwegian.

The 40-minute session is split in two. The first 15 minutes will present the project itself with a summary of the needs analysis report, curriculum and examples from the teacher resources. The last 25 minutes will be spent on launching the app to the public, demonstrating the content and how to use it, as well as giving the participants the opportunity to download the app.

Charlotte Arkenback-Sundstrom

Working as a Salesperson in the Digital Mobile Checkout - is it still to be regarded as unqualified work?

The evolution of digital technology and systems, in combination with increasing numbers of people around the world having access to the Internet and mobile technology, is driving the digitalisation of society and industrial economies. For a long time, mathematics has been considered the foundation for societal development and economic prosperity, and in a global market, citizens' knowledge and skills have become an essential competitive asset. However, technological development has also increasingly made the mathematics of working life invisible, hidden in digital artefacts and systems (Wedege, 2010; Williams & Wake, 2007). Inventions such as the cash register, the computer and the calculator have taken over the work of performing mathematical calculations. The disappearance of manual calculations at work can be one explanation why some occupations are considered low qualified; that is they do not require any specific educational qualifications or previous experience (Newton, Miller, Bates, Page, & Akroyd, 2006). Sales assistant work has long been regarded as a low qualified occupation and this work in progress aims to explore and enlighten how digitalisation has changed and continues to change sales assistants use of mathematics in connection with the point of purchase, POP, at checkout.

The first mechanical cash register, invented in 1878, was a simple adding machine combined with a safety box. When, some years later, it was improved by adding a paper roll to record sales transactions it came to revolutionise the retail industry (Crandall, 1997). From a mathematical perspective, the sales assistants' work with POP was considerably simplified as their main role now was to calculate the exchange and discounts at the checkout. The digitisation of the cash register began in the 1960s when retailers switched to electronic cash registers, while the physical layout of checkouts largely remained the same, still characterised by a cash register placed on checkout counter separating the sales assistant from the customer.

The real digitalisation of the retail sector started in the 1970s when the barcode scanner and the cash register as part of a computer system was introduced (Watson, 2011). In addition to carrying out calculations, the cash register, also called a POS system, had the task of checking that the sales assistants' calculations are correct at checkout. Since the beginning of the 21st century, customers in many grocery stores have taken over the work of sales assistants, by completing the purchase process themselves in self- scanning checkouts. The role of the sales assistants is instead to monitor and control. In other retail sectors, mobile sales assistants (MSAs) have been introduced to be part of the whole purchase process. With MSAs the sales assistants can intertwine the physical store with the virtual e-store.

This work is based on experiences that have evolved over the past four years studying the work of sales assistants and workplace-based learning in adult retail apprenticeships. Issues that have been raised during the process are:

- Is a sales assistant role in a digitised vocational practice still to be regarded as an unqualified work?
- What numeracy may be involved in the digitised checkout?

The empirical material has been produced through ethnographical methods (participating observation, shadowing, interviews) in two rounds, and consists of field notes, photos, film clips, interviews and logbook notes. The first round was completed between 2014 and 2015, in connection with a study of mathematics-containing activities in adult sales assistant apprenticeships (Arkenback-Sundström, 2017). The second round was completed between 2017-2018 through observations of checkout practices, and interviews with sales assistants and store managers working in different retail sectors (clothing, shoes, beauty and opticians).

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Sonja Beeli and Annegret Nydegger

The usefulness of "Maths Histories" as a holistic assessment tool

Adult learners of numeracy and mathematics comprise a very heterogeneous group (see for example Barton 2009): they may be studying for a mathematical degree at an institution of higher education, profit from specific mathematics learning support in diverse educational contexts or attend a numeracy course – to name but a few formal learning contexts. A key issue in any educational context, particularly when adults decide to enrol in classes again after being absent from the educational system for longer periods of time, is diagnostic assessment, as this is often used to inform the planning of and placement in classes (Cumming & Gall 2000). When it comes to adults with low educational achieve-ments, this issue is even more pertinent, since many of these people have had negative educational experiences and are averse to formal tests such as standardised paper and pencil tests (Evans 2000).

In order to overcome this challenge and offer an informal, yet systematic approach to talking about people's mathematical knowledge and experiences we aim at further developing a tool called "Maths Histories" (Archer & Newman 2003). This concept is based on the idea that individuals draw their personal maths history as a line graph along a time axis, using the second axis to indicate their knowledge and/or (non-) enjoyment of mathematics. These individual drawings can then be used to not only talk about a person's specific mathematical knowledge, and thereby also identify existing gaps, but to also to address his/her feelings about mathematics and how they impact learning. The tool should therefore address mathematics in a holistic manner and provide an assessment as encompassing as possible.

In our practical work we focus on low achieving young adults (16-25 years old), as their mathematical knowledge is crucial for their future training and employment at this point in life. In a first step of our development process we will test "Maths Histories" with both young adults with low mathematics achievements and their teachers. In these pilot interviews the participants will draw their personal maths histories, answer questions about their drawings and reflect upon the potential usefulness of the tool in view of the identified target group. In a second step it is planned develop a number of questions with which to systematically steer the talk after the drawing of the personal histories. Finally the tool will be tested with a larger audience. The pilot interviews will be conducted in May 2018 in Switzerland and we plan to present results from these interviews, including identified questions and discuss the way forward in the further development of the tool.

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Diana Coben and Judy Bowen

Numeracy in action: Combining task models of medical devices with numeracy skills and technical competence

In this paper we propose that by more closely aligning interdisciplinary work in the areas of numeracy education for medication dosage calculations and the delivery of medication using medical devices we may help address the incident-rate in incorrect medication calculations and delivery, given that such devices commonly require the user to engage with numerical information via a digital interface. We demonstrate the use of task models as a way of supporting safe, effective and efficient delivery of medication to the patient, taking as our example the use of infusion and syringe pumps in Nursing.

This paper builds on our interdisciplinary research in numeracy for Nursing, especially medication dosage calculation problem-solving (Coben & Weeks, 2014) and in the use of safety-critical medical devices (Bowen et al, 2014). In particular, we draw on the model of competence in medication dosage calculation problem-solving presented in Coben and Weeks (2014, p. 262) which brings together calculation competence, conceptual competence and technical measurement competence. We propose that task models may offer a way of elucidating how competent users interact with digital information while delivering medication via a medical device and also help to support the development of competence in novices.

Task models are used in interactive system design in a variety of ways: to help elicit user requirements; to model user goals; to analyse cognitive and action loads of achieving goals, etc.. Task models have evolved from their origins in psychology, where they were used initially to decompose tasks into hierarchically structured subtasks of observable behaviours. They can also, therefore, be seen as a fundamental way of linking interactive system design with user behaviours and activities. Accordingly, not only are task models ideal for modelling and understanding user tasks independently from computational systems, but they can be linked to such tasks via a common semantics and hierarchical structure. We believe task models may shed light on 'numeracy in action' in the safety-critical context of Nursing and help adults to navigate boundaries and cross bridges in pursuit of competent, safe and effective practice.

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Rachel Cook

Teaching the 'unreachable': 16-19 maths resit students

What do you do when your students do not have the confidence to attempt a question? When they aren't remembering basic facts and procedures? When they do not know their times tables nor understand negative numbers? How do you reinforce learning and the value of education when parents are absent? What do you do when young people have to be forced to sit an exam you know they will fail again? Are we responsible for making them more unreachable?

Last year (2017) approximately 156,000 young people in the UK did not achieve the expected grade for maths in the national exams taken at 16 (GCSEs), an increase of 1.6% from 2016 (Joint Council for Qualifications). Three years down the line these young people will reach age 19 and will no longer be under the current government's 'Condition of Funding' which makes it compulsory for them to continue studying maths alongside any other course they are taking. Currently, achievement rates for these repeating students are poor, with many students repeating the same examination year after year with little or no improvement in their result. Unless there is a change, we may only see 1 in 10 of these young adults achieving the 'gold standard' expected in maths. For many, the negative feelings towards their ability to learn and use maths with which they left school, may be then even more deeply ingrained.

The policy which enforces this exam cycle was initiated after a report on vocational education in the UK by Alison Wolf (2011). The report's findings were largely agreed with as it highlighted that young people were not moving into work with the maths and English skills employers seek. However, the execution of how to develop these skills has been far less popular. As Sir Michael Wilshaw, the previous head of the national inspectorate of education providers in England (OFSTED), puts it, "While the policy's intention to improve literacy and numeracy levels is well intentioned, the implementation of the policy is not having the desired impact in practice." (TES, 2016)

This session will be based on lessons I have learnt from managing the maths department of a London College where maths qualifications on entry for 16-19 year olds are in the bottom 2% of the country (MiDES, 2017). To tackle poor progression and achievement in maths we have used an evidence based approach to make judgements on the impact of changes to curriculum design and methodologies over time. To form these judgements, we have looked at outcomes in summative exams, regular formative exams and progress in specific topics. Further to this, we look at the impact on attendance, engagement in class and additional workshops, tracking the use of digital platforms and feedback from student forums.

Within this teaching the 'unreachable' session we will explore who these students are and what issues they present, from poor literacy to social, emotional and mental health needs. We will see how these issues manifest in the classroom and the knock on effect on provision, teaching and other students. We will use a framework to help explore what we can do to change results from an individual, departmental and institutional level. Finally,

there will be space to reflect on why this is so important for young people beyond their understanding of maths.

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Diane Dalby and Andrew Noyes

The challenges of teaching mathematics in English Further Education colleges

The English education system involves a distinct division of academic and vocational pathways at age 16 years, with students who are choosing vocational routes often transferring to Further Education colleges. Under current government policy, any students who have failed to achieve a specified minimum standard in mathematics at this age (grade 4 in the General Certificate of Secondary Education examination) are required to continue studying mathematics and work towards re-sitting the examination. This results in large numbers of young people studying mathematics alongside their vocational qualifications, thereby presenting complex logistical problems for college management, in addition to the challenges of teaching students who often lack confidence or exhibit negative emotional responses to learning mathematics (Dalby, 2014). These students can face difficult cognitive and affective journeys towards the goal of achieving a better grade in mathematics, with multiple factors from inside and outside the classroom affecting their learning experiences (Dalby and Noyes, 2016).

In the Nuffield-funded project, Mathematics in Further Education Colleges (MiFEC), we take a multi-scale view of this complex situation to examine the critically important issue of how to improve the quality of mathematics learning in colleges. A mixed-methods research design (Tashakkori and Teddlie, 2003) is used to investigate the interlinking factors that shape the mathematics learning experiences and trajectories of young people on vocational and technical pathways in England. The research involves four connected strands: a mathematics policy analysis over the last 20 years; the analysis of trends in student participation and success with mathematics from national data sets; case studies of 30 colleges and a survey of the mathematics teacher workforce. By developing a logic model in the theory of change tradition (Funnell and Rogers, 2011), we examine the ways in which mathematics policy is enacted in colleges under the influence of various drivers (Steer et al., 2007) and the effects on students' learning experiences.

In this session, we will focus on discussing some emerging findings from the college case studies. These are concerned with students' perceptions of mathematics teaching and the approaches adopted by teachers in Further Education colleges. Data from student focus group discussions, individual student card-sorting activities and teacher interviews in eight large colleges are analysed, with the use of coding and comparison methods to identify key themes within the qualitative sections.

We identify four dominant themes in teachers' accounts of their approaches to teaching students on re-sit mathematics courses:

1. The need to engage and motivate students who have negative attitudes.
2. The need to help students overcome anxiety and build confidence.
3. The need to develop sound conceptual understanding and fluency with basic mathematical operations.
4. The need to develop good examination techniques.

The importance of pedagogies that address the first three themes is evidenced by both school-based and adult studies (e.g. Buxton, 1981, Burton, 2004). For example, teaching methods that shift the emphasis away from memorizing routines towards the development of deep understanding (Watson and De Geest, 2005) may help repair insecure but essential foundations for these students. An emphasis on the relevance of mathematics can help to engage and motivate disaffected students (Dalby and Noyes, 2016), leading to more effective learning. In general, the classroom approaches that address these themes would seem consistent with a student-centred approach but data from students suggests that lessons are often more teacher centred. In the card-sorting activity for example, statements about mathematics classroom learning, similar to those developed for an earlier study (Swan, 2006), were categorised by students. The results indicate that teacher-centred approaches are dominant and suggest that the balance of teacher-centred to student-centred approaches to mathematics teaching in Further Education colleges has remained largely unchanged since Swan's (2006) study over 12 years ago.

Discrepancies between teachers' stated priorities and students' perceptions of classroom teaching may however be attributed to multiple contextual factors that shape teacher behaviour and an institutionalised resistance to changes in classroom practice. These teachers were clearly subject to tensions between prioritising students' needs in their lesson planning and ensuring conflicting demands were satisfied, such as ensuring the curriculum was adequately 'covered'. Influences arising from current government policy added complexity to teachers' decisions about appropriate approaches and led to constraints on their classroom practice.

In focus group discussions, students identified the merits of different teaching approaches and these were comparable to teachers' views of the most effective ways of engaging disaffected young people into successful learning journeys. These emerging findings suggest therefore that the failure of many students to make progress is not due to a lack of understanding about their needs or appropriate pedagogy, but a resistance to changes in classroom practice due to multiple systemic pressures.

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Hans De Zeeuw

Building bridges by mathematical gaming

In this session, we will present our experiences of working with people from other countries, refugees from wars. In October 2017, a teacher and I started to work with a class of 11 women and 10 men who were refugees from Eritrea, Syria and Afghanistan. We began to help them learn and interact together by playing mathematical digital games, which were in English.

The sessions were held in a computer-based classroom and the groups was divided into three sub-groups. There was one large group consisting of only women and the other two groups contained only men. After two months we were able to ascertain that the groups had considerably progressed in their overall proficiency in standards of Dutch, in mathematics, but also in their respect and tolerance towards all group members. For example, we observed that not everyone succeeded in starting up the digital mathematical game on their computers. The ones who did succeed though, then started to help the others with the start-up procedure. After 15 minutes everyone was busy playing the mathematical game and after 45 minutes of playing a few women entered the top 100 achievers for the game (calculated and recorded by the gaming software). We also noted how the women helped each other, whilst the men were mainly complaining at this point that the game didn't work.

The teacher arranged for the students to play this game every week. After a few weeks all the participants were helping each other to find the mathematical solutions. A few months later the groups were split up so as to create a mix of men and women and soon afterwards all started collaborating. The teacher reported that the game connected people so that the students were both teaching and learning from one another. In addition, I conducted an interview with the participants about their experiences. In this interview, they explained how they had even started to share the game with other people, including their children, showing how they themselves had developed enthusiasm for the activity and saw the benefits that could be gained from using the game more widely.

In this session, we will explain more about the game and the effects it had on the group when used regularly. The use of the game allowed people to learn together, making contact with each other, although they were not used to that in their own country. Even though the women in that group were more eager to learn and grasped their opportunity more readily, it was not long before the men were mixing with the women and gaining similar social skills. The development of social skills such as respect and tolerance will be discussed as well as the improvements in their standards of Dutch and mathematics.

Hans De Zeeuw

Mathematical gaming: a research study of young post-16 students in the Netherlands

The focus of this session is about building bridges between learning, gaming and socialising. I will report on a study carried out with 55 (mixed) young people between the ages 16-20 during a period of two months. Three similar peer-groups were also studied.

At the start of the school year I selected three groups, each group consisting of 18 youngsters, all in the same age group (16-18yrs old). They all had similar experiences of education and were at the same level in secondary education. Each group received three 45 minute mathematics lessons each week. Two groups followed the standard programme, which involved one lesson in a theoretical setting with direct training from the teacher and two lessons of digital training. The other group followed the same programme, but during the lesson in the theoretical setting we played a mathematical card game in the last 10 minutes.

In the digital training programme we created a playing account in the digital game "Cijferstorm" and encouraged them to play this game at the end of a lesson as well. For this digital game there is a top 100 score list and a competition arose in which students were keen to outscore their fellow students. After a while students started to explain to each other in what ways one could score more points and how to come up with solutions to more complicated mathematical problems.

After 8 weeks all the students took their first test on basic mathematics. We expected to see a difference, but were surprised with the results, which showed that the gaming-group had a more than 10% higher score in the mathematics test than the other two groups. This had been achieved in a mere 8 weeks. Three months later, in the second test, the subjects were percentages and ratios. In this test the difference in scores was 10% again. We have now started training the other two groups with a game especially designed for the third test. At the end of June we will be able to compare results.

In this session I will give a demonstration of the games, explaining about the different ways the games can be used. Then I will explain more about the research we did with these peer groups and show the remarkable results achieved by the students. We are now busy with another game and additional peer groups. I will also present the results from these groups and we will be able to discuss these findings.

Laura Di Milla

Dichotomies and paradoxes in the learning space of the present time

By bridging mathematics and numeracy with geopolitics, sciences and humanities, this workshop aims at trail-blazing new avenues to widen the adult learner's views on the contemporary world and to provide inputs toward renewed classroom discussions. The selection of topics and resources strives to construct a new lens to look through for a shared future, with a session that may lead the participants to reinterpret the present time in order to learn from its inner juxtapositions.

The workshop is organised into three sections, which include activities and tasks purposefully designed to further enrichment. Therefore, there will be time for feeding back and commenting on inputs, discussing outcomes and suggesting follow-up ideas to widen participation and enhance the potential to empower the adult through lifelong education.

Inspired mainly by the works of M. Yunus, J. Stieglitz and H. Rosling on social business, inequality and population growth in the globalised world, the first section of this workshop will involve participants in a teamwork aimed at comparing different ways in which poverty is or may be tackled, and how people could be actually driven out of it. By evaluating the effectiveness of possible solutions and their potential impact on individuals and communities in the long term, this task may reveal inherent difficulties, contradictions and hidden frictions in the contemporary world, but also unveil opportunities worth exploring, experiments worth trying or ideas worth formulating.

The underlying principle of this argument is that of capitalism as an economic theory left incomplete and only partially realised, fettered by a monetary view of success and failures and essentially constrained to serve solely the goal of financial imperialism; this, at the expense of the very multi-dimensional nature of the human being.

Participants may ultimately discover whether in the free-market economies there is a space for different solutions to be nurtured, propelled, developed and credited, and whether there are ways to understand in greater depth and resolve the problem of poverty across the planet.

The second activity focuses on technological advancement in terms of information technology and reliability of data. Although some of the risks ingrained in the development of computer science - from privacy breaches to the detriment of social interaction - were predictably announced and early understood by most of us, many aspects of our life and culture have been drawn into the automated spin by an apparently uncontrollable force. To experience what this means in practice and in the everyday reality, participants will be guided into analysing how some of the formulas or 'algorithms' work and can be used to address, transform or mould society.

Furthermore, since the velocity and extension of this advancement have been unprecedented in the modern history of mankind and because of a certain tendency of computerised technology to nest itself, the suggested task also involves an attempt to confront the incumbent problem concerning the actual reliability of data, what this could

mean for our institutions in the near future and whether these changes will destabilise rather than consolidate our structures.

In order to investigate why climate change represents one of the most 'irritating' as well as evident problem of our times, this third section of the workshop is targeted straight at the core of the environmental issue. The aim is to try and disentangle or deconstruct the stages of the save-the-planet policy of the last few decades, looking back at a summary of episodes of which the outcomes link to clear games of strategy, which are based on ensuring the best chances of survival for each player.

On the other hand, saving the planet was probably never said to be an easy task; for this reason one of the suggested activities inevitably explores the notion of sustainability as it has been developed since the 90s. This new mindset and school of thought can still reveal an amusing amount of 'chained' answers to apparently easy questions.

The final part of this session intends to help the participants reflect on the element of water, as one of the most contended and crucial political platform in the world nowadays. Overall, this workshop strives to provide opportunities to experiment with a different approach to mathematics, based on a pluralistic, critical and open-minded learning process, which involves both the rational and the affective domains of the learner.

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Javier Díez-Palomar, Gail FitzSimons and Katherine Safford-Ramus

Adults Learning Mathematics - An International Journal: Future Directions, Your Voice & Your Participation

ALMIJ is the only academic journal specific to our field. This presentation will be in two parts. In the first part, we will briefly outline the benefits to authors of having their work published here; also plans for a new structure. Feedback will be sought from participants to ensure continuing relevance.

In the second part, we will focus on the preparation of manuscripts for publication in this journal: the writing process. We will outline the process once a submission has been received, and the various forms a research article might take in order to meet the standards of a peer reviewed journal.

Jeff Evans

'Seeing the World as it really Is' (in at least 5 dimensions): the work of Hans Rosling

In Evans (2018), I discuss a 'crisis in statistics', which seems to threaten public discussion and policy-making (e.g. Davies, 2017). The challenge is to respond to such analyses, not with depression or avoidance, but to find more positive ways to enhance the development of numeracy through the learning of statistics, in a wide range of situations. Here I aim to focus on an approach that is both appealing in pedagogic terms, and is rooted in an exceedingly positive worldview. This is the work of the late Hans Rosling and his associates in the gapminder project (Rosling, 2018).

Teachers of adults' mathematics / numeracy have several strategies available for teaching data presentation and analysis. Among these is one aiming to support students in conducting small-scale surveys in the classroom, and in considering how to analyse the resulting data. Another is to use the increasing wealth of data made available without cost by government or other agencies nowadays (see Open Data Institute website): in the rapidly-expanding 'information age', often in a convenient form to generate discussion.

Hans Rosling and associates have made available a range of statistics on countries of the world, in the form of dynamic interactive graphics. These have been presented in an accessible form that allows interesting and informative comparisons, and allows teachers and learners to challenge (often mistaken) preconceptions about the world.

In this introductory session, I will outline several of the ten misleading 'instincts' that Rosling et al consider to interfere with a clear understanding of the world 'as it really is', in particular, the Gap Instinct (which leads us to think that the world is naturally and permanently divided into 'Developed' and 'Developing' countries); the Negativity Instinct (which these researchers argue flows from the way that the brain works); and the Destiny Instinct (which others argue flows from the supposed innate characteristics of national groups).

In the session I will briefly demonstrate examples of these extraordinary statistical tools – and illustrate how they combine comparative and dynamic historical features. Two examples are given below, with full URLs. I will also show how this work enables the development of data-reading skills.

To conclude, I will note why Rosling is at pains to assure us that 'things are better than you think'. This work represents, in my view, an exemplary use of statistics for the support of knowledge development, and for the focussing on insightful and collective ways of seeing our way to humane solutions for some of the world's geo-political problems.

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Illustrative Webpages

Child Mortality vs. Babies per Woman

https://www.gapminder.org/tools/#$state$time$value=1866&delay:188.1419354838712;&entities$filter$;;&marker$axis_x$which=children_per_woman_total_fertility&domainMin:null&domainMax:null&zoomedMin:0.83&zoomedMax:8.87&scaleType=linear&spaceRef:null;&axis_y$which=child_mortality_0_5_year_olds_dying_per_1000_born&domainMin:null&domainMax:null&zoomedMin:1.95&zoomedMax:756.29&scaleType=genericLog&spaceRef:null;&color$which=world_6region;;;&ui$presentation:true&chart$decorations$enabled:false;&trails:false;;&chart-type=bubbles

Life Expectancy vs. Income

https://www.gapminder.org/tools/#$state$time$value=2018&delay:100;&entities$filter$;;&marker$opacitySelectDim:0.17&axis_x$domainMin:null&domainMax:null&zoomedMin:null&zoomedMax:null&scaleType=genericLog&spaceRef:null;&axis_y$domainMin:null&domainMax:null&zoomedMin:null&zoomedMax:null&spaceRef:null;&size$domainMin:null&domainMax:null&spaceRef:null;&color$which=world_6region;;;&ui$presentation:true&chart$decorations$enabled:false;&trails:false;;&chart-type=bubbles

Gail FitzSimons

Developing mathematics and numeracy through thematic teaching: Transcending the boundaries of [official] curricula

In this workshop I will share my experience of curriculum development based on research combined with personal teaching experience. In many English speaking countries, at least, adult and vocational mathematics or numeracy programs tend to rely on contextualised curricula rather than a coherent curriculum. Whereas coherent curricula are underpinned by the structures of mathematics and offer students the foundation for further mathematical learning, formally or informally, contextualised curricula offer a smorgasbord of so-called relevant topics but which are mathematically disconnected, with the result that students are unlikely to develop new mathematical knowledge should the need arise and also less likely to make connections between the parts of mathematics they actually know. In pedagogical (or teaching) practice it is absolutely essential to make contextual links with what students actually know in mathematics (& elsewhere) and to draw on the richness of the individual life experiences they bring with them as adult learners. In other words, teaching involves the recontextualisation of disciplinary mathematics in ways that are relevant, drawing on the experiences of teachers and students alike.

For all learners, including adults, the rapid nature of change in all aspects of the world around us in an era of globalisation (e.g., work, technology, the environment, patterns of migration) mean that they are likely to be living in worlds that cannot even be imagined. This makes it essential to provide a coherent mathematics education, at whatever level, for whatever purpose. When those adults bring with them histories of failure, humiliation, lack of meaning, and a rejection of any [more] forms of testing, it is essential to begin to turn this around and engage them, inviting them to rejoin the mathematical world into which they were born and share with fellow humans.

Given that nobody on the staff in this project— teacher or tutors — had any post-school mathematics qualifications, and the teacher had only the minimal but mandatory pre-tertiary certificate, the materials had to serve a pedagogic role at this level as well. The goals for students were for them to find meaningful employment or, ideally, continue to vocational education studies. As discussed in FitzSimons and Boistrup (2017), mathematics can be regarded as a vertical discourse in contrast to everyday knowledge which is regarded as a horizontal discourse. Both are important, and people need to be able to draw on both at work or elsewhere. In subjects like mathematics, the design of curriculum must pay attention to sequencing in order to avoid missing crucial steps or creating gaps in students' knowledge. Given that these students were likely to already have such gaps, it was crucial that these were addressed in ways that did not exacerbate their already fragile confidence and appreciation of mathematics. Diagnostic testing — no matter how well intentioned — was not feasible. Despite the obvious heterogeneity of the student cohort, the group was enrolled in numeracy at the intermediate level of the three-level certificate vocational course which also included literacy, technology, and various vocational options. Students were also engaged in indigenous cultural studies.

The six numeracy learning outcomes were: Designing, Measuring, Money/Time, Locating, Data Representation, and Number. Each was accompanied by lists of skills to be assessed, through individual activities or across broader activities, with support documents suggesting a range of suitable activities. Close inspection showed that this list, although readily contextualisable, does not immediately indicate a curricular coherence within the outcomes themselves or with the preliminary, foundation level set of numeracy outcomes. My first task was to rearrange them into a more coherent framework and indentify their underlying mathematical structures. I also had to take into account that there was likely to be a range of levels at which the students were working ,and the need to address possible knowledge gaps. First of all I [unofficially] renamed the outcomes with more meaningful headings such as

- Number: Seeing patterns & relations for calculating
- Money & Time: Measuring & calculating man-made realities
- Measuring and calculating physical quantities and qualities in practical situations
- Space & Number: Seeing, creating, and using designs [noting the organic link between design and measuring]
- Collecting, representing, and analysing and interpreting data.

I then identified the assumed knowledge in the listed skill sets for each outcome, along with a list of freely available, relevant online resources. Because I had no personal knowledge of the individual students or tutors, but was aware that the class generally operated in groups of 6-8 students, I designed some workshop materials that enabled students to actively become more familiar with underlying structure of the number system, including significant fractions, decimals, and percentages, along with the metric system in terms of the basic unit of metre and the better known prefixes. This is the kind of knowledge that could easily be taken for granted but any gaps here could ultimately have serious consequences. The concrete artefact students created could be easily carried around, as well as personalised.

In order to develop the major activities of the semester around the formal learning outcomes framework, the teacher and I brainstormed mathematically rich themes that he believed would suitably engage the students based on their interests in sport and personal health and fitness. One highly enjoyable activity centred on the students in each group designing, producing, and serving a healthy meal within given budgetary constraints. Each group's meal was to be evaluated by the other students in a democratic competition, where they also had to develop and reach a consensus on the criteria. The task engaged the students creatively and memorably as they shared their creations on social media, and simultaneously addressed many of the numeracy criteria. Students also found new mathematical questions to answer, well beyond the official list, while immersed in the task physically, cognitively, and affectively.

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Kooske Franken

Presentation by the Dutch prize winners!

This session will showcase the work of the winners of a national competition for teachers that has been held in the Netherlands. During the last school year, this competition was held for third time, with the aim of generating good ideas and good practices from Dutch practitioners for Adults Learning Mathematics. The three prize winners will each present their ideas:

Nori Kreetz, ROC Midden Nederland with "The Shakers"

In this assignment, students from the Business Administration and Junior Assistant Accountant (MBO 4) will start working with financial data to prepare a presentation for crowdfunding for the rapduo ""The Shakers"".

Dirk Megens, ROC Nijmegen with the "Geometry Quest"

The Quest is an activating method to allow students to apply the learning material of measuring and geometry in the school building.

Dimitri Verzijl, Albeda Rotterdam with "Mojo Concerts"

The students (MBO 4) of the College Economics & Entrepreneurship will investigate from a realistic case what is actually required to organize a Beyonce performance at Ahoy as a production manager at Mojo Concerts.

The competition entries were assessed for their degree of originality and whether the idea was:

- concrete and complete
- motivating and inspiring
- convincing and well developed
- feasible and scaleable
- in the profession-specific context.

The session will provide a great opportunity to view and discuss some innovative approaches to use when teaching mathematics to adults.

Kooske Franken and Mirjam Bos

Numeracy in vocational education in Holland: making your maths lessons more attractive

How can you make your maths lessons more attractive with manipulables? Do you want a smile on the face of your students, do you want them to enjoy math?

Numeracy in vocational education in The Netherlands is often taught in a boring and dry way. It is hard for students to relate knowledge to real life situations. Often teachers stick to their traditional methods of teaching numeracy. They generally follow methods that make their teaching dull and dominated by verbal communications. We suggest that the teacher should instead adopt concrete means to encourage more practical work in mathematics and numeracy.

Numeracy plays a vital role in the lives of our vocational students for professional purposes. It is applied broadly in the field of agriculture, accountancy, banking, business, engineering, carpentry, nursing, tailoring and surveying etc. Because numeracy has so many practical applications, it is important to use concrete manipulables for all sorts of activities. This makes teaching numeracy motivating and easier to remember for the students. In this workshop we will demonstrate several specific manipulables which are very easy to collect. You will be inspired to make your own manipulables and find out how to integrate them in your lessons. We will use them perform calculations and help us do other activities.

In this workshop we will refer to the ""iceberg model,"" developed by the Freudenthal Institute (2003). This model has been used to support teacher identification of informal and preformal representations that build students' understanding of formal mathematics (Webb et al., 2008). Using the principle that much of an iceberg is hidden but is essential for the iceberg to float, teachers identify and develop foundations that are essential to student learning. Webb et al. (2008) also suggest wider uses of this model to support professional development, collaborative instructional planning, and identification of appropriate interventions. The importance of the model underpins our workshop and we will show you how this can lead to lessons that are attractive to students in vocational education.

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Elisabeth Gerger

Bridging between traditional and new numeracy practices: A report of a numeracy pilot project for women in Senegal

Following research into traditional numeracy practices of a people group in the south of Senegal, I developed a numeracy programme for women as part of a literacy programme in local languages. Together with three of our local literacy partner organisations, I organised and managed a pilot programme from 2015-2017, in three Senegalese languages. After two years of learning to read and write, 110 women in six classes (2 per language) learned basic numeracy skills in the third and fourth year.

Numeracy practices of societies depend on the context and are developed in response to the needs of the society and its members. The numeracy pilot programme was developed with the basic assumption that all cultures have the necessary tools, linguistically as well as cognitively, to meet their members' needs. Therefore the numeracy programme builds on strengths, for example traditional numeracy practices, cohesion and collaboration between women, and the women's ability to speak, read and write in their language. At the same time, the programme was designed to bridge to new numeracy practices. The women who attended the classes live in a context where traditional practices are confronted with strong influences from the outside. Whilst the traditional systems are still valuable in many situations, economic and other changes in society require new numeracy skills. Examples include traditional or international measurements, the choice of language, with French as the official language and the language of instruction versus local languages that are used in most other domains, or the use of money and its denominator in French versus the denominators of money in local languages. Money plays an ever-increasing role in traditionally non-monetary societies, for example with the increasing offer of goods and services like electricity or schools.

It took us several years to prepare the numeracy programme. Preparations included the development of mathematical terminology in each of the three languages and the development of a curriculum and a French teacher guide that was translated into the three languages.

The curriculum includes topics like reinforcing counting skills in local languages as well as mental calculation skills, the four basic written operations, using a calculator, estimation in the context of money, and measurements of length, weight and capacity. The women learned how to manage their family finances and their small business finances more efficiently. For example, they learned how to write a budget, how to keep a cashbook with receipts and expenditures, and how to calculate profit. With exercises taken as much from daily life as possible, the women analysed problems and applied their skills and knowledge to various situations. Reasoning aloud to explain one's strategy, work in pairs and group discussions were encouraged in order to foster problem-solving skills. Some lessons served to raise awareness of various issues, and creativity was part of the programme as well.

I will present the numeracy programme and some quantitative and qualitative results. The qualitative results are mainly testimonies of some of the women who attended the classes.

Then I will discuss the value of working with traditional practices before bridging to new numeracy practices. I will describe some of the challenges the women faced in mastering the new numeracy practices, and some ongoing challenges as they try to put into practice what they have learned. Finally, I will present a brief discussion whether the new practices should replace the traditional ones, or whether there is a place for both.

Norma Honey

Teaching maths for 'mastery' in post-16 education

In this session, we will consider the application of ‘Teaching Maths for Mastery’ in English post 16 education, especially for students resitting the GCSE examination normally taken at age 16 years. The Education and Training Foundation has supported two small projects to take elements of the ‘Teaching Maths for Mastery’ approaches, led by the National Centre for Excellence in the Teaching of Mathematics (NCETM) in the primary and secondary sectors, and consider their application to teaching the GCSE resit. Evidence from the NCETM work suggests that there is merit in the approach and the ETF projects have set out to investigate how and where they might be applied in Further Education in England, particularly with GCSE resit courses.

The first ETF project commissioned the development of a suite of resources which were reviewed by a group of teachers and trialled in a few classes. The outcomes from this project were positive and teachers were very interested in learning more. The second project was larger and recruited 3 providers who worked with teachers to trial the resources further and develop more resources. This project is ongoing, but early reports suggest that a difference has been observed in learners.

In this session we will look at the projects in more detail and some of the early feedback to discuss where/how teachers can be supported in their teaching and learners can be supported to achieve by introducing a Teaching for Mastery approach. With the recruitment of Centres for Excellence for mathematics in English Further Education, and an emphasis on innovative and engaging methods of teaching being part of the brief, ‘Teaching Maths for Mastery’ could be an important starting point.

Kees Hoogland, Javier Díez-Palomar and Madeleine Vliegenthart

Towards a Common European Numeracy Framework for Adults

We are well into the 21st century now and the urgency for life-long learning is growing especially regarding numeracy. There are major societal and policy pressures on education to prepare citizens for a complex and technologized society, in literature most of the time referred to as “21st century skills” (Voogt & Pareja Roblin, 2012)“global competences” (OECD, 2016a) or “the 4th industrial revolution” (Schwab, 2016). International research has demonstrated the economic and social value of literacy and numeracy knowledge and skills (Hanushek and Wö□mann, 2012; Grotlüschen, et al. 2016).

With respect to numeracy (and/or mathematics) education, we will discuss in the workshop the implications of these pressures to the mathematical demands at individuals living and working in modern life, and what is expected from numeracy education as society moves further into the 21st century. New means of communication and types of services have changed the way individuals interact with governments, institutions, services and each other, and social and economic transformations have in turn, changed the nature of the demand for skills as well.

Too many European citizens lack the necessary numeracy competencies to participate autonomously and effectively in our technologized and number-drenched society and consequently many citizens are overlooked for certain jobs and have problems in their daily life, dealing with the abundance of number-related issues.

The results of the last PIAAC survey (OECD, 2012, 2013, 2016b; PIAAC Numeracy Expert Group, 2009) show that a quarter of the participating countries in PIAAC have results below level 2 of the 6-point scale. These results on numeracy give rise to serious cause for concern for the future economic development of Europe. This is an even more pressing issue since the amount of numerical data that needs to be interpreted and used is rapidly rising due to technological developments and the prevalence of (big) data.

On average, school leavers between the age of 16 and 24, perform at a lower level than people between the ages of 25 and 44 (OECD, 2016). The lack of numeracy skills among these people increases the risk of unemployment and may influence family life and social inclusion. In particular, low-skilled workers are at risk in the labour market, particularly when faced with technological developments in the labour market. The Council of the European Union emphasises that adult learning is a means for upskilling or reskilling those affected by unemployment, restructuring and career transition, while simultaneously it makes an important contribution towards social inclusion, active citizenship and personal development. The European Council recommends the enhancement of basic skills including literacy, numeracy, problem solving and digital skills as part of the Europe 2020 Strategy. In the frame of lifelong learning, therefore, adult numeracy education has an important role in the development of good programs for basic skills for the future.

Evidence informed adult numeracy education may be the key for attaining the goals set out in the Europe 2020 strategy. According to previous studies, high levels of literacy and numeracy skills positively impact on social outcomes, including social trust, participation,

political efficacy and health (Reder, 2017). In most European countries, adult numeracy education is a locally based endeavour with a plethora of practices, some efficient, some less so. Furthermore, there are a variety of underlying assumptions on what constitutes good adult numeracy education. The availability of a good collection of (piloted) professional development modules, based on a Common European Numeracy Framework (which contains relevant content and insights in adults learning numeracy and mathematics), might contribute to a quality adult numeracy education across Europe, and thereby contribute to policies and activities which address the low-numeracy levels in many European countries. Effective numeracy education in European countries, based on a common framework, may lead to a higher level of societal participation and inclusion of adults, and thereby to improvement of the European economy.

This workshop is related to a possible future Erasmus+ project in 2019-2021 which focus on the design of such a framework, based on some empirical data from pilots of teacher education courses to teachers and volunteers in adult numeracy education.

The following institutes are involved in the planning for this project: HU University of Applied Sciences Utrecht in The Netherlands, Berufsforderungsinstitut Oberösterreich (BFI-OÖE) in Austria, University of Barcelona in Spain, and University of Limerick in Ireland.

In the workshop, after an introduction, we will ask the participants to work with us in order to co-create the possible core ingredients of a Common European Numeracy Framework for Adults. We will be looking further than only content descriptions and will also focus on numerate behavior, knowledge, skills, competencies, attitudes and dispositions.

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Kees Hoogland, Terry Maguire and Javier Diez-Palomar

Towards the 2nd cycle of PIAAC

One of the core elements of the Programme for the International Assessment of Adult Competencies (PIAAC) is a survey of adult skills. The survey measures adults' proficiency in literacy, numeracy, and problem solving in technology-rich environments - and furthermore gathers data on how adults use their skills at home, at work and in the wider community. The second cycle of PIAAC will take place in 2021 and 2022 and preparations have started by the Numeracy Expert Group by reviewing the numeracy framework used in the first cycle and designing items which will be used to measure the numerate capabilities and numerate behavior of adults.

In this endeavour, the expert group is guided by the recommendations, which were formulated in a 2016 Review of the PIAAC Numeracy Assessment Framework (Tout et al., 2017), The final report formulates it as follows: "Being numerate in the 21st century means being able to cope with the aspects of the world as we encounter it, which includes the digital and technological aspects of information and society—society generally already has all kinds of techno-mathematical aspects. Research shows that much 21st century workplace mathematics and numeracy practice interacts with technology. The review found that 21st century digital technologies provide tools and processes that mediate thinking as well as action and are not just devices that can be used to complete manual, hands-on tasks more efficiently. These tools and processes often change the numeracy task itself and so transform practices within adults' lives and within the workplace. The use and application of a range of techno-mathematical literacies underpins much of this. This aspect of 21st century representations and tools was missing from much of the existing PIAAC numeracy framework discussions, and not reflected in the definition and elaborations. This needs to be addressed across many aspects of the numeracy framework and construct."(p.48-49)

In the review a number of specific issues were raised in relation to the PIAAC numeracy framework definition and descriptions. In the first cycle framework by the PIAAC Numeracy Expert Group (2009) numeracy is defined as a competence, but being "numerate" also means to produce numerate behavior, "which is the way a person's numeracy is manifested in the face of situations or contexts which have mathematical elements or carry information of a quantitative nature." (p. 10). More general issues originated from theoretical developments, developments in 21st century representations and tools, and lessons from PISA and other numeracy models.

These issues were:

- disposition to use mathematics
- the ability to see mathematics in a numeracy situation
- critical reflection
- degree of accuracy.

More specific issues originated from the assessment content and delivery. There were three related aspects recommended for consideration in the development:

- Representations, reading demands, and authenticity-related issues
- Item formats and responses
- A dimension for reviewing assessment possibilities.

One of the conclusions from an exploration in current digital assessments was that more sophisticated assessments utilising advanced technological possibilities are not necessarily aimed at more complex or higher order skills, but in practice contains many or solely items which are simple and quite one-dimensional (see also Burkhardt and Schoenfeld (2018); Hoogland and Tout (2018)).

For PIAAC the focus is more on the multifaceted and multimodal nature of numeracy problem situations encountered in real life. To assess a sophisticated concept of numeracy there is the need for multimodal options to better represent reality, in which the respondents can show their competence (or not). For an assessment of numeracy in PIAAC, the assessment stimuli and items should be, as far as possible, authentic and representative of what adults might meet in their lives. Digital and technological aspects need to be included in the next cycle of PIAAC, alongside the possibilities of 21st century assessments to facilitate more enhanced representations of stimuli.

A strong recommendation from the review was is that the next cycle of PIAAC contains the potential of technology to support a more effective and representative 21st century assessment, for example, through greater use of non-text based media, such as the use of videos or animations, in assessment items. Use of different technology, media and associated supports has the potential to transcend not only some of the challenges with literacy and/or language that may impede some adults' ability to demonstrate their numeracy capability, but also to make the assessment more relevant to the 21st Century.

In the presentation we will inform the participants on the latest developments and discuss with the participants the intricacies in assessing adult numeracy behavior, illustrated by some examples of possible future items.

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Marcus Jorgensen

A framework for successful teaching of mathematics to adult learners: Margin = Power/Load

Howard Y. McClusky, a former Professor of Educational Psychology and Community Adult Education at the University of Michigan, developed the Theory of Margin as a way to think about adult learning and participation in learning activities. He proposed that margin is related to power and load in this way: Margin = Power/Load. As McClusky describes, power includes the resources (abilities, possessions, position, allies, etc.) which a person can command in coping with load. Power can be physical (energy, health), social, mental, economic, and skills. Load refers to the demands made by self and society where internal load includes self-concept, goals, personal expectations, etc. External load includes the tasks of life (e.g., family, career, socio-economic status). "It is this margin that confers autonomy on the individual, gives him an opportunity to exercise a range of options, and enables him to reinvest his psychological capital in growth and development" (McClusky, 1974, p.130).

Main (1979) indicates that a power/load ratio of less than one means the adult could be at a breaking point or near crisis in terms of getting by in life. A ratio equal to one indicates the person is breaking even and hanging in there (but barely). A ratio of greater than one indicates a surplus in which there is a "life space within which to maneuver" (p. 23). In the latter case, the adult student is able to engage in learning. "If a person is able to lay hold of a reserve (Margin) of Power, he is better equipped to meet unforeseen emergencies, is better positioned to take risks, can engage in exploratory, creative activities, is more likely to learn, etc." (McClusky, 1970, p. 82).

I propose that the Theory of Margin has direct and practical application to teaching adults and has particular relevance to teaching mathematics. It helps provide a lens in which to see the adult students more clearly. And learning mathematics seems to come with its own set of emotions (Evans, 2000) and issues (Jameson and Fusco, 2014) that can add to a student's load or decrease power and coping ability of the student. For example, Bibby (2002) discusses the impact of shame on adult learners of mathematics. I have seen many examples in my practice of adults who are embarrassed at learning school maths, maybe even at the same level of their own children. Shame and embarrassment can be seen in the framework as part of an internal load carried by some adult learners. Which leads to the question of what can be done to minimize that load or, ideally, to help increase their power to cope with shame.

In the presentation I plan to: (a) define "adult learner," being careful not to overgeneralize; (b) introduce McClusky's work; (c) show examples from my practice and the literature that connect the framework to adults learning mathematics; and (d) lead a discussion on ways in which practitioners can minimize students' load or increase their power to be successful. The importance of self-awareness of margin, power, and load by practitioners and also students will become apparent.

Day and James (as cited in Hiemstra, 1984) examined how teachers of adults can contribute to instructor-generated load which includes, among other things, instructor's attitudes.

Load was increased when teachers treated the adult learners as inferior, ignored their opinions, or were too impatient or rigid. They suggest that teachers do the following: "(a) acknowledge that the concept of margin exists in your adult; (b) understand that the concerns of your learners do not just center on the content of the course; (c) acknowledge that you as an instructor contribute to load in learners, and that you do so in a number of ways: through your behavior, learning environment, attitude, and the structure/content of your class; and (d) Address the issue of margin during the first class meeting." Other suggestions for practitioners will be shared from actual practice and from the literature (e.g., Bol, et al., 2016).

My interest in this Theory of Margin stems from observing students who, while ultimately unsuccessful, seemed very capable of learning the content. So, why did they fail? My hypothesis is that they had no margin because of their life's load as adults and did not have the resources to cope. During the term of study, life happens to them and they do not have the margin to avoid or clear the hurdles.

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David Kaye and Charlotte Arkenback-Sundstrom

Common sense, mathematical knowledge and adults learning – a workshop discussion

This workshop has evolved out of a synthesis of many strands of research and recent political developments. The initial impetus for looking at this topic was Sophia Rosenfeld's *Common Sense – a political history* (2011) together with some well informed critiques of this publication such as *Paradoxes of Plain Thinking* (Melkonian 2017).

This led to reconsideration of the use of common sense in the context of mathematics education and particularly in the field of adult numeracy and mathematics educational practice. It became apparent that that there was a brief flowering of interest amongst mathematics education researchers in ' common sense' in the period 1990 – 2000, including a conference held in 1995 entitled 'Mathematics Education and Common Sense: the challenge of social change and technological development (ICSIMT .CIEAEM). The work of Coben and Thumpston (1995) on personal maths histories and the work of Coben (1999) making connections between common sense, the work of Gramsci and ethnomathematics were also significant. The workshop leaders added their own experience to this mix; Arkenback-Sundström with a background in mathematics at work and Kaye with a focus on identifying the uses of 'adult numeracy' in mathematics education research.

Rosenfeld draws on a diverse range of authors including the 18th century playwright Henry Fielding and the political activist Thomas Paine, and the 20th century political philosopher Hannah Arendt. Interestingly, Rosenfeld does not give much consideration to Gramsci's use of common sense. These writers use common sense as a philosophical and societal concept and tool to address and interpret major political events of their times. These may seem remote from our concerns in ALM. However it is important to note that our casual use of 'common sense' to help empower our students' own interpretation of mathematics may contain not only positive but also negative attributes. To quote from Rosenfeld's introduction

In the light of these larger historical phenomena, what quickly becomes clear is that nothing about common sense is, or has been, exactly what it seems at first glance. Common sense may (still) conjure up something universal, permanent, unassailable, non-ideological, and rooted in the ordinary experience of everyone, a kind of infallible wisdom of the heartland. That is, of course, how it is used today by politicians, pundits, and advertisers alike, who typically set it in opposition to complexity, expertise, inside knowledge, urbanity, jargon, conflict, partisanship, and debate. But examined historically, it becomes apparent not only that common sense's tenets are culturally and temporally variable in content. What gets counted as common sense is also never really fully consensual even in its time. (Rosenfeld, 2011 pp14/15)

In the workshop we will provide a short introduction to some perspectives of common sense and then look at problems that can occur in everyday and work situations. We will want to work with you in categorising possible solutions as common sense or mathematics (or numeracy?). Sources will also be made available via links.

We will be asking how and when we use 'common sense', how does common sense relate to mathematics education and 'Bildung' and are contradictions introduced when valuing common sense explanations?

In conclusion we should note that both numeracy and common sense have been identified as 'slippery' concepts. Manly, Tout, van Groenestijn, and Clermont (2001 p 79) observed:

Overall, numeracy is a multifaceted and sometimes slippery construct. Our basic premise is that numeracy is the bridge that links mathematical knowledge, whether acquired via formal or informal learning, with functional and information-processing demands encountered in the real world.

And we are told by Rosenfeld (2011 p 7)

And ever since, common sense has also served to underwrite challenges to established forms of legitimate rule, including democracies, in the name of the special kind of intuition belonging to the people. This, then, is meant to be a book about a slippery subject: the long, complex marriage between the populist (and now largely taken for granted) appeal to the people's common sense and the political form we call democracy.

We will welcome everyone's views on these two slippery subjects and hope to consider the boundaries between academic knowledge and commons sense and the bridges that link them.

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Beth Kelly

The Role of Emotions and Confidence in Motivation to Learn Mathematics

While researching adults' motivation to learn mathematics in the workplace organised by their trade unions, I noticed the adult learners used many emotional words and phrases to describe their experiences. Not just negative words, although there were many, but they also described positive emotions related to an increase in their confidence after successfully learning mathematics. The possibility of adults moving from negative to positive feelings about mathematics is important as this develops the adult learners' confidence to learn and use mathematics both inside and outside the classroom. Inside the classroom, increasing their motivation to learn mathematics and outside the classroom, using their mathematics skills to negotiate more confidently with company management on pay or to feel more confident when considering mortgages or other personal financial decisions. The adults use emotional words and phrases to describe a change in feelings, confidence and motivation and wider research (Bandura, 2004; Debellis and Goldin, 2006; Hannula, 2012) led me to develop the expression an Affective Mathematical Journey (AMJ) to describe these changes.

This notion of feelings about mathematics influencing motivation is important when teaching adults or young people returning to learning after experiencing 'failure' as research indicates previous experiences influence people's motivation to learn (Covington, 1984; Hannula, 2012). But rather than assuming these negative feelings are 'fixed' traits (Dweck, 1996) or 'mind-sets' (Boaler, 2016), I agree with Hannula (2012) and Debellis and Goldin (2006) who suggest feelings about mathematics can change, sometimes very rapidly, and so in this research I explore the possibility of changing adults' emotions and their relationship with motivation to learn mathematics. As a practicing teacher trainer, I am looking for the possibilities of developing 'the gift of confidence' (John-Steiner and Mahn, 1996) through particular social experiences, enabling what Illeris (2014) terms 'transformative learning' through mathematics.

My research points to adults describing emotions in relation to motivation in different ways. When adults describe their initial motivation to reengage with learning mathematics they speak about being driven by what McLeod (1994) might term personal needs and goals; in this study related to job security, keeping their 'minds active', developing their mathematics skills, helping the family and gaining wider recognition of their skills through qualifications. But this initial engagement also depended on the social interactions such as 'trust' which potential learners have in their fellow trade union members who encourage them to overcome negative memories and re-engage with mathematics. Indeed Barbalet (1996) asserts trust is one of the three social emotions 'necessary for the social processes of agency, cooperation and organisation' (p. 75), the other two being confidence and loyalty.

When talking about their successful experiences the trade union members speak about their emotions, describing feeling more 'relaxed' about learning with a group of adults who work collaboratively and encourage each other. They also need the learning to find relevance to their lives, what Deci and Ryan (2000) call "social and cultural belonging and Dalby and Noyes (2015) describe as aligning with their values and interests. These findings are supported by research that shows the important role of social influences on motivation and

learning (Vygotsky, 1994; Barbalet, 1996; Lerman, 2000), the social context of the classroom (Op't Eynde and De Corte, 2006 and DeBellis and Goldin, 2006) and the importance of experiencing learning in an 'emotionally safe environment' (Schorr & Goldin, 2008, p. 131). In my research, the support of others to both access and experience a collaborative learning environment is key to trade union members experiencing an Affective Mathematical Journey, where their feelings change influencing their motivation and success when learning mathematics.

This research reinforces the importance that changes in feelings and motivation play in the learning of mathematics and identifies different, less formal teaching approaches, described above, that encourage that change. Practitioners in more traditional education contexts should reflect on the role of emotions when teaching adults, including 16-19-year-old learners, who have had poor previous learning experiences but still find reasons to re-join mathematics classes.

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Aristoula Kontogianni and Konstantinos Tatsis

Proportional reasoning of adult students in a Second Chance School

Introduction – Rationale of the study

Proportional reasoning has been described as the foundation for the understanding of algebra and the transition from informal to formal mathematical thought (Doyle et al., 2016). At the same time, many adults and students fail to reason proportionally (Lamon, 2007). Teaching of fractions is a precursor of the teaching of rational numbers. Whilst there are many studies about children's understanding of fractions and proportional reasoning (e.g. Charalambous & Pitta-Pantazi, 2007), few studies refer to adults either in a community college setting (Baker et al., 2012; Doyle et al., 2016) or with different ages and schoolings (Alatorre & Figueras, 2005). The objective of our study was to examine the ways that adult students use fractions in proportional reasoning problems. Our research questions were:

1. To what extent do students understand the different sub-constructs of fractions?

2. How do students use sub-constructs of fractions in solving problems involving proportions and percentages?

Context and methodology

We designed a task sheet with 13 open-ended tasks and asked 30 adult students in a Second Chance School to complete it in 1.5 hour. These students had been taught fractions and their representations, fraction equivalence, percentages, fraction addition and problems that required proportional reasoning. The mathematical skill levels of these students varied from basic elementary to secondary. Most were women and unemployed or unskilled workers. Then we conducted interviews with three of them in order to have more data about their ways of thinking. The tasks were chosen and categorised according to the fraction sub-constructs' definitions of Charalambous and Pitta-Pantazi (2007) as implemented for adults by Doyle et al. (2016).

Results

We present the preliminary analyses of Tasks 1 (Doyle et al., 2016), 3 and 6 (Charalambous & Pitta-Pantazi, 2007):

Task 1 (ratio): John and Maria are making lemonade. Given the following recipes whose lemonade is going to be sweeter? Justify your answer.

1. John uses 2 spoons of sugar for every 5 glasses of lemonade. Maria uses 1 spoon of sugar for every 7 glasses of lemonade.

2. John uses 2 spoons of sugar for every 5 glasses of lemonade. Maria uses 4 spoons of sugar for every 8 glasses of lemonade.

Task 3 (quotient): Three pizzas are shared equally among four students what fraction of a pizza will each student receive?

Task 6 (part-whole): Does the shaded part of the rectangle correspond to the fraction ? Justify your answer.

In Task 1 most students computed fractions, used the notion of ratio, and then tried to compare them. Some converted the fractions to other equivalent ones with the same denominator and compared them:

I get the largest denominator and I put it in the first fraction and the second denominator in the second fraction. I do it in reverse. And then I multiply 2×7=14 and 5×7=35. I continue the next and compare 14/35 with 5/35. Of course 14/35 is larger, since it has the bigger nominator. The sweeter lemonade is John's.

Others divided the nominator with the denominator or tried to find how many spoons of sugar are used for every glass of lemonade:

It is 2 spoons of sugar in 5 glasses of lemonade and 4 spoons of sugar for every 8 glasses of lemonade so the 8 glasses have 4 tablespoons of sugar and the 5 glasses… Because in the 8 glasses it is about 1 spoon in every 2 glasses while here at 5 comes less than half of a spoon for every 1 glass of lemonade. Isn't it?

In Task 3 many students constructed three rectangles representing the three pizzas and divided them to four pieces.

In Task 6 all students except one answered no. During the interviews they said that they relied on the fact that the three pieces were not equal. Some students drew the correct divided rectangle.

Discussion

Our ongoing study focuses on proportional reasoning during problem solving of adult students. Most students easily solved tasks that required the formulation of a fraction either from a sentence or from a pictorial representation. At the same time, they had difficulty with the tasks that referred to the measure sub-construct. Our results will be enriched by data collected by interviews.

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Franc Lafeber

Building bridges in vocational education

The 2012/13 educational report for the Netherlands showed us that, according to international research, Dutch students are the least motivated. “The Dutch student does not want to learn”, says the educational inspection. They are not interested if they are not being graded for an assignment and if they do, a six (low grade) would be sufficient.

In 2018 Monique Vogelzang from the educational inspection said, in response to a new educational report, that there needs to be more ambition in education. To every teacher, manager, parent she says ""I challenge you to find your own role and look for the opportunities to collaborate with other people"".

In my 18 years of working as a teacher in the secondary vocational education I have seen some ‘unmotivated’ students. They have carried out actions such as drawing on a piece of paper, folding it, tearing it apart or just playing with it. When I recently switched jobs, I realized that this behaviour can be used to create rich meaningful exercises and doesn’t necessarily mean that these students are unmotivated. They just think in a different way.

Cibap Vocational College for the Creative Arts is a leading secondary vocational education college where talented student are challenged to excel as future professionals in the creative industry. Cibap has specialized in training talented craftspeople for more than 60 years. Future professionals meet each other here. They learn to transform their creative ideas into images with an increasing eye for economic and social developments. Creativity, craftsmanship, entrepreneurship, contextual awareness and communication form the core values of all courses. We teach our students to look beyond the limits of boundaries. We offer them possibilities to go abroad. We take them on an international excursion to Rome, Madrid, Kopenhagen and we stimulate our students to do an internship in a foreign country.

In my work as a numeracy teacher at the Cibap in Zwolle (Netherlands) I use the creativity of the student in my lessons. Explaining mathematical figures like a square, triangle and circle are actions every numeracy or mathematic teacher will perform. I thought it would be interesting to let students experience those concepts for themselves but it worked better when I gave the students feedback during their work rather than at the end. In this session I will show the results from my students, but participants will also experience this concept thinking in small groups in an interactive, hands-on creative workshop. As the subtitle of the conference says, Boundaries and Bridges: adults learning mathematics in a fractured world, the goal is to create a bridge but not only a physical one but also a bridge between the people you work with. You will see that the core values from Cibap: creativity, communication and contextual awareness will also be the distictive features to be experienced in this workshop.

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The references for the report are found on the website:
https://www.onderwijsinspectie.nl/documenten/publicaties/2014/04/16/de-staat-van-het-onderwijs-onderwijsverslag-2012-2013

The comments from Monique Vogelzang can be found on the NRC site (NRC is a Dutch newspaper): https://www.nrc.nl/nieuws/2018/04/11/in-onderwijs-mag-meer-ambitie-zijn-a1598957

Judy Larsen

The invisible teacher – engaging students in a 'thinking classroom'

Occasioning student engagement in mathematical thinking can be challenging, particularly within school environments where normative behaviours allow students to avoid thinking (Liljedahl & Allan, 2013a, 2013b). Motivated by the curiosity stemming from failed attempts at evoking problem solving within mathematics classroom contexts, Dr. Peter Liljedahl has spent more than ten years researching and developing practical approaches for promoting a culture of critical thinking and meaningful engagement with course content, which he has come to term as a 'thinking classroom' (Liljedahl, 2016):

A thinking classroom is a classroom that is not only conducive to thinking but also occasions thinking, a space that is inhabited by thinking individuals as well as individuals thinking collectively, learning together and constructing knowledge and understanding through activity and discussion. It is a space wherein the teacher not only fosters thinking but also expects it, both implicitly and explicitly (Liljedahl, 2016, pg. 365).

As more and more teachers implement thinking classroom practices in their classrooms, research is already indicating that these practices help to break down social barriers (Liljedahl, 2014), reduce mathematics anxiety (McGregor, 2018), improve mobility of ideas and students (Pruner, 2016), and help evoke optimal experiences of 'flow' (Chiru, 2017; Liljedahl, 2016, in press). The shifts in classroom norms and the focus on problem solving also provides the potential of having students encounter more of the curriculum in a shorter amount of time than via traditional lectures (Kerkhoff, 2018).

Even when I first started incorporating thinking classroom approaches, initially in combination with elements of a 'flipped' classroom (Larsen, 2013), I found that students who participated in the collaborative environment afforded by thinking classroom practices (i.e., visibly random groups and vertical non-permanent surfaces) evidenced significant improvements in anxiety, self-efficacy, and orientation towards learning within an adult mathematics upgrading setting (Larsen, 2015). As I have progressed in my journey as an adult mathematics educator, I found that the lecture videos I was suggesting students preview prior to classes as part of the 'flipped' classroom approach were unnecessary because students who didn't watch the videos still thrived by participating in the collaborative environment (Larsen, 2018). As I worked to adopt more of the thinking classroom elements, I discovered that my students became meaning makers, and my role as teacher transformed into 'culture builder', where my responsibility has become upholding the value of meaning making in the classroom (Larsen, 2018).

Having had the privilege of working and collaborating with Dr. Liljedahl as my graduate supervisor, attending many of his workshops on thinking classrooms, visiting a variety of school environments where thinking classroom approaches are implemented, and adopting the tools from this framework into my own practice as an adult mathematics educator, I have firsthand experience with the profound shifts in classroom culture, engagement, and mathematical affect that the thinking classroom practices evoke. In this session, I will reveal some of these learnings and provide opportunities for experiencing elements of a thinking

classroom. Implications for adult mathematical learning environments will be discussed. Given that many adult learners are burdened with negative past experiences with mathematics, the opportunities for finding enjoyment in mathematics that a thinking classroom provides has true transformative potential.

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David Miller and Belle Raim

Numeracy Achievement Gaps of Low- and High-Performing Adults: An Analysis Within and Across Countries

Rationale

With the release of results from the Program for the International Assessment of Adult Competencies (PIAAC), country rankings based on average country performance dominated news headlines around the world (Ahlstrom, 2013; Kameda, 2013; Ramesh, 2013). Unfortunately, country rankings and average scores do not provide information about performance along the achievement distribution, in particular, how a country's low- and high-performing adults are doing. Published reports from large-scale international assessments, including PIAAC, have included tables with percentiles of achievement that show, for example, how scores at the 10th and 90th percentiles compare across countries. However, there has been very little research systematically investigating and statistically testing these achievement gaps, and prior research has not examined the relationship between these country-level achievement gaps and income inequality.

Data Source and Methods

Using numeracy data of 16- to 65-year-olds from the 2012/2014 administrations of PIAAC, this study examines average scores and the cut-point scores of each country at the 10th and 25th percentiles (representing the low side of the achievement distribution) and the 75th and 90th percentiles (representing the high side of the achievement distribution). In this set of analyses, the achievement gap between low- and high-performing adults in each country is represented by the difference between the 10th percentile and 90th percentile cut-point scores. This study includes data for the 30 education systems (mostly countries, but also the Flanders region of Belgium, and England and Northern Ireland as representing the United Kingdom) with data available in the PIAAC International Data Explorer (IDE), which is a free online tool for producing tables and doing statistical analyses with the PIAAC data (http://nces.ed.gov/surveys/international/ide/). Using the PIAAC IDE, estimates were produced from cross-tabulations of the data, and t tests were performed to test for differences between estimates. SPSS statistical software was used to compute correlation coefficients.

All of the estimates and comparisons that are discussed in this paper are statistically significant at the $p < .05$ level to ensure that they are larger than what might be expected due to sampling variation. No adjustments were made for multiple comparisons.

Results

Research Question 1: Do countries vary in the numeracy achievement of low- and high-performing adults, especially relative to comparing average performance within countries? There were considerable cross-national differences when examining average numeracy achievement and performance at the 10th, 25th, 75th, and 90th percentiles. For example, Canada and the Republic of Korea had average numeracy scores that were not statistically different from each other, but high-performing adults (as represented by the cutscores at the 75th and 90th percentiles) did better in Canada than in Korea, and low-performing

adults (as represented by the cutscores at the 10th and 25th percentiles) did better in Korea than in Canada. As another example, the United Kingdom (represented by England and Northern Ireland) outperformed Ireland on average and among high-performing adults, but there was no statistical difference in the numeracy scores of the low-performing adults.

Research Question 2: How large are the within-country gaps between low- and high-performing adults and are these achievement gaps in numeracy related to national averages? The size of the achievement gaps in numeracy varied substantially across countries. For example, Japan, the Czech Republic, Estonia, and the Republic of Korea had a more equitable distribution of student performance (score gaps ranging from 110 to 115 points), while Chile, Israel, and Singapore had relatively large performance gaps (154, 158, and 175 points, respectively). In the United States, the gap was on the larger side, at 143 points.

Next, we investigated whether the variation in the size of these within-country achievement gaps is related to the variation in countries' overall average numeracy performance. For example, do countries that have low numeracy scores, on average, also tend to have small achievement gaps between low- and high-performing adults?

We found that countries that scored lower on average (e.g., Chile and Turkey) also tended to have some of the larger achievement gaps, and countries that scored higher on average (e.g., Japan and the Netherlands) also tended to have some of the smaller achievement gaps. When we computed the correlation coefficient between countries' average numeracy scores and the size of their achievement gaps between low- and high-performing adults, we found a negative correlation ($r = -.513$, $p < .01$, $N = 30$). That is, at the country level, smaller achievement gaps tended to be associated with higher average scores.

Research Question 3: Are achievement gaps in numeracy related to national income inequality? Using the Gini coefficient and PIAAC numeracy data, we found a positive correlation between the achievement gaps and income inequality at the country level ($r = .634$, $p < .001$, $N = 29$). That is, larger achievement gaps in numeracy were associated with higher levels of income inequality at the country level.

Conclusions and Significance of Research

There are several conclusions that can be drawn from this study. First, the results showed that examining countries' average achievement fails to provide information on the numeracy skills of countries' low- and high-performing adults. Second, the size of numeracy achievement gaps varied substantially across countries, with some countries having a more equitable distribution of numeracy performance and others having large performance gaps. Third, smaller achievement gaps tended to be associated with higher numeracy scores, which is desirable, especially from an equity perspective.

In thinking about policy implications, we would argue that countries that are committed to fostering equity and opportunity and looking to attain technological and economic competitiveness should be concerned about maximizing the potential of both their low- and high-performing adults in the workforce.

Finally, this study suggests that the effort among industrialized countries to reduce the disparity between low- and high-performing adults in numeracy may also help to reduce income inequality, and vice versa.

Zekiye Morkoyunlu and Alper Cihan Konyalıoğlu

Parents' opinions on "Parent Mathematics Seminars"

In this study, 6th grade students' parents were involved in mathematics seminars, aiming to be helpful for their childrens' mathematics studies. The purpose of this study is to reveal the opinions of these parents about the parent mathematics seminars. The study was carried out in the 2015-2016 spring and 2016-2017 fall semesters. Parent mathematics seminars were carried out for eight weeks. Duration of each seminar was 2 hours. In these seminars, mathematical concepts that the students learned at school were shared with parents. The parents were also informed about how they can support their children at home about mathematical issues. During the first semester studies, parents' written reflections were gathered from the parents in the middle and at the end of the semester. During the second semester of the study, the parents were asked to write a journal about the study and a face-to-face meeting was carried out at the end of the study.

In the study, the questions of "How did the seminars affect parents' support for their children?"" and ""What is the change in the way parents look at mathematics before and after seminars?"" were asked to the parents in order to learn the answers to the question of "What are the parents' opinions about the seminar?".

Regarding the first question, several findings emerged. Parents memorized several formulas about the explained concepts, parents were able to solve problems and share ideas with their children at home, parents began to notice the efficiencies of their children's mathematical knowledge and skills. Parents were able to share the knowledge they have easily, parents were able to explain easier than before, parents have learnt from their mistakes. In addition to these findings, it was also found that the children began to think that mathematics is not a subject to worry about, parents and the children began to be happy during the study of mathematics, the children's self-confidence in mathematics has increased, the children began to communicate when they needed help with mathematics.

Further findings include: the need for help from others such as neighbours has decreased or disappeared because of the parent-child interaction, the children and the parents began to use the same language when studying mathematics, the parents began to believe that they had the sufficient knowledge on mathematics, and how they could help their children on mathematics studies, the parents began to be helpful to their children, they thought that they were able to teach their children as teachers, parents and the children were able to spend more time together at home, parents began to have the courage to support their children when studying mathematics. [These findings could be listed and grouped ini an orderly fashion.]

Similarly, Civil and Planas (2010) also found that the mathematics seminars were helpful to the parents in terms of providing them to have sufficient mathematical knowledge and how they could teach this knowledge to their children. Additionally, Bratton, Quintos and Civil (2004) found that, with the seminars covered by the project, parents were more focused on improving themselves for their children during the seminars than seeing these seminars as typical classroom lessons, and these parents could easily express and share their ideas

about mathematical topics in such an environment. On the other hand, Zalm & Roisin (2010) found that parents demonstrated a willingness and enthusiasm for dealing with children's [learning?] and children's assignments, and a wider understanding and acceptance of the change [what change?] at a deeper level after the seminars.

Regarding the second question, the parents stated that they came to believe that mathematics is not a difficult subject, that mathematics began to be enjoyable for them, and that their understanding get wider because of seeing different solutions to a problem with their children. Parents also stated that learning is possible at any age, that they began to love mathematics, and that they were able to teach what they know about mathematics to their children.

As a result, the parents involved in the study were found to be satisfied with the seminars and the whole study. They stated that they were able to be useful for their children and also for themselves in terms of mathematical knowledge and mathematical necessities.

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Naeem Nisar

How effective questioning and discussion can help to remove misconceptions in the adult mathematics classroom

Through the use of effective questioning techniques, tutors can use multiple wh-questions to elicit hidden techniques and ideas in maths from learners' activities in their daily life. These hidden maths techniques can then be contextualised with the learners' own experience and used to encourage them to discuss common mathematical misconceptions.

In this way, the tutor as a facilitator encourages a learner centered approach through open discussion and the removal of misconceptions in both the GCSE and Functional Skills class room. This approach:

- encourages learners to read problem solving tasks, and discuss in pairs/groups before going on to find solutions
- sets a framework or environment for cross-cultural discussion about the topics to help classroom learners identify errors and to remove misconceptions, focusing on methods, rather than 'answers'.

The teachers can move from traditional teaching to active learning: from 'passive' to 'active' learning. From 'passive' to 'active' learning means adapting strategies, those can inculcate meaningful, positive, pragmatic learning attitude. As mentioned by Swan (2005, p4) "make mathematics teaching more effective by challenging learners to become more active participants. We want them to engage in discussing and explaining their ideas, challenging and teaching one another, creating and solving each other's questions and working collaboratively to share their results. They not only improve in their mathematics; they also become more confident and effective learners". The practitioners can then deliver meaningful teaching: moving from 'transmissions' problems to 'challenging' problem solving creating an active learning environment.

Swan (2005) seems to suggest that traditional teaching is usually based on 'transmission' approaches, which can appear superficially effective when short-term recall is required, but they are less effective for longer-term learning. He further suggests that mathematics is an interconnected body of ideas and reasoning processes, and learning is a collective activity in which learners are challenged and arrive at understanding through discussion.

I will report on his views: challenge learners through effective, probing questions and manage discussion in the classroom that can help learners to make connections between their ideas.

The questioning in numeracy teaching should be based on the following aspects as suggested in the Maths for Life Pathfinder report (Hudson, 2006):

- asking questions: what questions do we need to ask a potential learner to find out his/her motivation?
- checking understanding: how do we make sure a potential learner has understood?

- use of non-verbal communication, in combination with speaking and listening: use of facial expression, eye contact, positioning and movements etc.

I will present a practitioner's view on using effective questioning based on the above points in the classroom, which can cater well for spiky profiles, a 'pragmatic eclecticism' to enhance learning. I will also report on 'group discussion': exploring how students from diverse backgrounds can contribute from their own experience in the classroom including 'my learning journey'.

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Sophie Parker

Using Lego to understand Algebra

Struggling to show students that maths is fun? Not sure how to demonstrate that maths is used in the real world? Maths is used on almost a daily basis by everyone everywhere. In school, this is pretty obvious – we have maths lessons and so of course we use maths! But what happens when students aren't at school? Do they realise maths is fundamental for rollercoasters to stay on course upside, or that your luggage at the airport needs maths to arrive in the right place?

The Operational Research (OR) Society runs workshops to show young people how playing with LEGO (and other great games) can showcase the usefulness of maths and operational research (OR) in the real world. In this workshop session we want you to make a table and chairs out of Lego (but don't worry – we'll provide the Lego for you)! Perhaps you want to make the tables with square blocks and the chairs with rectangle blocks. Or you may want to use all square bricks for the tables but different colours. We will show you how to master algebra, draw graphs and interpret them using different lego bricks.

Questions such as 'What size plane should British Airways buy?' or 'How can the NHS reroute ambulances for faster service?' Or 'Where should Thompson send their summer holiday reps?' can all be answered with operational research (OR). OR practitioners are people trained and experienced in finding effective approaches to real-world problems by using maths and science. OR opens the door for students to enter careers using cutting-edge tools like artificial intelligence, big data, analytics, and machine learning. New OR workers make a difference in the world from day one. Using OR techniques, such as mathematical modelling to analyse complex situations, they help leaders make informed business, government and charity decisions. Employers who recruit for OR analysts are large and varied, spanning across all different industries - think British Airways, Google, The UK Government, EY, Tui, Expedia, DSTL, British Gas, Disney, NHS, Capgemini and RBS.

The OR Society is the professional home of the operational research and analytics community with 3,100 members in 60 countries. Originally founded as the Operational Research Club in 1948, The OR Society promotes the understanding and use of operational research in all areas of life, including industry, business, government, health, and education. The society is a registered charity which offers OR learning, encourages students to engage with STEM subjects, and facilitates pro bono consultancy services. See more at www.theorsociety.com. Follow us @ORinSchools or @TheORSociety.

Maria Ryan, Olivia Fitzmaurice and Patrick Johnson

"Divorce, Evil, and the Regime of Terror" - Personal Characterisations of Mathematics in the Lives of Mature Students

Mature students represent a heterogeneous cohort in undergraduate programmes in higher education. Their challenges can be manifold, and can differ considerably from 'traditional students' who have completed school and progressed straight to higher education. In particular, returning to education after having been out of that environment for a number of years can be intimidating, as can the exposure to different teaching and learning methods compared to what mature students would have encountered at school. Service mathematics is a feature of many undergraduate programmes, and may pose a further challenge for the mature student, who may not have associated mathematics as a likely component of study of their chosen discipline of study. In this regard, the presence of a mathematics module in their programme may come as a surprise to the mature student.

With an overarching focus on investigating the existence of mathematics anxiety among mature students studying service mathematics in Ireland, the research design has comprised a mixed methods approach; phase one was a survey targeting mature students across the University and Institute of Technology sectors; this captured the respondents' scores on the 23-item Mathematics Anxiety Scale U.K. (MAS-UK), as well as some biographical data (N = 107). This phase was followed by semi-structured interviews with twenty mature students who opted in from phase one, and who are studying service mathematics in higher education undergraduate programmes, at both University and Institute of Technology sectors in Ireland.

To get an insight into the participants' feelings about mathematics, and to elicit the stories of mature students' engagement with mathematics throughout their lives, the interview format used an adapted version of McAdams's (1993) Life Story Framework; this framework was deemed fit for purpose as it aims to elicit the stories from different stages of the interviewee's life course – childhood, adolescence, adulthood, future, as well as examining strategies adopted throughout their life to-date, and their overall characterisation of their life experience. This framework aptly paralleled the course of a student's typical engagement with mathematics throughout their lives; consequently, the format of the interviews was guided by this structure. Participants were invited to give accounts of their engagement with mathematics at primary school, and post-primary school, as well as mathematics beyond school – either in the workplace or in further engagement with education –, and the role of mathematics in their decision to return to education, and the part they see mathematics playing in their future. The framework also provided scope in the interview to examine the strategies the participants had taken to engage with mathematics, as well as the characterisation of mathematics in the form of a personal theme for their relationship with mathematics. It is the responses to this last part of the framework that inspired this paper, with the focus on the characterisation of mathematics by the participants, and the stories behind them in order to illuminate the themes.

Katherine Safford-Ramus and Brook Istas

Power in Numbers: Advancing Math for Adult Learners - The First Two Years

The United States Department of Education project, Power in Numbers: Advancing Math for Adult Learners, is working to help adult learners receive the higher-level math skills they need to succeed in the real world. This initiative combines market research with efforts by adult educators to expand the accessibility of adult education technology used to support adult learners in the math classroom.

Market research has included collaboration with a panel of Subject Matter Experts (SMEs) from the fields of technology, mathematics, and pedagogy. Power in Numbers brings all nine thought leaders together for regular convenings to discuss relevant topics within adult edtech including: the types of edtech and supplemental training material that currently exist, how teachers are reporting their use of and need for such materials, criteria for sorting and evaluating edtech, and integration and access issues within adult education. Research findings and insights from past convenings have informed a series of three reports.

- The first report, The Math Gap: Implications for Investing in America's Workforce, makes the case for the use of open educational resources (OER) in the adult education classroom. It delves into the adult education landscape, analyzing the key stakeholders — employers, learners, and educators — and explores how technology solutions can meet their unique needs, with a focus on OER.
- The second report, Multiplying Impact: Five Frameworks for Investment in EdTech for Adult Learners, explores the current adult edtech market, assessing the existing landscape of solutions, and provides a framework for analyzing impactful technology investments in adult education. This report proposes that edtech investors and developers focus on five key areas in which technology can greatly enhance adult education outcomes.
- The third and final report discusses the current market dynamics of adult edtech. We discuss stakeholders in the adult edtech system, analyze problem areas, and identify opportunities to better facilitate the production and integration of high-quality edtech in the adult classroom.

The Power in Numbers team has also collaborated with 37 adult educators from 21 states to increase the quantity and quality of OER available to adult math educators. Across two separate cohorts (user groups), these educators both rigorously evaluated and curated OER to benefit future adult educators, and produced original content to facilitate classroom use of OER.

- User Group 1: In fall of 2017, the first user group rated, reviewed, and categorized more than 70 OER for adult math, addressing the primary issue of curation and searchability of adult appropriate OER. These standards-aligned, free, and accessible resources are now available and searchable for all adult educators.
- User Group 2: In spring of 2018, the second user group created original OER guides, designed to support the integration of OER into adult math classrooms. These

resources, made by educators for educators, open the door for more educators to experiment with and benefit from OER.

In this presentation, Brooke Istas, an adult math educator and participant in User Group 1 and 2, and Dr. Katherine Safford-Ramus, a Power in Numbers Subject Matter Expert and research contributor, will discuss how OER can help serve the unique needs and learning styles of adult learners.

Both will share how the various Power in Numbers initiatives have worked to explore and enhance the capability for OER to improve adult education outcomes. They will discuss:

- The potential for OER in adult education, in math, and beyond.
- Best practices for creating and managing a nationwide community of practice.
- Learnings and key takeaways from exercises in OER curation and dissemination.

Jenny Stacey

First Language Interference: a guide for teachers of mathematics

The delivery of mathematics in English to classes of students whose first language may not be English is present in many countries including the UK, where the language of education is English, but the population may have varying levels of English competency, as it may be a second, or even third, language.

I teach adults in a further education college in the UK, and in the last few years about 25% of my students are English language learners (ELL), half in discrete ESOL (English for Speakers of Other Languages) or Functional Skills Mathematics classes, and half in GCSE (General Certificate in Secondary Education) provision. These qualifications are generally taken by 16-18 year olds, and are used as markers by Higher Education for university entrance, hence the need for adults returning to education to gain the necessary grade for a successful onward journey into, say, teaching or nursing.

The impact of the differences between languages on students' ability to engage with the material in mathematics classes and exams is surprisingly high, and can reduce students' mathematics competencies from between one and eight levels. In this session I will show the way some other languages are structured, how there are differences in word content, and that there are many variations in the sounds that are present, all of which may impact on learners' understanding, and the amount of time it can take to decode or translate before maths problems can be attempted.

There are also some specific issues with the language used in English, as some words have two or more meanings, only one of which is mathematical. Some words may have a different meaning in other languages, which may lead learners to assume a meaning. These words are called 'false friends', and include 'offer' and 'first'. Many symbols used in UK mathematics classes are global, but some are not, and these differences will also be explored, along with variations in methods, such as the one used for division in the rest of Europe and Asia.

I will then show some of the actions and initiatives that are taken in my classes to try and overcome these barriers to learning, and that the initiatives put in place can be valued by all learners, not just those without English as a first language. This is not intended to be a comprehensive guide to all of the differences between English and other languages, but to help raise awareness of the extent and content of those differences. Of course, this is just one barrier to learning that our students may experience.

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Shin Watanabe

Construct a football with Origami - discover the hidden mathematics in a paper football

I will first introduce the practical activity and give some background. Practising to discover hidden mathematics within our familiar surroundings plays an important role in continuous learning and to enjoy and enrich our lives. In this workshop we will see how learners can be helped to experience the joy of solving mathematical problems such as the Four colour theorem and Euler's polyhedral formula, by constructing an origami football with regular triangles.

More polyhedrons can be built using regular triangles, e.g. regular tetrahedrons, regular octahedrons and regular icosahedrons. Furthermore, when leaving gaps between connecting regular triangles one can construct truncated tetrahedrons, truncated octahedrons and truncated icosahedrons. The origami football that the learners will construct in this workshop will be a truncated icosahedron. This is a very practical approach to create polyhedrons which is different from building it from a net of polyhedrons.

Secondly I will discuss the importance of using practical activities in lessons. Mathematical problems are written with the condition that they are solvable - especially practice exercises which are guaranteed to have certain mathematical solutions. By constructing tangible paper polyhedrons, as illustrated by this workshop, learners are able to discover and experience a joy of solving mathematical problems in front of their own eyes. In addition, by using such mathematical activities, which are very much different from practice exercises in textbooks, learners are able to acquire the skills and techniques of lifelong learning.

Then we will consider the realisation of how learning mathematics is relevant and important in real life. To be able to think for themselves and solve mathematical problems it is necessary to have real examples which relate to daily life as general mathematics is usually a series of abstract and hard to approach. It is also crucial for learners to understand that mathematics can be discovered in real life by anyone when using their mathematical eyes. Seeing the real world through mathematical eyes is one of the most important factors for learners to be able to discover mathematics and which leads to the realisation of how important it is to learn mathematics.

Finally we will think about lifelong learning and a process of solving problems. Once learners realise that mathematics is interesting and they gain the desire to share the joy of mathematics, this can then lead to the self-motivation of lifelong learning. For lifelong learners it is crucial to be able to think and solve problems themselves thus it is important for practitioners to provide lessons which would help them understand that the learning happens when they are proactively involved. Moreover, it is necessary for the learners to realise this through their experience in lessons.

If practitioners can facilitate learners to realise through practical and active learning lessons that to any given problems, one would always consider its conditions and under these given conditions, one then try to find the best possible solution "optimum solution" and can act

upon it. This process of thinking and solving problems can be applied not only to mathematical problems but also can be applied to any problems in real world.